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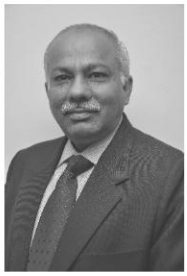
Information Technology *for* Management

Second Edition

About the Author



Ramesh Behl is professor and area chairperson of information systems at International Management Institute, New Delhi. His teaching expertise includes Information Technology based Decision Making, Systems Analysis and Design, e-Business, Information Systems Management, Business Intelligence, Enterprise Systems, Customer Relationship Management and Decision Support Systems. He is also an active researcher in the area of e-business and information systems management. He has designed and developed a number of software for various industry applications.

A United Nations fellow on information systems and international operations and also a SAP certified consultant, he is an international accreditated professor of International Accreditation Organization (IAO), USA. He has over 27 years' of teaching, research and consulting experience. He has worked earlier with Indian Institute of Foreign Trade (IIFT), New Delhi; Indian Institute of Management (IIM), Lucknow; and *The Statesman,* New Delhi.

Professor Behl has been a part of a number of research and consulting assignments for government and private organisations in the areas of information systems and international trade. Author of over fifteen books and a number of research papers, and consultant to a number of international and Indian companies, he has delivered lectures and conducted many workshops in international forums. He was the member of the Core Group on Electronic Commerce set-up by Ministry of Commerce, Government of India. He was awarded "Outstanding Academic Award 2010" by SAP, South East Asia, Japan and "Best Professor Award in Information Technology" as part of Asia's Best B-School Awards presented by CMO Asia in Singapore in July 2011.

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Ramesh Behl

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With Love to my Family Members
for their Continuous Support

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Foreword

I vividly remember my first brush with computers. The year was 1971. At IIT Delhi, we had an ICL 1901. It was a giant machine, housed in over 10,000 sq.ft. with whirling magnetic tapes and chattering card readers. At that time, computers were supposed to solve complex differential equations, analyse massive civil engineering structures, model chemical formulations, work out rocket trajectories and so on. The notion that computers could solve business problems was remote. The giant mainframes were for scientists and engineers to cope with mathematical drudgery. Not for addressing small business issues.

How all that has changed! The power of that giant machine is a fraction of the power that I have in this laptop that I am using for writing this foreword. The quiet hard disk on this machine can store many more bytes than all those tapes could. I have been fortunate to watch this transformation. Word processing, spreadsheets, business presentations, the PC, local area networks, the internet, enterprise wide solutions, client servers, the web, etc. have completely altered the business scenario. One often wonders how businesses could ever be run without the computing power available today. Business applications have taken centre stage and the scientific and engineering applications have been relegated to the background.

What a transformation!

It is in this context that this book ***Information Technology for Management*** has a special significance. It is a book that envelops this transformation and features the rapid developments that have taken place. It talks about the comprehensive role of Information Technology (IT) and the integral role that it is playing in a business at a strategic and an operational level. And a finer author than Prof Ramesh Behl could not have written it.

I first met Ramesh a decade back when Cyber Media decided to set-up the School of Convergence at IMI. He was very enthusiastic about this project, supported it whole-heartedly; and worked towards ensuring success of the School. During the next few years, we struck a great rapport and created a fine journalism school. What impressed me was Ramesh's in-depth knowledge about various aspects of information technology—decision models, systems analysis and design, electronic business, information systems management, business intelligence and decision support systems. He had complete mastery over all these topics. No wonder the United Nations appointed him a Fellow in Information Systems. His 25 years of experience at various

educational institutions, his numerous research papers, consultancy assignments and more than a dozen books implies that the reader is bound to get, not just the theory, but the practical aspects of business.

This becomes unmistakably apparent and the reader will discover a wealth of knowledge in the pages of this book. The coverage is comprehensive across various generations of hardware, software and applications technology. Written in a simple style with very little jargon, this book will help the readers understand the concepts, organise their thoughts and get a realistic picture of the impact of IT on businesses.

I am very happy that Ramesh has used a lot of material from Cyber Media's publications—Dataquest and PCQuest. The content from the magazines has been converted into great case studies. The reader will therefore get the practical side of IT usage in business organisations besides the theory.

The book serves as an excellent text book as the material is organised brilliantly. Each chapter starts with a set of questions thereby laying out the scenario ahead. The concepts are covered in few jargon-free words—no long explanations. And there is a wealth of stuff at the end of each chapter. A management summary, keywords, review questions, questions for discussions, exercises, group projects and caselets will provide the reader with lots to do after the text has been read.

Happy reading!

Pradeep Gupta
Chairman
Cyber Media (India) Ltd
Gurgaon

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Preface

The first edition of *Information Technology for Management* focused on information technology as an *essential* management tool—the second edition focuses more on information technology as an *indispensable* management tool. Across industries, survival and even existence without extensive use of information technology (IT) is inconceivable, and IT plays a critical role in increasing productivity and sustaining the competitive business. Although IT has become more of a commodity, when coupled with complementary changes in organisation and management, it can provide the foundation for new products, services, and ways of conducting business that provide organisations with a strategic advantage.

IT has become a common and indispensable tool for modern businesses. But the basic question is: whether businesses today take real advantage of the possibilities? This edition of the book tries to answer this question by providing a thorough understanding of the role of IT in organisations. This entails understanding the role of process analysis and design that help in adding value to organisational growth by integrating information technology. To accomplish this, both the technological possibilities and management's ability to bring about organisational change is to be taken into account. This helps in redesigning business processes in such a way, so as to make optimal use of the possibilities information technology offers – both within organisations and in dealing with external parties.

The emergence of a global economy, transformation of industrial economies, transformation of the business enterprises, and the emergence of digital firms make information systems an indispensible tool of business. Information system is a foundation of conducting business today. In many businesses, survival and the ability to achieve strategic business goals is difficult without extensive use of IT. In this context, this edition of the book provides up-to-date information on latest technologies like in-memory computing, virtualisation and cloud computing, etc.

The complete book has been restructured and rewritten in an easy-to-understand format and language, based on the feedback received from the valued readers. Based on this feedback, sections II and III of the book have been re-organised to add two more chapters on *Computer Software* and *SPSS: A Statistical Decision Tool*. Two additional learning notes on *Introduction to Word* and *Introduction to Powerpoint* have been added as part of Annexure, which are available on the book's companion website.

WHAT'S NEW

- Completely rewritten chapters focusing on managerial issues, while covering the technical aspects
- Emphasis on emerging technologies and concepts like virtualisation, cloud computing, business intelligence and enterprise solutions, etc.
- Emphasis on networks, internet technologies, e-business and their applications in business
- Over 60 latest "real-world" case-examples, drawn from Indian and international organisations
- Chapter on *Computer Hardware* rewritten to add topics like number systems and boolean algebra
- Chapter on *Computer Software* added to cover more concepts and applications
- Chapter on *SPSS: A Statistical Tool* added to discuss the concepts and applications of decision-making using SPSS
- Easy-to-read and understand writing and presentation styles making the text student-friendly
- Clearly laid out chapter objectives to facilitate better understanding
- Margin notes for all important topics and concepts
- Self-study questions to help improve the learning process
- More practical examples and application problems

TARGET AUDIENCE

The book is targeted at undergraduate and postgraduate level management courses offered in universities and autonomous institutions. It can be used for an introductory course on computers. The book is equally useful for courses on Introduction to Information Technology, Computer Applications, Information Systems, Management Information Systems, Business Decision Models, etc.

Being richly supplemented with Indian examples and cases, it can also be used by the professionals as a reference material.

PEDAGOGICAL FEATURES

A number of pedagogical features have been used in the book for the benefit of teachers and students.

Sectional Case Each section begins with a case on a technological issue. These cases have been selected to cover the theme of the section that is being discussed in the subsequent chapters. Each of these cases raises certain problems with respect to the learning objectives, for the students to debate on and find solutions.

Chapter Objectives Chapter objectives given at the beginning of the chapter would help the students to quickly understand the important concepts and applications that are discussed.

Introduction Each chapter begins with an introduction, which would help in understanding the depth of technological issues that are covered in that particular chapter.

Margin Notes All important concepts and definitions are explained using margin notes.

Summary Each chapter ends with summary of important concepts that are being covered in the chapter.

Self Study, Review and Discussion Questions Each chapter has a number of self-study questions, review questions and discussion questions. Self-study questions would help the students to evaluate themselves. Review questions would allow them to review the concepts that have been covered in the chapter. Discussion questions are more thought-provoking ones, based on the concepts and applications covered in the chapter.

Real World Cases The book provides a complete range of real-world cases. Each chapter has a minimum of four case studies–two as part of the main text and two at the end of the chapter. These cases would help students to understand the concept behind the technological issues that are covered in the chapter in a better way, and also help in finding the real applications of the technology. End-of-chapter cases highlight some of the problems encountered by organisations while selecting or implementing the technology.

Application Exercises Each chapter focuses on application exercises as well. These exercises can be done individually or in smaller groups. These exercises encourage the student to find resources to solve the application problems.

Group Projects Comprehensive group projects have been given for the students at the end of each chapter. For these projects, students are expected to identify the resources from internet, libraries and organisations; prepare the detailed solution as per the project scope and present the solution to the class. These projects would also help the students in developing team skills and communication skills.

SUPPLEMENTARY MATERIAL

Extensive supplementary material is available on the companion website of the book. It comprises:

- Power Point Presentation
- Test Bank
- Data Sheets
- Application Problems
- Additional Reading Material
- Additional Cases

While most of the resources are available for all the readers, Test Bank and Power Point Presentation are available only for instructors.

ACKNOWLEDGEMENTS

A number of individuals have contributed at various stages of this work. It is always a challenge to quantify the contribution of each individual–some helped in the research work, others in creating the content, helping in critical reviews, while some others contributed through their creative and new thoughts and ideas. Writing a book is a process, where the author keeps learning from the environment and keeps gathering thoughts and ideas from everyone, directly or indirectly related to the project.

Special thanks are due to our Director General Dr. Pritam Singh, who continuously guided and inspired me to complete this book.

I would like to thank Ms. Omana Rajeev, my personal secretary, who put in her efforts in putting the content together–collecting material from the library, organising it and typing; Mr. Anup Sharma, our librarian, who has been very helpful in searching the content and making it available on time; and Mr. Dinesh Sharma, our systems manager, for extending the complete IT support. My colleagues at the institute always extended the necessary support and guidance, as and when I needed. I thank my staff at the institute for all help they extended.

This book would not have been possible in its current form without the expert advice of the reviewers, who have given their valuable feedback on the first edition of the book.

I thank everyone else who directly or indirectly contributed in this endeavour.

I wish to thank the team at Tata McGraw-Hill Education, Ms. Vibha Mahajan, Mr. Tapas K Maji, Mr. Hemant K Jha, Ms. Amrita Marik, Ms. Silvi Dua, Mr. Yogesh Kumar, Mr. Manohar Lal and Mr. Atul Gupta who always maintained the necessary pressure and helped me complete the book. My sincere thanks to the complete team at Tata McGraw-Hill Education for their continuous support and guidance.

I cannot complete this without acknowledging the support of my family members and I am really thankful to each member of my family.

Ramesh Behl

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Preface to the First Edition

Information Technology has become an essential management tool. The speed and flexibility that it provides to business organisations often offers the competitive edge which allows an organisation to survive and flourish. Information technology also offers a similar competitiveness to individuals who are managing the technology and also who are dependant on the technology. The purpose of this book is to create an understanding of how information technology and technology networks work, how they are used for management functions, what they can and cannot do and how the manager or user should use this to gain competitive advantage. The book also covers the application of technology in management and the opportunities it can provide for more effective performance, as well as covers the emerging technologies and addresses the concerns about data integrity, security, and privacy.

The major objective of this book is to provide not only a foundation for understanding information technology in the context of today's business environment, but also to impart those skills necessary for solving a range of information-based problems in this competitive environment. Briefly, the aims of this book are

- To provide students with a basic understanding of the technologies used in managing information and information systems
- To make them understand the skills needed to manage and use information technology in changing technological and organisational settings
- To create an awareness about how to use these technologies for effective and efficient decision making
- To provide basic concepts about the role of information technology in decision making
- To identify strategies, policies, and procedures for effective management of the information system
- To provide exposure to the current and emerging trends in information technology
- To learn to use common technologies to support effective decision process.

The real motivation to write this book is to create a comprehensive text on the subject. There are hardly any comprehensive text books that cover the complete perspective about information technology. Moreover, there was a need for a book that covers the application of technology for

business decision making. It is easy to know about technology, but very difficult to understand its real application. This is the subject which is being taught at all business schools and also in most of the universities in India and abroad.

Earlier, computers and information technology was isolated in specialised data processing departments, but for past several years information technology has played an increasingly important role in all areas of business. In many industries, obtaining competitive advantage became directly related to the deployment of information technology to design, create and provide the main products or services. As a result, it is now essential to have a basic understanding of information technology to ensure the effective use of systems present in the organisations.

Global competitive pressures and continuous innovations are forcing many organisations to rethink the manner in which they do business, and to re-engineer themselves. The role of information technologies has changed from support to the overall operations of the organisation, to contribution to the overall organisational strategy. The widespread dissemination of information technology among businesses and consumers coupled with the increasing use of the internet has created a whole new way of doing business for small and large enterprises. E-business will continue to grow, drawing a larger number of enterprises that will use the technology to handle a wide variety of business tasks.

It is clear that the Internet has transformed business relationships between customers and suppliers as well as changed the competitive dynamics of the marketplaces. The Internet is not just another marketing channel or advertising medium. It does not simply speed up transactions; the changes are much more profound and go far beyond technology. Concepts like Supply Relationship, Customer Relationship, Knowledge Management, EAI, RFID, Business Intelligence etc. are being integrated by a number of organisations. Firms need to rethink their business strategies or adopt new ones.

However, in order to figure out the answers, we need to understand why, where, and when Information Technology is important. The purpose of this book is to provide students with the skills they will need to work with information systems (IS), apply information technology to a wide variety of business problems and understand how to manage the information systems. The content of the book is structured into several inter-related sections:

- Business Organisation and Role of Information Technology
- Technology Infrastructure
- Information Technology for Decision Making
- Inter and Intra-organisational Systems
- Building Intelligent Systems for Business
- Planning, Implementing and Managing Information Systems

UNIQUE FEATURES

The purpose of the book is to provide frameworks, tools, skills and comfort in the understanding and use of IT in business from the point of view of a business manager, an IT manager, an employee and a student. The book will have the following unique features:

- Use of real life cases and illustrations to understand and be able to use frameworks and tools relating to the strategic and operational use of IT in business
- Case studies drawn from Indian and international organisations.
- Over fifty cases incorporated in the book
- Use of many technology based solved and practice examples to instill skills and comfort in decision making around IT projects.
- Updated examples to cover the necessary basic concepts of business management in relation to IT
- Aids to develop an in-depth understanding of the organisational and management processes that underlie IT-induced organisational change.
- Discussion on the ability to respond to the organisational and management of current and emerging technologies. This will be supported by updated references for detailed studies.
- Practical experience in the use of computer based softwares for efficient and effective decision making with the help of commonly used technology tools. A complete section on IT based decision making has been introduced.
- A case on the theme of the section begins each section of the book.
- Learning objectives, illustrations, case studies/caselets, examples, summary, important technology terms, questions, exercises etc. for each chapter.

TARGET AUDIENCE

The book is targeted at undergraduate and post graduate level universities/ institutions courses. One can use the book for courses on Introduction to Information Technology, courses on Information Systems, Management Information Systems, Business Decision Models etc.

The book can also be used for an introductory course on computers at undergraduate and post graduate level. Because of its richness in Indian examples and cases it can also be used by the businesses as reference material.

CHAPTER ORGANISATION

The book is divided into six sections and twelve chapters as per the following broader content:

Section I: Business Organisation and Role of Information Technology. Section One has two chapters – Introduction to Information Technology and Strategic Information Systems. The focus of this section is to give an overview of Information Technology and its strategic importance in the organisation. It also covers the role of technology in organisations and various levels of management. The section also covers the different strategic information models and how the organisation can gain competitive advantage by implementing these systems. New technological trends have also been covered in this section.

Section II: Technology Infrastructure. Section Two has two chapters – Information Technology and Networks & Telecommunication Systems. This section covers the technical issues with respect

to hardware, software and telecommunication infrastructure required for setting information system solutions. It covers the technological topics from inception to latest trends.

Section III: Information Technology for Decision Making. Section Three is about business application. It covers topics on different decision problems and how to solve these problems using common software tools like Excel and Access. This section is again divided into two chapters – Excel based Decision Models and Access based Database Systems. These are the two software tools that are commonly available and most of the decision makers are not aware of how to use them for effective decision making. The section also covers the concept of databases and their importance for managing information systems.

Section IV: Inter and Intra-organisational Systems. Section Four focuses on the role of Internet based business models and also on enterprise wide information systems. This section is divided into two chapters – E-business Models and Integrated Enterprise Systems. The chapter on E-business describes the concept of e-business and the various models being followed and the role of M-commerce in business. The chapter on Integrated Enterprise Systems defines the concept of ERP, CRM and SCM.

Section V: Building Intelligent Systems for Businesses. Section Five focuses on decision theories and IT based decision models. The first chapter in this section is on decision models and different types of IT based decision support systems being used by various organisations. The concept of data warehousing and data mining is also covered. The second chapter in the section is on Knowledge Management and Intelligent systems. It covers the role of artificial intelligence in decision making and building intelligent businesses.

Section VI: Planning, Implementing and Managing Information Systems. Section Six is an important one which covers the concept of information system planning and development. It also covers the role of CIO and how to implement business continuity planning. The section is divided into two chapters – Planning and Implementing Information Systems and Managing Information Systems and Organisational Change.

ACKNOWLEDGEMENTS

A number of individuals contributed at various stages of the manuscript of the book. It is always a challenge to quantify the contribution of each individual. Some help in the research work, some in creating the content, some do the critical review, some do the creative work and some give new thought and new ideas. Writing a book is a process, where the author keep learning from the environment and keeps gathering thoughts and ideas from everyone directly or indirectly related to the project. I thank everyone who has contributed in this endeavour.

Still, I would like to mention few names – Ms. Omana Rajeev, my personal secretary who did lot of work in putting the content together – collecting material from the library, organising the same, and keying in material. Mr. Anup Sharma, our librarian, was very helpful in searching for the content and making it available on time. Mr. Dinesh Sharma, our system manager, extended complete IT support. The Director and Faculty colleagues at the Institute always extended the necessary support as and when I needed. The staff at the institute also extended all the help.

The editorial team at McGraw-Hill Education, Mr. V. Biju Kumar, Mr. Tapas Maji, Mr. Hemant K Jha, Ms. Shalini Negi, Ms. Anubha Srivastava, Mr. Manohar Lal, Ms. Deepa and Mr. Atul Gupta, who always maintained the necessary pressure and forced me complete the book. My sincere thanks to the complete team at McGraw-Hill for their continuous support and guidance.

I cannot complete this without acknowledging the support that my family members have extended. I am really thankful to each member of my family.

Ramesh Behl

A List of Technologies/ Concepts Discussed in the Book

A number of leading technologies/concepts have been discussed in the book. For the managers of today, it is important that they know about the technologies that exist in the market and their applications in business. These include:

- Analytical CRM
- Artificial Intelligence
- Artificial Neural Networks
- Boolean Algebra
- Bus
- Business Continuity Planning (BCP)
- Business Impact Analysis
- Business Intelligence (BI)
- Business Process Re-engineering (BPR)
- Capability Maturity Model (CMM)
- Cloud Computing
- Cognitive Science
- Control Objectives for Information and Related Technology (COBIT)
- Critical Success Factors
- Cryptography
- Customer Relationship Management (CRM)
- Data Mining
- Data Warehouse
- Decision Support Systems (DSS)
- Digital Economy
- Digital Signature
- Disaster Recovery Planning
- E-Business
- Enterprise Resource Planning (ERP)
- Enterprise Wide Information Portal
- E-Procurement
- ETL
- Expert Systems
- Fuzzy Logic
- Genetic Algorithms
- Grid Computing
- Information and Communication Technology (ICT)
- Information Intensity Matrix
- Information Technology Infrastructure Library (ITIL)
- Infrastructure As A Service (IaaS)
- Infrastructure Management
- In-Memory Computing
- Intelligent Business
- IT Governance
- IT Infrastructure Management
- IT Maturity Model
- IT Service Continuity Management
- Knowledge Economy

- Knowledge Management (KM)
- Management Support System (MSS)
- M-commerce
- Multidimensional analysis
- Object Modeling
- OLAP
- Platform As A Service (PaaS)
- Pod casting
- Rapid Application Development (RAD)
- Reverse Auction
- RFID
- Sales Force Automation
- Simulation Softwares
- Software As A Service (SaaS)
- Software Development Life Cycle (SDLC)
- SPSS
- Storage Area Network (SAN)
- Strategic Information System
- Synchronous Optical Network (SONET)
- Tacit Knowledge
- Virtual Machines
- Virtualisation
- Wi-Fi

Contents

On Website

- *Excel Keyboard Shortcuts*
- *Introduction to Word*
- *Introduction to PowerPoint*

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Section I

Business Organisation and Role of Information Technology

CASE I: IT for Success

Information Technology is everywhere for everyone. Information Technology has been harnessed to transform our business and even personal lives. There are a number of success and failure stories and each story is a learning process that the smart manager uses as a success formula. Whenever new technology is introduced, people generally try to find problems and limitations with it, but some risk-taking managers always adopt it for acquiring more knowledge.

In today's world every business is essentially an information business. The information-based businesses are not new. Even in the industrial age, organisations were being managed by managing information. The tasks that managers perform relating to planning, coordination and decision-making are mainly based on manipulation of information. The repid transition from industrial age towards information age is very significant when more and more businesses are defining their strategies in terms of information or knowledge.

Information management is not only confined to technology start-ups. Organisations in more traditional sectors too are showing the way. For example, the traditional automobile sectors are using more advanced computer engineering tools and techniques to reach out to their customers. But while IT was central to most of the project's success, organisational factors—such as the use of multidisciplinary teams working in parallel, complementary relationships with strong leadership from senior managers—were equally important.

ROLE OF INFORMATION MANAGEMENT

As organisations expand in size and complexity, importance of information management also increases simultaneously. The way information is managed, depends upon the technology available. With the advent of the personal computers and Internet based networking technologies, the focus has shifted to innovation. This will assume fundamental importance as electronic networks proliferate.

The increasing power of information technology has eliminated many of the traditional bottlenecks and asymmetries in information that many businesses were facing. With the passage of time, difference between the richness of information exchanges and the reach of people with whom those exchanges can take place has disappeared. This change happened because of the Internet and mobile technologies becoming the reality. Today, more and more applications are being developed on these mediums. Because of these, large numbers of individuals will be able to obtain, manipulate and evaluate information about any facet of life—from weather report to personal finance. As a result, there will be less incentive for them to accept the conveniently bundled offerings of traditional business, which may have to redefine themselves for survival. In the coming years, such shifts will transform not only traditional relationships with consumers but also corporate supply chains and even organisation hierarchies.

The major challenge to make any technology successful is to make it core to users' applications and working styles. It is easier for the information system to develop a technology-enabled solution but may be very difficult to get it accepted by the end- user. So, it is important for the technology providers to create attractive technology based solutions that would develop addictions among users. The ultimate goal is to promote a bonding by making the technology solution the medium of choice for essential business processes like email, the Internet and mobile.

The amount of information that is generated and made available to the users has grown exponentially in recent years. The key managers are finding it challenging to manage and use this information effectively. The four most important aspects that need to be considered are: identification of correct information needs, the medium to be used to communicate the information, presentation format of the information to suit the end-user needs, and time and its frequency.

Strategic Uses of IT

Information technology has already started shaping most aspects of organisations' operations and strategies. Yet many CIOs need to justify the Return on Investment for most of their IT projects when it has become an integral part of every business and is

a major enabler. In today's context, IT investment is to be treated as infrastructure necessity, which will deliver benefits. These benefits can be of two types: first it helps in improving the infrastructure efficiency, as earlier information systems were developed and/or assembled in piecemeal over the years are being replaced with integrated systems that are more flexible, have greater reach and less expensive; and second it offers new business opportunities by integrating new IT platforms. These opportunities include improvements in external and internal processes, tapping knowledge from all stakeholders, and the creation of networked communities of customers, suppliers and employees. The ideal IT project—at least to begin with—will streamline a highly leveraged, resource intensive activity, produce measurable results within a year and have a clearly defined scope; but astute managers will also look out for any new business opportunities it opens up.

While some organisations have no significant contracts and some put their entire budgets out to third parties, most organisations adopt a mixed approach to IT outsourcing. There are risks with both extremes—keeping everything in-house can be expensive and inflexible, while going outside can involve unanticipated overhead costs. The organisational cost reduction, efficiency and improved service continue to drive many initiatives, but companies are increasingly seeking ways to gain strategic advantage from outsourcing.

The concept of 'alignment' is a critical one in IT strategy. IT strategy means supporting business strategy, which underlines the fact that business and IT strategists go hand-in-hand to shape new business platforms; IT is not to be looked at independent of business strategy, but is to be integrated with it. The best new business platforms—which essentially determine an organisation's value proposition to customers and its core processes—have three interdependent vectors, a customer focus vector, whereby organisations sense and respond to customer's fast changing needs; an asset configuration vector, whereby companies form close relationships with one another and outsource key processes; and a knowledge leverage vector, whereby companies identify, nurture and create knowledge assets. The role of IT is to create a common foundation for these three vectors. The organisations will create the greatest value if they can incorporate all three into their strategies simultaneously; unfortunately, most companies focus only on individual vectors.

THE PROJECT

Santo Automobiles has been making up market four-wheel drive vehicles for last 100 years. The company has not changed its designs much over the last 100 years. Then, with the change in competition, company decided to launch new models and also upgraded the design of some of its old models. The management also decided to integrate information management solutions into the designing of new projects.

For Santo Automobiles the challenge was to develop a forerunner for the emerging market segment of compact 'utility' vehicles. The marketing brief that was given was to uphold the established values of the company while interpreting them for a younger group of owners with lower budgets. Evidently, considerable technological innovation was required. Responding to the challenge, the project team delivered a desired vehicle within 30 months of project launch while simultaneously achieving excellent performance in parameters, key to profitability and customer acceptance. No doubt, successful information management was integral to each dimension of that achievement.

To enable rapid creation of a high-quality design, the company made an unequivocal commitment to computer-aided engineering. The complete vehicle project was divided into multiple sections, each of which was allocated a team of design and production engineers. To ensure the integrity of the vehicle as a whole, each team had immediate access to the work of its peers using concurrent mock-up assembly system. Each team also had access to an electronic library of blueprinted concepts. When working on a component invisible to the customer, a designer could draw on a blueprint.

All blueprints were available in the central system and the benefits of such use of blueprints are the time saved by 'not reinventing the wheel' and the tapping of right resources. Majority of the product cost is driven by design-time decisions on components. Add to that the standardisation of part numbers helped the company in streamlining the supply chain.

A three-dimensional electronic model of the target assembly building was created, with complete details. Using advanced virtual reality (VR) equipment, planners were able to simulate the experience of operating the processes in real time. Assembly workers, process specialists, suppliers who would be directly feeding the line and health care and safety professionals

were all drawn into the manufacturing design process through the VR model. Once the electronic process was complete, the facility was built, equipped and put into operation in half the time required by previous practice.

Another challenge was to devise a supply chain and production process for the customised offerings. A customer from any part of the world can select and pick up the specifications as per the customised needs from soft or hard top, petrol or diesel, with choice of colour, and interior design. Company creates a customised vehicle in less than three weeks. Owing to perfect IT integration, company was able to change the industry standards by reducing the inventory for customised vehicles from twenty days to two days; customised product delivery from six to eight weeks to three weeks.

All this was possible because of perfect management of supply chain. The company created a powerful electronic link with its suppliers and networked them into its own intranet, by creating a powerful extranet. In an integrated information management system, the company's dealers enter the customer's order online and identify the delivery schedule from the company's production plan, which is also available online. Not so long ago the delivery of this degree of customisation would have added further increments of complexity, inventory and cost to the already high levels of inventory held in case of assembly line outages. This close partnership and sophisticated electronic links with suppliers—many of whom were involved throughout the product design—have been instrumental in delivering a world-class 'lean production' system.

The success story described here is not so unique. What is more important out here is to know the way in which IT—even in mature industry sectors—has enabled radically different ways of working that deliver new standards of performance. Behind the hype, and the skepticism, successes have been achieved. Information technology becomes an integral part of all kinds of businesses for any sector. One should remember that the IT investments alone do not deliver business advantage.The company's ability to complete the project in less than three years was dependent on three things: the use of multidisciplinary teams; the fact that those teams worked in parallel, in an iterative and learning-orientated development process; and the provision of an information infrastructure that integrated all project activity and provided a common language for contributions among all players. While details may vary by business context, those three elements are found in all examples of reducing delivery time to market.

The company's ability to deliver quickly to customer specification without high levels of complexity and cost depends on redesign of the stronger supply chain, as well as the integrated enterprise–wide information network. One may also relate the similar concept adopted by Dell and Sony. This successful information management is an integral part of the implementation of a superior business idea.

The success of any IT project is also dependent on the involvement of the top management. The absence of such top level commitment can be very costly. For example, one of the larger carmakers discovered in the early 1990s that it was actually spending more than twice as much on IT as a key rival, yet that rival strongly outperformed it.

The basic problem is that information technologies are developed without predetermined application purposes; application is defined at the point of use rather than as the power of manufacture. In the current case, an environment was created for the team to use IT that would enable radical change; it had no interest in uses of peripheral to the business focus. Finally, the senior management needs to see IT as an agent of business transformation, and to focus its use on radical improvement of the business activities that matter most.

As technology continues to develop, ideas familiar in one business context become viable in new contexts. The organisations would continue to integrate the technology into their businesses. As a consequence, opportunities would increase and the importance of successful information management simultaneously increases.

Questions to Think About

1. What are the IT success parameters that one can draw from the case?
2. Does the IT integration offer strategic advantage to companies? Justify using case examples.

The McGraw-Hill Companies

Chapter 1

Introduction to Information Technology

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- Why an organisation should invest in IT-based solutions?
- What are information systems and how they are different from Information Technology?
- What level of IT solutions organisations should implement?
- What are the major changes that need to be addressed in terms of organisation and management?
- What are the different levels of activities being performed by various levels of managers and their information solutions needs?
- What are the latest trends in Information Technology?

INTRODUCTION

Information technology has become an integral part of our lifestyle. Whether searching for information or product or may be doing/performing a banking transaction, we all are dependent on technology. With the changing lifestyle of consumers, businesses need to integrate technology into their processes.

It is accepted by everyone that today's business depends on technology. But the reality is that businesses of today have moved ahead of that dependence and are embodied into the technology. In this competitive environment, most businesses change as fast as the technology.

In the initial era of computing, Information Technology (IT) was viewed by most senior executives as 'back office' of accounting and routine transaction processing. Today it has broken out of that image. In most of the executive meetings today, the talk is about the Internet, electronic

commerce, mobile technologies, cloud computing, knowledge knowledge management, IT for business transformation, and IT governance and architecture.

It is evident that in an increasingly competitive global environment, businesses must transform themselves to be more productive, to gather and store customer and competitive information and to capture the 'tacit' knowledge that employees hold in their heads. A number of large software companies like SAP, Oracle and Microsoft, etc. explore the potential of transformation operations, supply chains, and customer relationships. A successful implementation of one of these solutions can provide new or better information to an organisation's decision-makers, and enable global manufacturing and distribution processes. On the other hand, the critical path to business success is not the technology itself, but changing the business process and the work supported by the technology. The substandard implementations can complicate product and service deliveries and prove extremely costly, in at least the short term.

Now, organisations are transforming their entire supply chain. At one end of the supply chain, companies like GE and automobile manufacturers are demanding that all their suppliers interact through the Internet. At the other end, both Internet start-up companies and more established brick-and-mortar organisations are enabling customers around the world to buy from them through the Internet. Increasingly, firms are enabling customers to access their internal systems to determine when orders will be delivered.

Industries themselves are rapidly changing form and business methods due to IT revolution. The banking, entertainment and travel sectors are some of the examples, where major transformations have happened. The new services have been created, such as grocery store delivery, online auctions, and Web development companies. The partnerships and alliances are being forged among former competitors, in technology services or transportation, in order to provide complete solution to large customers.

India has emerged as the fastest-growing IT market in the world. The Indian information technology (IT) industry has played a major role in placing India on the international map. The industry is mainly governed by IT software and facilities for instance System Integration, Software experiments, Custom Application Development and Maintenance (CADM), network services and IT solutions. According to Nasscom's findings Indian IT-BPO industry expanded by 12% during the fiscal year 2009 and attained aggregate returns of US$ 71.6 billion. The IT industry in India will continue to be on the growth trajectory of 16–18 percent during 2011-2012 fiscal even as the industry maintains a cautious outlook due to the economic uncertainty in US and Europe. The role of IT is defined in most organisations as that of a business partner. There is complete awareness at the top about the potential of IT to facilitate the fulfilment of business objectives. Most of the technological investments that are made by businesses today, whether in storage infrastructure, enterprise applications, or shop floor automation, are made keeping the business necessity in the mind. As a result, it is important to align IT to business, as IT implementation without business imperatives attached to them are nothing but wasted efforts. The role of technology is to help streamline business activities, make it more cost-effective, reduce wastages, and optimise resources.

The top five business priorities for which IT is considered are: improving business processes; controlling costs; maintaining customer relationships; improving competitiveness; and regulatory compliance.

Source: Various issues of *Dataquest* and http://business.mapsofindia.com/india-industry/it.html, accessed on November 8, 2011

But at the core of these visible manifestations of the strategic impact of IT in organisations and industries lies the IT infrastructure. The executive attention has come to focus on the investments, outsourcing options, organisation and staffing of infrastructure to drive and support the transformation to digitised business. The issues become the critical concern of the board and top management. Why organisations should invest in IT and to what level?

WHY INFORMATION TECHNOLOGY?

The computers are there almost since Independence in India, but no one considered it to be a necessity for the business. The computers were always treated as the desirable part of business processes for managing high-end data processing activities. Organisations used computers selectively for certain key processes, but never integrated it to their overall business strategies to gain the competitive advantages. But since early 1990s, most of the organisations worldwide started looking at information technology to be an integral part of their businesses. Why this shift happened?

What is Information Technology and How is it different from computers?

Information Technology can be defined as a collection of computer hardware, software, databases, networking and telecommunication devices that helps the organisation to manage the business process more effectively and efficiently. The computers are just one component of information technology. Or, in simple terms, one may say, any technological device that helps the organisation in managing its processes more effectively and efficiently qualifies to be part of the IT.

Some of the key reasons, why organisations started integrating IT into their businesses are dissussed below.

Opening of Global Markets

This led to more business opportunities and more competition. In order to take advantages of globalisation, it is essential for organisations to maximise efficiency and collaborate with partners and suppliers around the world. Further in order to remain competitive in the global marketplace, organisations started integrating technological solutions into their business processes. For example they started integrating concepts like Global Work Groups and Global Delivery Systems by tapping the cost-effective resources across the world. The introduction of these concepts led to the emergence and popularisation of the concept of 'Outsourcing', which led to serious need for business integration using information technology solutions.

• ***Business process outsourcing (BPO) is about contracting a specific business process or task, such as payroll, to a third-party service provider.*** Usually, BPO is implemented as a cost saving measure for those processes that an organisation requires but does not depend upon to maintain their competitive position in the marketplace. This cost saving can be achieved by either taking advantage of economies of scale or because of lower labour costs in different countries as in India.

• Knowledge Process Outsourcing (KPO) involves outsourcing for knowledge-driven work—like work on intellectual property, equity and finance, analytics, market research and data management, etc. ***Knowledge Process Outsourcing is a value-added process in which the achievement of goals is largely dependent on the skills, knowledge and experience of the people carrying them out.*** The cost savings, operational efficiencies, access to a highly talented work-force and improved quality are all underlying expectations in off shoring high-end processes. The KPO is not an extension of BPO as, it is driven by the depth of knowledge, experience and judgment; whereas, BPO is more about size, volume and efficiency.

- ***Shift from Industrial Based Economy to Knowledge Based Economy.*** Over the last two decades, businesses have also changed, with increasing competition. Days are gone, when organisations used to manufacture a product and then try to locate customers and sell. In those days, the time taken to recover the cost of manufacturing used to be is also considerable. In the current scenario, the competition is happening on real-time, because of which product life cycle has reduced. In order to remain competitive, organisations need to keep innovating in their products and services for which they need to integrate information technology into their business.
- ***Shift in Organisational Structures.*** Organisations are moving out from typical hierarchical structures to more flat and networked structures. With the change in structure, organisational decision-making process is also changing from centralised to de-centralised decision-making. The concept of virtual working groups are being introduced, where employees need not physically move to project locations but instead can participate from their own work locations. All these are possible, if organisations integrate their information flow on a common network for which they need to integrate information technology.
- ***Emergence of Digital Economy.*** We are into an era of ***knowledge economy, which is driven by the 'knowledge' acquired by the organisation and its employees.*** As a result, the lifestyle of people has changed, which also led to integration of technology. The emergence of digital economy has developed the ability to access and share information instantly and communicates in ways that transcend the boundaries of time and distance has given rise to an era of unprecedented productivity and innovation.

Organisations started looking at information technology more seriously as they started believing that information technology help organisations to transform. The developments in information technology based tools like software and communication networks are transforming the way organisations streamline their communications, automate processes, and enable employees to access the information that supports them to respond to new opportunities effectively and efficiently.

Digital economy is defined as economy based on Information Technologies including computers, Internet, intranets, and extranets.

Since the inception of Internet and email for new-age business purpose, we started communicating instantly with people without worrying about traditional limitations of time and location. At work, we started collaborating with colleagues in distant locations. The, concepts of global supply chains emerged, which enabled businesses to manufacture products and move them to market with incredible

speed and efficiency. These mobile devices ensured that we remain productive, no matter where we belong.

But this is just a real beginning of the IT era. As more and more of the world's information, commerce, and communications started moving to digital form, it will open the door to a new world of connected experiences that link our interests and our communities into a seamless whole extending across home, work, school, and play. Already, a new generation of technology is transforming expectations about how we will conduct business, communicate, access entertainment, and much more. As a result, the concepts of virtualisation, cloud based computing has emerged.

Information Systems

The information systems are mostly used in every profession. These systems are not meant for a select class or profession of people in the society. The housewives use information system to manage their monthly domestic budgets, students in the university use them to manage their grades, and accounts clerks use it to manage organisation accounts, while the financial controller in the same organisation may use it to manage the fund flows. In today's context, information systems are indispensable, as it helps its user to remain updated and competitive in the environment he/she is working.

ITs About Making Lives Smarter

IT does matter and IT matters a lot, if only IT is harnessed just for adding meaningful value to business, society and planet.

As technologies, markets and social conventions have evolved over the years, it is critical to calibrate new approaches for stimulating innovation, enriching lives, building smarter cities, and making the world better. Let's consider cities, home to more than half the worlds population. They can be seen as complex networks of components: citizens, businesses, transport, communications, water, energy, city services and other systems. The citizens and businesses rely on infrastructure systems for their activities and well-being.

So, the improvements or disruptions in transportation, communications and utility systems can have dramatic impact on the daily activities of citizens and businesses. The city services integrate and coordinate the activities taking place in the other components. Understanding how cities improve and change through the lens of these elements offers cities new perspectives on the progress, they are making towards achieving strategies and objectives.

The cities continue to develop and refine their economic and social goals and the strategies to achieve them. The performance of core systems of todays cities is fundamental to social and economic progress. A new generation of solutions that capitalises on instrumented, interconnected and intelligent capabilities can be applied against virtually any of a city's core systems. Faced with major challenges, these systems can be improved and optimised through the application of smart IT solutions.

The rapid instrumentation enables cities to gather more high-quality data in a timely fashion than ever before. For example, utility meters and sensors that monitor the capacity of the power generation network can be used to continually gather data on supply and demand of electricity. The pervasiveness and low cost of existing devices and sensors, like gas, electricity and water meters, offer the ability to measure, sense

and understand the exact condition of virtually anything. Add to that, new sensors and devices that offer further data gathering possibilities, such as RFID tags. These existing and new sensors and devices can now be embedded across key city systems as a first step in addressing and solving many of the challenges cities face, ranging from improving library services to maintaining sewerage systems.

Besides, interconnection creates links among data, systems and people in ways not previously possible. For example, billions of people will use the Internet. Soon, the world will be populated by more than a trillion connected and intelligent things, such as cars, appliances, cameras, roadways and pipelines, collectively creating an internet of things. These interconnections enable communication and coordination among objects, people and systems across the city framework, opening up new ways to gather and share information.

Also, intelligence in the form of new kinds of computing models and new algorithms enables cities to generate predictive insights for informed decision-making and action. Combined with advanced analytics and ever-increasing storage and computing power, these new models can turn the mountains of data generated into intelligence to create insight as a basis for action. For example, statistical models with time-dependent data feeds to predict traffic flows can be used to adjust and optimise congestion pricing according to need.

Further, they can help illuminate the interactions among different systems, giving leaders better understanding of what's happening in their cities and allowing for more effective action as a result.

In order to take advantage of how smarter city approaches can help advance those strategies, the city authorities and stakeholders need to understand how their city is performing today and where progress is being achieved in infusing intelligence into their systems. This calls for a systematic assessment of a citys position in relation to its peers. Such an assessment can identify and help communicate emerging strengths and weaknesses. Indeed, it can highlight where real progress is occurring and inform a plan for future improvements, and help cities prioritize actions.

Also, the cities will have to continually be innovating. However, that progress can only come if successes also occur simultaneously on all 4 fronts: political, economic, social and technological, not just along one dimension. The national and regional governments have a central, indeed crucial, role to play in leading their citizens and institutions through this economic development.

The only way to achieve this and thrive in todays increasingly challenging environment is by innovating in technologies, innovating in strategies, and innovating in business models. Indeed, today, what matters most is the value that arises from a creation and not just technology for its sake. There is an intense need to think collaboratively and in a multifaceted manner. By far, the key precondition for real change now exists: there is a growing hunger for fundamentally new approaches. For sure, the world will continue to become smaller, flatter and smarter. We are moving into the age of the globally integrated and intelligent economy, society and planet. And, the future holds enormous promise.

Source: Adapted from *Dataquest*, May 15, 2011

People always relate information systems with computer-based information systems, but the reality is information systems can also be manual. The manual information systems are one, which are maintained by organisations using paper–pencil techniques in the form of books and ledgers. On the other hand, Computer Based Information Systems (CBIS) are the systems that are dependent on Information Technology. **In the context of this book, we will refer to Information Systems that are dependent on Information Technology, i.e. the Computer Based Information Systems.**

Information system is a set of procedures that collect, process, store and disseminate information to support decision-making. Information system can also be defined from a business perspective as an organisational and management solution, based on information technology, to a challenge raised by the environment. Information system may include manual or automated processes.

A system can be open or closed; stable; or dynamic.

- **The Closed system** is one that does not interact with other systems or with the environment.
- **Open system** is one that interacts with other systems and also with the environment.
- **Stable system** is a static system, whereas the **dynamic system** is one which changes with the change in needs.

Like any other system, information system also includes inputs, process, output and feedback (Figure 1.2). The information systems always have a pre-defined boundary and operate in an environment which includes other systems and also players like customers, suppliers and government departments, etc. Explaining the concept further, let us take an example of a manufacturing organisation. The information system of a manufacturing organisation will collect data about raw materials and associated processing instructions known as an *Input,* send it for *Processing* using the information technology tools as per the processing instructions to produce an *Output* comprising of reports about finished products. A *feedback* process keeps sending control signals to maintain the quality of output being produced. The boundary of the system is the manufacturing process. As this manufacturing process is one of the many such processes in an organisation, so the environment in which this system operates will include all such other systems (or referred as ***subsystems***) of the organisation, for example, inventory management system, accounting system, sales order system, and many more.

Information system is a set of procedures that collect, process, store and disseminate information to support decision-making

The environment of the information system also includes customers, suppliers, government departments, competitors, etc. In order to create a flexible, dynamic open information system, it is important to understand the role of each one of these players. The information system must have close interaction with its customers; it helps the organisation to understand the need of each of its customers. A close interaction with its suppliers

Data is a collection of raw facts and figures.

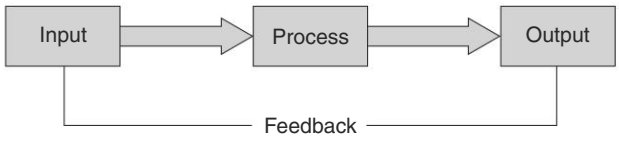


Figure 1.1 Components of System

• ***Data is a collection of raw facts and figures***. Data is an element of a transaction. Any transaction facts collected which reflect about the lifestyle of credit card customers, or point of sales or demographics and geographic are examples of data. Data needs to be processed before it can be turned into something useful. Data comes in many forms —numbers, words, symbols. For example, name of students, age of students, qualification of students, etc. collected as a part of student's profile transactions are data elements.

Knowledge is defined as the experience and expertise acquired by an individual.

• ***Information is a collection of data (facts and figures) arranged in more meaningful manner, which helps in the decision-making.*** For example, information would be: Sahil lives in Mumbai; Prachi buys branded products; Sales of creamy soap is more in metro cities etc.

• ***Knowledge is defined as the experience and expertise acquired by an individual. Knowledge can also be defined as level of understanding in interpreting the information available for effective decision-making purpose.*** Having knowledge means understanding information better, means clarity about decision-making. For example, people buy eggs 64 per cent of the time when they buy bread; amount of liquor consumption is more in hilly regions.

• ***System can be defined as group of entities that work together to achieve a common predefined goal.*** For instance, an organisation is a perfect example of system where a group of entities like employees, procedures, machinery and culture all work together to achieve a common goal. In computing terms, we define a system to have inputs, processing and output with feedback (Refer Figure 1.1).

System can be defined as group of entities that work together to achieve a common predefined goal.

help the organisation to maintain low inventory levels; new governmental policies and regulations can be easily implemented by having regular interaction with government departments and regulators. The information system should also have interface with competitor information, to understand their policies and strategies better. In the era of digital economy, these interactions play an important role.

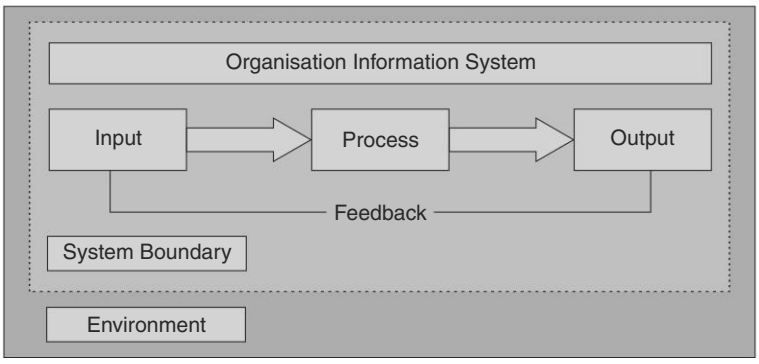


Figure 1.2 Components of Information System

Information technology versus Information system

- Information technology is a means to Information system as they are similar to heart and soul relationship.
- Information technology provides effective and efficient means of storing, processing and disseminating the information.
- To manage effective information technology solutions, one needs to have good understanding of computers, networks, communication systems and other technological tools and techniques.
- Information system provides best practices to manage business processes.
- For designing and developing good information system solution, one needs to know the businesses processes better, the environment in which it operates and good project management skills.
- To learn about information systems, one needs to understand the organisation, management and technology.
- Building information system solution without strong Information technology backbone is not possible.

Major Characteristics of Information Systems

- Intrinsic:
  - Accurate and error free information
  - Meet the objective of the system
  - Information must be gathered from reliable and authenticated sources
- Accessibility:
  - Information systems are easily accessible
  - While providing accessibility, access security must be maintained
- Contextual:
  - Relevant information as per the context
  - Information system must add value to the outputs
  - Timeliness—Must provide timely information when it is needed
  - Completeness—Must generate complete reports
  - Information needs to be made available as per-defined frequency
- Representation:
  - Interpretability—Easy to interpret the reports
  - Ease of usage and understanding
  - Concise representation
  - Consistent representation
- Information system needs to be economical to develop and maintain
- Information system needs to be flexible and adaptable

Uses of Information

The organisations need information for many purposes. The needs of each organisation are different at different levels. The main uses of information include:

- **Identification:** Each organisation needs to identify the resources of information that are available. Right information leads to right decisions, so identification of right information is key usage.
- **Collection:** Information identified needs to be collected and stored for further processes. Information needs to be collected to manage the business properly.
- **Controlling:** The control mechanism is important to ascertain the quality and relevance of information, which in turn help in managing the resources better.
- **Measuring:** Information is a vital resource to manage the business, so it is important to use information to measure performance of any business activity. One can measure the sales by collecting the sales data.
- **Decision-making:** One of the major usages of information is decision-making which can be used at all levels.

Organisation and Management

An organisation is a collection of people, hardware, software, processes, procedures and many other resources that work together to achieve a common goal. Every organisation needs information system to manage its business. In order to develop an effective information system one needs to understand the organisation, its structure, its standard operating procedures, its culture and its management.

Organisational Structure. Organisations are structured in many ways, which is dependent on their objectives and culture. The structure of an organisation defines how it is going to operate and perform business. With organisation structure one defines the responsibilities for different functions and processes to different departments and employees. Organisational structures are created to maximise the efficiency and success of the organisation. So, it becomes important to understand the complete structure of an organisation while implementing the information system.

The most *common organisational structures that exist are:*

- **Hierarchical:** ***In Hierarchical structure organisation, employees are organised at various levels (or layers) within the organisation, each level being one above the other, typically like a pyramid*** (Figure 1.3). At each stage in the chain, one person has a number of workers directly under him, within his span of control. A tall hierarchical organisation has many levels and a flat hierarchical organisation will only have a few.
- **Flat:** ***A flat organisation will have relatively less number of layers as compared to hierarchical structure or just one layer of management*** (Figure 1.4). This means that the reporting levels are less but the 'span of control is wide'. Owing to the small number of management layers, flat organisations are often small organisations.
- **Matrix:** **The *Matrix structure organisation contains teams of people created from various sections of the business*.** These teams will be created for the purposes of a specific

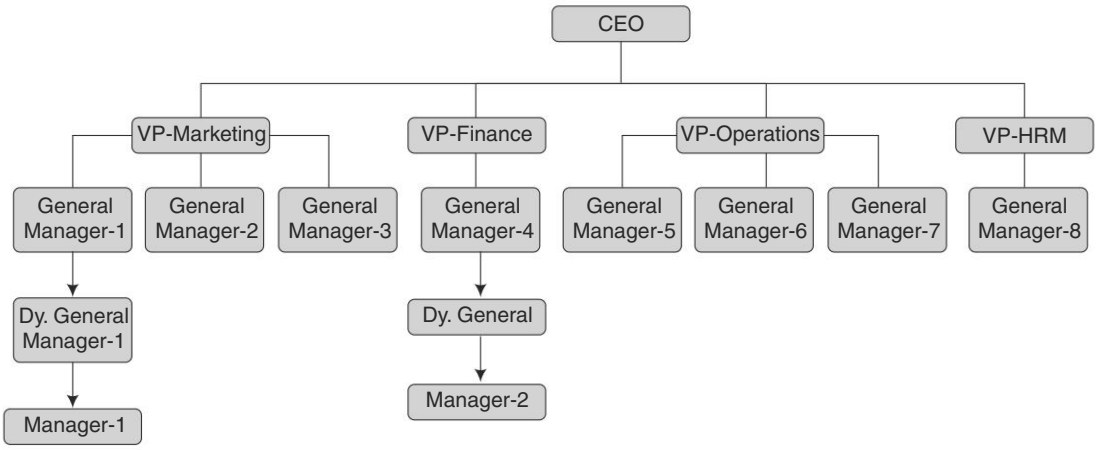


Figure 1.3 Hierarchical Structure

With close to 400 offices across the country, Bharat Petroleum Corporation Limited (BPCL) deals in a variety of products, including LPG, petroleum, lubricants, aviation fuel, and industrial products. For about seven to eight years, BPCL was facing several issues related to hardware, software, PCs, printers, network connectivity, etc. The internal team of IT was unable to cope with the pressure of increasing needs. BPCL decided to outsource the Facility Management Services (FMS) to Wipro. As part of FMS, Wipro was given the task of managing facilities such as desktop/laptop operations, printers, network support, asset management and vendor management. The vendor management was critical as most of these products are purchased and maintained by multiple vendors.

BPCL was able to successfully outsource its FMS, which have resulted in cost savings; service desk was created to provide 24 × 7 services; in-house technical team can now focus more on development work; and Wipro's large service-centre network can provide onsite support easily.

Source: *Dataquest Case Book*, December 31, 2007

project and will be led by a project manager (Figure 1.5). Often the team will only exist for the duration of the project and matrix structures are usually deployed to develop new products and services.

Thus information systems play an important role in sharing information across levels and helps organisations to implement the benefits of flat structure. With good information system in

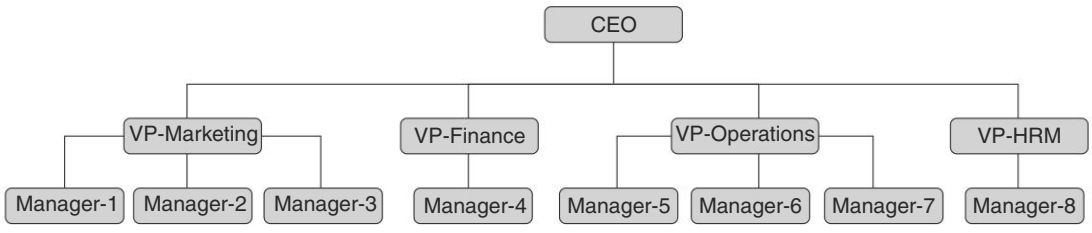


Figure 1.4 Flat Structure

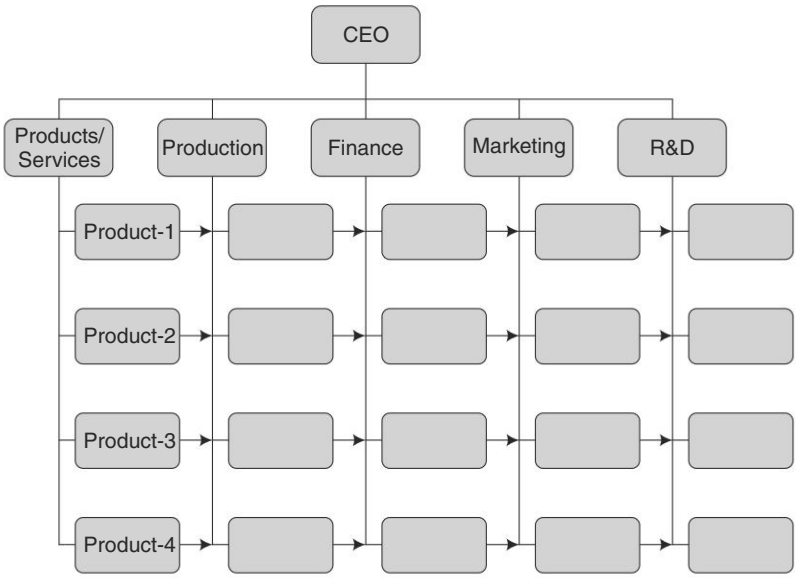


Figure 1.5 Matrix Structure

- ***Empowerment gives more authority and responsibility to employees to take decisions and also give sense of ownership.***
- ***Organisational Culture is about how the organisation manages its business processes, organises itself, to value system, rules, procedures, beliefs, and the decision-making process that it follows.***
- ***Management is an important aspect of economic life, which relates to those personnel who are concerned with managing the organisation and its business activities.***

place, employees might also be empowered to develop their own simple systems to support their decision processes.

Like organisation structure, the organisational culture also affects the development and operation of information system. For example, a newly developed payroll system in an organisation conflicts with a non-standard allowance disbursement rule which is part of organisational culture. Organisations that follow ad hoc decision-making process are the tough ones to implement information system solutions.

The management is essential wherever human efforts are to be undertaken collectively to satisfy the needs of the organisation. The managers have the authority to use organisational resources and to make decisions. In organisations, there are typically three levels of management: top level, middle level, and lower level. Some organisations may have more than three levels, but in our discussions, we will consider three levels. While developing Information Systems of an organisation, it is important to understand the management levels and their primary job

responsibilities. It is also important to understand the types of management tasks each does and the roles that they perform in their jobs, as this will help in understanding the information needs of each individual manager.

Management Levels

The management levels are required to be understood for better implementation of Information systems, as the needs and responsibilities of each manager at different levels are different. The information needs of each of the levels must be met in an effective manner. Any failure to address the needs of any one of the levels will lead to failure of the system, which may not fit well within the strategic goals of the organisation. In organisations, there are typically three levels of management:

- ***Top Level Managers.*** The top level managers are also called senior management or strategic level, which is comprised of the Chief Executive Officer (CEO), the Chief Operating Officer (COO), and other functional heads. The managers at this level take decisions affecting the entire organisation. They are responsible for defining policies for the organisation. They do not direct the day to day activities of the organisation; rather, they set goals for the organisation and direct the company to achieve them. They are ultimately responsible for the performance of the organisation, and often, take strategic decisions.
- ***Middle Level Managers.*** The middle level managers, who form the tactical level, are those in the levels below top managers. The managers at this level are responsible for converting the goals and policies set by the top level managers to action plans. They do so by setting goals for their respective departments and other business units. The middle managers are also interface between the top level managers and the lower level managers. As middle managers are more involved in the day to day working of a company, they may provide valuable information to top managers to help improve the organisation's bottom line. The middle level is perhaps the most interesting and important, as it covers all the information shared within teams, divisions, business units, etc.
- ***Lower Level Managers.*** The lower level managers are also called first line managers or operational level. The managers at this level are responsible for the daily management of organisational activities. Although first level managers typically do not set goals for the organisation, they have a very strong influence on the organisation working.

The degree to which top, middle, and lower level managers perform each of these functions is presented in Figure 1.6. It is mentionable that the top managers do considerably more planning, organising, and controlling than do managers at any other level. However, the task of directing is much less at this level. The most of the directing is done by the first line managers with respect to daily activities. The amount of planning, organising, and controlling decreases down the hierarchy of management; directing increases as one moves down the hierarchy of management.

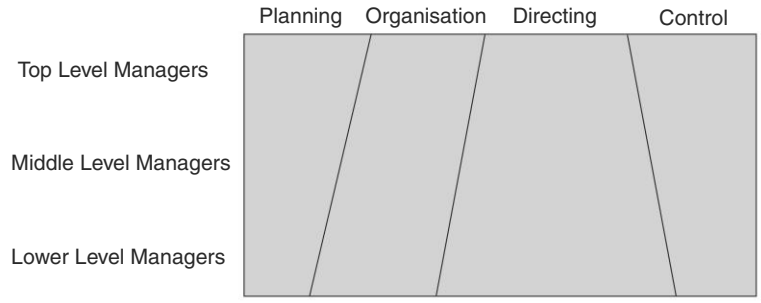


Figure 1.6 Time Spent on Management Functions at Different Management Levels

MANAGEMENT ROLES

In addition to the broad categories of management functions, the managers at different levels of the hierarchy perform different managerial roles. These roles were categorised by researcher Henry Mintzberg, and grouped into three major types: decisional, interpersonal, and informational.

- ***Decisional Roles.*** The decisional roles require managers to plan strategy and utilize the resources. There are four specific roles that are decisional - the *entrepreneur*; the *disturbance handler;* the *resource allocator;* and the *negotiator.* Figure 1.7 tries to depict the decisional roles performed by the different levels of managers in an organisation.
- ***Interpersonal Roles.*** The interpersonal roles require managers to direct and supervise employees and the organisation. The *figurehead* is typically a top level manager. A *leader*

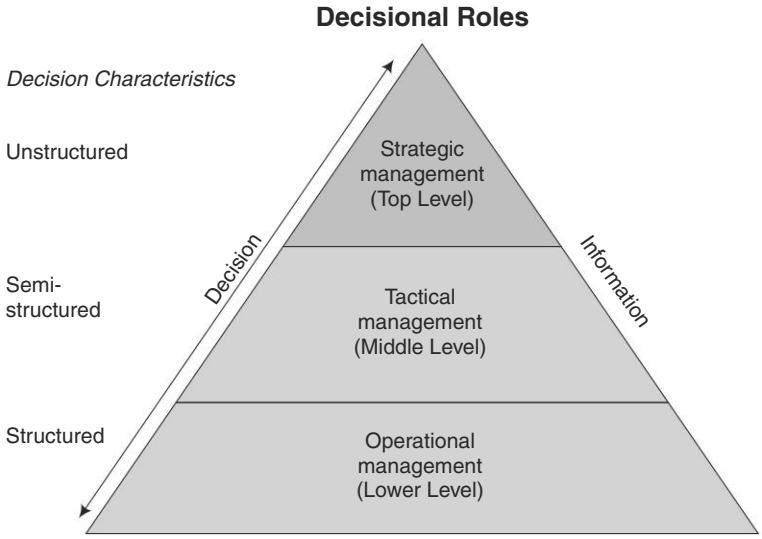


Figure 1.7 Decision Characteristics of Management Levels

acts as an example for other employees to follow, gives commands and directions to subordinates, makes decisions, and mobilises employee support. The managers must be leaders at all levels of the organisation. In the role of *liaison,* a manager must coordinate the work of others in different work units, establish alliances between others, and work to share resources.

- ***Informational Roles.*** The informational roles are those in which managers obtain and transmit information. These roles have changed dramatically as technology has improved. The *monitor* evaluates the performance of others and takes corrective action to improve the performance, if necessary. The role of *disseminator* requires that managers inform employees of changes that affect them and the organisation. They also communicate the organisation's vision and purpose.

Organisational Functions

In order to manufacture and sell the product or service most organisations will need to undertake six key functions:

- Design and Production
- Accounting and Finance
- Human Resources
- Sales and Marketing
- Administration
- Research and Development.

Each of the functions need to combine together to achieve the organisational objectives. In order to achieve the objective, communication across the various functions is the key activity. A starting point for this type of communication is the creation of a clear set of organisation objectives which each function needs to be aware of.

- **Design and Production:** In order to generate a product or service an organisation will need to combine labour, capital, energy, materials, and information.
- **Accounting and Finance Function:** The financial department of the organisation will keep all the accounting and financial data of the organisation. This information will then be used to produce various financial statements for statutory and legal requirements.
- **Human Resources Function:** Human resources department's main responsibility is the recruitment, selection, training, and development of employees.
- **Sales and Marketing Function:** The marketing department will research customer needs to develop strategy and products to satisfy the customer needs.
- **Administrative Function:** This involves dealing with all administrative functions of the organisation like mail handling, attending to enquiries/complaints, catering, and computer services.
- **Research and Development Function:** The aim of research and development is to improve existing products, create new and better products, improve production methods, and create effective processes. This will enable the organisation to reduce costs, increase profitability and remain ahead of the competition.

TYPES OF INFORMATION SYSTEMS

The information needs of each manager in an organisation are different as per their role and their position in the management hierarchy. In order to develop an effective information system solution, it is important to understand the management levels in an organisation and also the key functions being performed by each manager, as the information needs at each level will differ. As per the management levels in an organisation, information needs can also be categorised into three types—operational, tactical, and strategic level information. The strategic level managers need information to help their business planning. The middle management needs more detailed information to help them monitor and control business activities. Managers at operational level need information to manage their routine activities. As a result, businesses tend to have several 'information systems' operating at the same time. Figure 1.8 describes the major roles of information systems in an organisation.

There are six kinds of information systems which are used by different organisations. The types of information systems are summarised in Figure 1.11.

Transaction Processing System (TPS)

It is a type of information system that collects, stores, modifies and retrieves the transactions data of an organisation. The TPS systems are designed to process routine transactions efficiently and accurately. Its always capture the data from point of origin. An organisation may have one or more TPS systems. There are two types of transaction of processing:

- **Batch processing:** where all of the transactions are collected and processed as one group or batch at a later stage.
- **Real-time processing:** where the transaction is processed immediately.

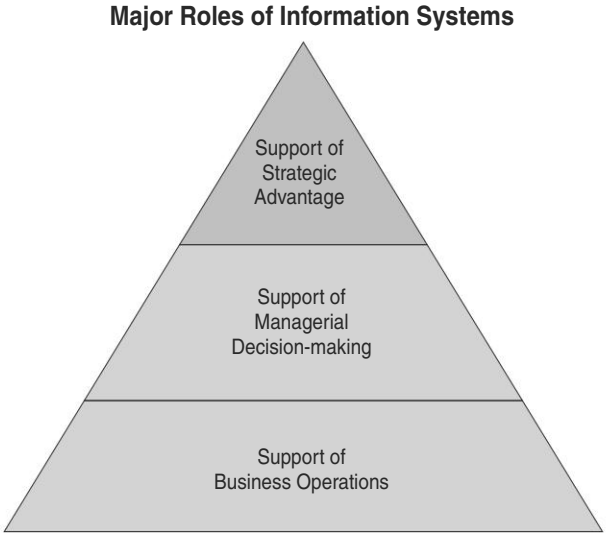


Figure 1.8 Major Roles of Information Systems

The basic characteristics of TPS are:

- Serves the operational level or lower level management.
- Performs and records the daily routine transactions.
- Tasks, resources and goals for the TPS are predefined and highly structured.
- Captures data about the organisation and its environment.
- Major producers of information about the organisation.
- Failure of the TPS will result in failure of the organisational system.
- It is often linked to other systems.
- It is a main feeder of data to other information systems
- Serves the most elementary day to day activities of an organisation.
- It can have strategic consequences (e.g. railway/air reservation system).
- It usually has high volumes of input and output.
- The TPS systems are meant to be repetitive and predictable.

Application of Transaction Processing Systems in Functional Areas

Organisations can create the TPS for each of the functional areas and also integrate them. The applications of TPS in some of the functional areas are as follows:

Transaction Processing Systems are meant for the operation level managers that collects and stores transactional data.

- **Sales and Marketing:** The system objective is to support the sales and marketing functions in an organisation by facilitating the movement of goods and services from manufacturer to the eventual customer. Examples include: Sales Management; Market Research; Sales support to keep customer records; Telemarketing; Order processing—process orders, Produce invoices, Supply data for sales analysis and inventory control, etc.
- **Manufacturing and Production Systems:** The systems that supply data to operate, monitor and control the production process. Examples include: Materials resource planning systems; Purchase order control systems; Engineering systems; Quality control systems; Inventory management, etc.
- **Accounting and Finance Systems:** The systems that maintains financial records and are concerned with the flow of funds within and outside the organisation and produce necessary reports like income statements, balance sheet, general ledger, etc. Examples include: Cash management system; Payroll system; Accounts receivable and payable systems, etc.
- **Human Resource System:** The system that deals with employee management related processes like recruitment, performance evaluation, etc. Examples include: Compensation management; Training and development system; Personnel record keeping system; Employee tracking system, etc.

Founded in 1906, Bank of India today has more than 2,600 branches across India, in both urban and rural areas. It also has 24 branches abroad. In 2002, Bank of India decided to implement a core banking solution. The project, budgeted at more than Rs. 500 crore, included setting up of data centre at the head office, networking of branches across India, enabling computerisation at all branches, training of employees, maintenance, networking and facility management. The IT implementation started in 2003 and has already given encouraging results. It enabled the bank to grow and to meet its customers' requirement efficiently. Bank of India has posted a CAGR of 25–30 per cent post implementation. The transaction volumes have increased and humanpower has been reduced. The bank is also able to manage more business with less manpower. Earlier, each branch had to handle its own back office, which has now been centralised. This helps the bank to depute more humanpower to interact with its customers and address their issues. Thus, products and services provided to the customers have improved, leading to increased customer satisfaction.

Source: Adopted from *Dataquest Case book*, December 31, 2007

Management Information Systems (MIS)

The management Information Systems (MIS) support the information needs of the middle level or the tactical level managers in an organisation. A **Management Information System (MIS)** is mainly concerned with internal sources of information. The MIS usually takes data from the Transaction Processing Systems (TPS) and summarise or aggregate or analyse the data into a series of management reports. The basic purpose of these information systems is to monitor and control day to day operations and to allocate resources effectively.

Management Information Systems support information needs of the middle-level managers by generating structured summarised reports from the TPS.

The basic characteristics of Management Information Systems include:

- Provide managers with reports and in some cases online access to the organisation performance.
- Serves the management control level.
- Produce summary reports generated by the TPS.
- Have limited analytical capabilities and use simple models.
- Address structured questions that are known well in advance.
- It is not very flexible.
- Rely more on existing organisational data and data flows.
- Generally past and present oriented.
- The MIS are generally reporting and control oriented.
- Produce Exception reports.

The major MIS reports that are generated by organisations include Periodic Reports, Exception Reports, Demand Reports, and Push Reports (Figure 1.9).

- **Periodic Reports** are generated at regular intervals like Payroll summary report at the end of every month. These reports are routine reports that are always generated by the information system solution irrespective of the fact whether it is required by the manager or not.

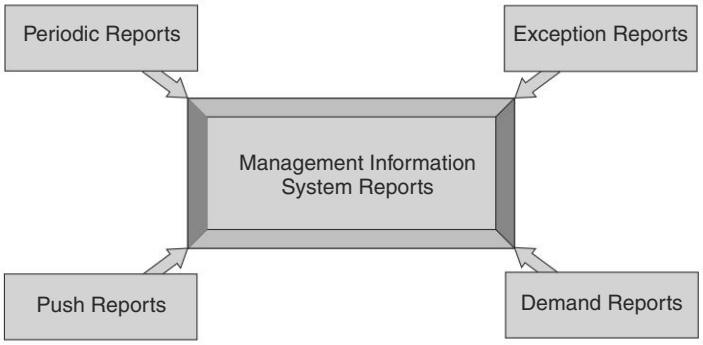


Figure 1.9 Major MIS Reports

- **Exception reports** are very important characteristics of MIS. These reports are control reports used by tactical level managers to monitor their business activities. These are generated only in case of exception as per pre-defined exception (control) parameters set by the manager. For example, exception report is a list of all salespersons who have met and who have not met the pre-defined sales targets with a tolerance limit of 10 per cent.
- **Demand reports** are the ad hoc reports that are generated as per the need of a specific manager, which are not part of periodic reports. For example, list of employees with a specific type of skill set. This kind of report is required for a very specific type of project.
- **Push reports** are the reports that are periodic reports meant for a set of managers, but are pushed to other managers for necessary action. For example, a monthly accounts receivable report which is usually meant for accounts managers is being pushed to sales manager for necessary payment follow up.

Office Automation Systems (OAS)

The Office Automation Systems (OAS) are information system solutions that aims at improving the productivity of employees of an organisation. The best example of Office Automation Systems include packages like Microsoft Office which include word processors, spreadsheets, databases, presentation software, email, the Internet, desktop publishing programmes and project management software. Its objective is to create the technology driven environment in an organisation as that it provides individuals effective ways to process personal and organisational data, perform calculations, and create documents. They are used for increasing productivity and reducing paper work by processing major work electronically. The communication systems and groupware concepts facilitate the implementation of OAS.

Office Automation Systems meant for all levels of managers that helps in creating technology driven environment in the organisation.

- ***Communication Systems.*** It helps people work together by sharing information in many different forms. Teleconferencing, data conferencing, audio

conferencing, videoconferencing, electronic mail, voice mail, and fax are all part of powerful office automation tools.

- ***Groupware System.*** It helps teams work together by providing access to team data, structuring communication, and making it easier to schedule meetings. It is also meant for sharing information, controlling work flows, communication/integration of work.

The police department has a 'Police Control Room' (PCR) in every city to monitor the activities associated with law and order. It gets a large number of calls related to information and complaints. Distress calls, VIP calls, hoax calls, etc. are part of the calls recieved. All these calls reach police control rooms in various cities, which in turn transfer them to PCR vans stationed at respective locations. These vans are connected with the control room through walkie-talkies. The incoming calls increase during natural calamities, festivals, or any special events. It was therefore essential for the police department to have an efficient mechanism to cater to the ever-increasing need and to live up to the expectation of the citizens. The police department needed a solution to track telephone calls made, and to record the complaints registered on the phone. They also needed to speed up their response time and improve their communication links.

HCL developed a Dial 100 solution based on information and communication technology (ICT). The Dial 100 solution contains Calling Line Identification (CLI) and Direct Inward Dialling (DID) to help identification and routing. It also provides connectivity to mobile PCR vans through two-way radios/ GPRS. The solution has been successfully rolled out in 18 cities across India.

Decision Support Systems (DSS)

The decision support systems (DSS) are specifically designed to help the top level or strategic level manager to take decisions. The DSS supports the decision-making process of these managers but do not take decisions. It is widely used for structured, semi-structured and unstructured decision situations. It is more useful in situations where there is uncertainty about the possible outcomes of those decisions. It comprise modeling tools and techniques to help gather relevant information for analysis to generate alternatives. It DSS often involves use of mathematical, statistical and financial models using various decision modeling software. Any spreadsheet software like Microsoft Excel or SPSS is the best example of DSS tools. They are flexible, adaptable and quick. The user controls the inputs and outputs. An example of a DSS job would be a five-year operating plan. Another example of a decision support system is the simple analysis tool that banks use to help formulate loans for the prospective customers.

The Basic Characteristics of Decision Support Systems include

- Semi-structured and unstructured decisions
- Managers at different levels
- Groups and individuals
- Adaptability and flexibility
- Effectiveness, not efficiency
- Human controlled machine
- Modeling and knowledge based

Decision Support Systems are meant for top-level managers to support their structured, semi and/or un-structured kind of decisions.

Types of Decision Support Systems

Broadly, the decision support systems are categorised as Data Driven DSS and Model Driven DSS.

- ***Data Driven DSS are those that help managers to take decisions with the help of data extractions from large databases.*** This technique is used only if large amount of data is available for extraction purpose, which helps in decision-making purpose. For example, data-driven technique is used to determine the buying behaviour of the customer.
- ***Model Driven approach uses mostly scientific modeling techniques for pattern identification.*** Again, Model Driven approach is also dependent on rich databases. This approach helps in doing what-if, sensitivity analysis, etc. For example, model driven approach is used to forecast future sales demand.
- **Analytical DSS Models** used by various organisations are what-if analysis, sensitivity analysis, goal seeking analysis, and optimisation analysis (Figure 1.10).
  - **What-if analysis** is used to determine what will happen to the output, if the participating variable values are changed.
  - **Sensitivity analysis** is a finer variation of what-if, which helps in determining how sensitive the model is to change in parameter value.
  - **Goal seeking analysis** helps in doing the backward calculations, which means help in determining the input values when output is known.
  - **Optimisation analysis** helps in optimisation of resources using statistical models.

Executive Support System (ESS)

An Executive Support System (ESS) is designed to help top level or strategic level managers in an organisation. The ESS is designed to take strategic decisions by using and analysing the key internal and external information used in the business. Sometimes, it is also referred as an Executive Information System (EIS), as it provides executives information in a readily accessible, interactive format. They are a form of MIS intended for top level executive use. An ESS/EIS

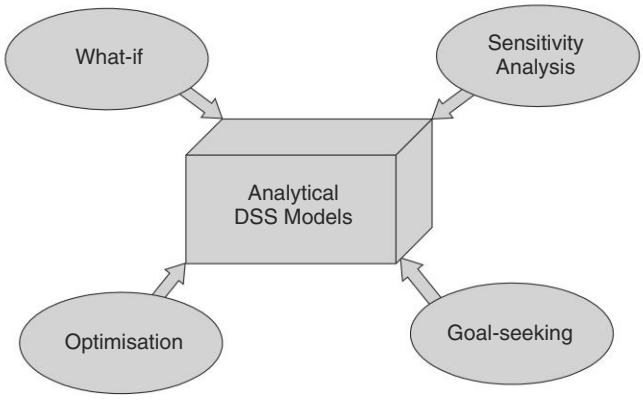


Figure 1.10 Important DSS Analytical Models

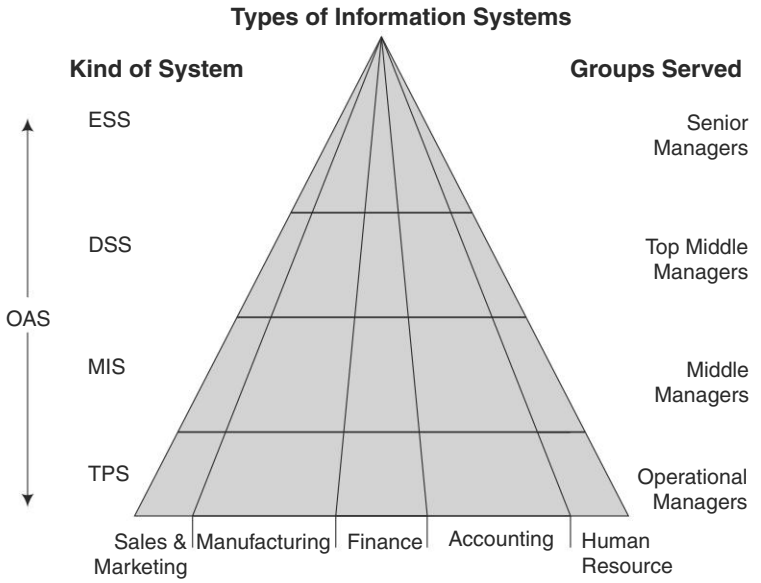


Figure 1.11 Types of Information Systems

helps in generating summary report of the entire organisation and if desired, one can drill the report to specific levels of detail. They also use data produced by the ground level TPS, so that the executives can gain an overview of the entire organisation. The ESS are usually designed to suit the individual needs at top level.

The characteristics of Executive Support System include:

- Serves the strategic level.
- Address unstructured decisions and involve a generalised computing and communication environment rather than fixed application.
- Dependent on internal and external information.
- Make less use of analytical models.
- Are more oriented towards external events.
- More graphic oriented.
- Suggests nature of business to be undertaken.
- Gives information about the activities of competitors.

Executive Support Systems are meant for Top Executives of the organistion that helps in supporting strategic decisions.

Expert Systems (ES)

An Expert System (ES) is a computer system or program that uses artificial intelligence techniques to solve problems that ordinarily require a knowledgeable human. The expert systems help to guide users to find solutions to problems that would otherwise need expert advice. They are useful in diagnosing, monitoring, selecting, designing, predicting, and training. An expert system will gather information by asking the user to answer series of questions after interpreting the answers, it will provide a suggested course of action. The expert system generally recommends a decision,

Expert Systems are based on Artificial Intelligence Techniques to solve the known problems.

but the final decision is of the user. It offers advice like an expert. Some examples of expert systems are programs, which help doctors to diagnose a patient. In fact, there are some web sites that will even diagnose patients. Another example of an expert system might be a program where a person feeds the vital statistics and then the program helps to advise about a fitness programme which that person can then follow.

The expert systems imitate human experts in many different fields of expertise. As these systems are built with decision-making rules, and they can ask humans a series of questions to narrow down the correct answer. One early and influential expert system was MYCIN, a disease diagnosis system.

The advantages of Expert Systems

- The computer can store far more information than a human.
- The computer does not 'forget' or make silly mistakes.
- The data can be kept up to date.
- The expert system is always available 24 hours a day and will never 'retire'.
- The system can be used at a distance over a network.

Examples of TPS, MIS and DSS

Examples of TPS include:

- Customer billing systems
- Weekly and/or monthly payroll system
- Production and purchasing systems to calculate raw material requirements
- Automatic Teller Machines (ATMs)

Examples of MIS include:

- Monthly sales report
- Regional or departmental reports
- Cash flow statement at the end of quarter and a comparative study into the same quarter of the previous year
- Product level inventory
- Annual budgeting system

Examples of Decision Support System:

- Insurance companies use DSS for customer buying patterns, fraud detection.
- Banks use DSS for analysing customer profiles.
- Fast Moving Consumer Goods (FMCG) companies use DSS for pricing, advertising, promotion, selection; etc.
- Railways use DSS for train dispatching and routing.
- Airlines use DSS for flight scheduling, passenger demand forecasting, etc.

Knowledge Work Systems (KWS)

Organisations of the current century are more knowledge driven. As a result, some of these organisations have introduced new level of management called knowledge workers. The knowledge workers are none, but the data workers who manage the information resources or who belong to research and development activities. The Knowledge Management Systems (KMS) is meant to serve the knowledge workers in an organisation. It exists to help organisation create and share information. These are typically used in a business where employees create new knowledge and expertise—which can then be shared by other people in the organisation to create further business opportunities. Some good examples include firms of lawyers, accountants and management consultants. These systems are also used by technical staff and may include computer-aided design/manufacture (CAD/CAM).

WHERE DOES TECHNOLOGY GO FROM HERE?

The technology over the past 10 years has progressed at lightning speed and things continue to evolve. What will be the future with technology being so disruptive? More than the question it is the fact that one needs to understand is that you need to understand the future if you want to be a part of it. The inclusion of numerous smart technology becoming the order of the day, like smart sensors that enable energy harvesting, or smart trash dumpsters that voice the need of when need to be emptied. But over all there are certain challenges faced by companies is that of cyber security. But with the perspective of cyber security of many governments changing, it is expected to be managed similar to that of the physical world.

But the biggest challenge remains how the balance between the virtual world and the real world can be maintained. But in such a dynamically changing society how can a Chief Information Officer (CIO) blend IT with business to leverage on its benefits.

Innovation: The amalgamation IT with the trends will enable transform business and also enhance customer experience. The key trends are being witnessed in relation to how mobile can shorten distance from intent to action. In relation to video the trend is about from talk to me to show to me. The changes in software deal with common language that drives the integration. The cloud refers to shift of shared infrastructure. The IT leverages on the technology fronts trends to create business velocity front and also enhance the innovation.

IT and business: With technology becoming the order of the day, CIOs and CEOs will demand more from less. Currently, cloud computing is the technology which is disruptive but enables speed and innovation and has had a profound impact on how the CIOs function. It will lead to a positive impact for many CIOs and has fundamentally changes the role of the CIO. All the new developments in technology are required to take IT to a next level. This switching from one technology to another will require a lot of investment but will have to be done by applying due diligence.

So what are the key IT trends? How will organisations adapt to them? Gartner defines a 'strategic technology' as one with the potential for significant impact on the organisation in the next couple of years. The factors that denote significant impact include a high potential for disruption to IT or the business, the need for a major dollar investment, or the risk of being late to adopt.

A Gartner release said a strategic technology may be an existing technology that has matured and/or become suitable for a wider range of uses. It may also be an emerging technology that offers an opportunity for strategic business advantage for early adopters or with potential for significant market disruption in the next five years. These technologies impact the organisation's long-term plans, programs and initiatives. Some of the biggest technology influences includes– next-generation mobility, social media, cloud computing, and big data.

- **Media Tablets and Beyond:** Now, users can choose between various form factors when it comes to mobile computing. No single platform, form factor or technology will dominate and companies should expect to manage a diverse environment with two to four intelligent clients through 2015. The IT leaders need a managed diversity program to address multiple form factors, as well as employees bringing their own smartphones and tablet devices into the workplace. Organisations will have to come up with two mobile strategies – one to address the business to employee (B2E) scenario and other to address the business to consumer (B2C) scenario. On the B2E front, the IT must consider social goals, business goals, financial goals, and risk management goals. On the B2C front, which includes business to business (B2B) activities to support consumers, IT needs to address a number of additional issues such as surfacing and managing APIs to access enterprise information and systems, integration with third-party applications, integration with various partners for capabilities such as search and social networking, and delivery through app stores.
- **Mobile-Centric Applications and Interfaces:** The user interface (UI) with windows, icons, menus, and pointers will be replaced by mobile-centric interfaces emphasising touch, gesture, search, voice and video. The applications themselves are likely to shift to more focused and simple apps that can be assembled into more complex solutions. These changes will drive the need for new user interface design skills. By 2015, mobile Web technologies will have advanced sufficiently, so that half the applications that would be written as native apps in 2011 will instead be delivered as Web apps.
- **Contextual and Social User Experience:** The context-aware computing uses information about an end-user or objects environment, activities, connections and preferences to improve the quality of interaction with that end-user or object. A contextually aware system anticipates the user's needs and proactively serves up the most appropriate and customised content, product or service. The context can be used to link mobile, social, location, payment, and commerce. It can help build skills in augmented reality, model-driven security and ensemble applications. Through 2013, context aware applications will appear in targeted areas such as location-based services, augmented reality on mobile devices, and mobile commerce. The social information is also becoming a key source of contextual information to enhance delivery of search results or the operation of applications.
- **Internet of Things:** The Internet of Things (IoT) is a concept that describes how the Internet will expand as sensors and intelligence are added to physical items such as consumer devices or physical assets and these objects are connected to the Internet. The vision and concept have existed for years, however, there has been an acceleration in the

number and types of things that are being connected and in the technologies for identifying, sensing and communicating. These technologies are reaching out to critical mass and an economic tipping point over the next few years.

- **Near Field Communication (NFC) payment:** The NFC allows users to make payments by waving their mobile phone in front of a compatible reader. Once the NFC is embedded in a critical mass of phones for payment, industries such as public transportation, airlines, retail, and healthcare can explore other areas in which NFC technology can improve efficiency and customer service.
- **App Stores and Marketplaces:** The application stores by Apple and Android provide marketplaces where hundreds of thousands of applications are available to mobile users. Gartner forecasts that by 2014, there will be more than 70 billion mobile application downloads from app stores every year. This will grow from a consumer-only phenomena to an enterprise focus. With enterprise app stores, the role of IT shifts from that of a centralised planner to a market manager providing governance and brokerage services to users and potentially an ecosystem to support entrepreneurs.
- **Next-Generation Analytics:** The analytics is growing along three key dimensions:
  - From traditional offline analytics to in-line embedded analytics. This has been the focus for many efforts in the past and will continue to be an important focus for analytics.
  - From analysing historical data to explain what happened to analysing historical and real-time data from multiple systems to simulate and predict the future.
  - Over the next three years, analytics will mature along a third dimension, from structured and simple data analysed by individuals to analysis of complex information of many types (text, video, etc…) from many systems supporting a collaborative decision process that brings multiple people together to analyse, brainstorm and make decisions.

The analytics is also beginning to shift to the cloud and exploit cloud resources for high performance and grid computing.

- **Big Data:** The size, complexity of formats and speed of delivery exceeds the capabilities of traditional data management technologies; it requires the use of new or exotic technologies simply to manage the volume alone. Many new technologies are emerging, with the potential to be disruptive (e.g., in-memory DBMS). The analytics has become a major driving application for data warehousing, with the use of Map Reduce outside and inside the DBMS, and the use of self-service data marts. One major implication of big data is that in the future users will not be able to put all useful information into a single data warehouse. The logical data warehouses bringing together information from multiple sources as needed will replace the single data warehouse model.
- **In-Memory Computing:** An enormous use of flash memory in consumer devices, entertainment equipment and other embedded IT systems is expected in coming years. In addition, it offers a new layer of the memory hierarchy in servers that has key advantages — space, heat, performance, and ruggedness among them. Besides delivering a new storage tier, the availability of large amounts of memory is driving new application models.

The in-memory applications platforms include in-memory analytics, event processing platforms, in-memory application servers, in-memory data management, and in-memory messaging.

- **Extreme Low-Energy Servers:** The adoption of low-energy servers — the radical new systems being proposed, announced and marketed by mostly new entrants to the server business —will take the buyers on a trip backward in time. These systems are built on low-power processors typically used in mobile devices. The potential advantage is delivering 30 times or more processors in a particular server unit with lower power consumption vs. current server approaches.
- **Cloud Computing:** The cloud is a disruptive force and has the potential for broad long-term impact in most industries. While the market remains in its early stages in 2011 and 2012, it will see the full range of large enterprise providers fully engaged in delivering a range of offerings to build cloud environments and deliver cloud services. The Oracle, IBM and SAP all have major initiatives to deliver a broader range of cloud services over the next two years.

These top technologies will be strategic for most organisations, and the IT leaders should use this list in their strategic planning process by reviewing the technologies and assessing how they fit into their expected needs.

Source: Adapted from various issues of *Dataquest* and *CIOL* website.

SUMMARY

- Information Technology has become an integral part of life. It has become an indispensable tool for everyone to achieve goals, be it a business or an individual. Organisations started investing in technology to remain competitives, individuals started learning about technology for their survival. The real boom in information technology started in India only after 1990s, when the concept of globalisation, liberalisation and privatisation was promoted by the Government.
- Information technology is important, but it is significantly different from computers. Information technology in simplistic form is collection of computing and communication tools that help organisations to manage the business processes better. The major reasons, why organisations started looking at IT based solutions include, change in methods the way we do businesses; global competition; global opportunities; introduction of concepts like business process outsourcing; emergence of digital economy; shift towards knowledge based economy; change in organisation structure; and setting of virtual organisation.
- Information plays an important role in any business, it acts as glue to an organisational process. It is always derived from Data, which is a collection of raw facts and figures. It is a processed meaningful data that helps in decision-making. On the other hand, knowledge is a skill required to interpret the information and system is a group of entities that work together to achieve organisational goals. The Information System, which is an important component of complete technology solution, can be defined as a set of procedures that collect, process, store and disseminate information to support the decision-making.
- Information Systems can be manual or computer based. The Manual Information Systems solutions are based on paper-pencil techniques, whereas the Computer Based Information Systems (CBIS) are the ones which are based on information technology. The CBIS always operate within a

predefined boundary having input, process, output, feedback. It always has an impact of the environment in which it operates. Some of the major characteristics that information systems needs to have include—Intrinsic, Accessibility, Contextual, Representative, Flexibility, Adaptability, and Economical.

- Organisations use information systems to manage its business activities and achieve business goals. While implementing IS solutions for an organisation it is important to understand the organisational and management structures. An organisation is a collection of people and other resources that work together to achieve the organisational goals. Organisations are similar to systems with inputs, processes, and outputs.
- Organisational structure determines how it operates. These structures are created on the basis of their objectives and culture. The common structures are: Hierarchical, Flat and Matrix. Organisational Culture is also important to understand how business processes are being managed by the organisation. The different kinds of cultures being followed by different organisations include—Power, Role, and Task cultures. The most common among these is the Role culture, which splits the organisation into various functions and each function is assigned a specific role.
- The function of management needs to be understood wherever human efforts are involved. Typically, most organisations are divided into three management levels: Top level, Middle level and Lower level. The key function that these managers perform at various levels are Planning, Organising, Directing, and Controlling. The top level managers take decisions affecting the entire organisation like policy formulation; middle level managers define action plan as per the formulated policies and the lower level acts as per the defined action plan. In addition to the broad management functions, managers also perform different roles like decisional, interpersonal and informational roles.
- After understanding the organisational structure and management level in an organisation, it is clear that information needs of each individual in an organisation are different. One single information system may not be able to serve the needs of each level of manager. There are six kinds of information systems which are used by different organisations at different levels. These systems are Transaction Processing System (TPS) meant for lower level managers, Management Information Systems (MIS) meant for the middle level managers, Office Automation System (OAS) which helps in bringing IT culture in an organisation by introducing Office Support Systems, Decision Support System (DSS) meant for the senior middle level executives for semi and unstructured kind of decisions, Executive Support System (ESS) meant for the top level executives for strategic decisions, and Expert System (ES) are meant for application specific intelligent systems.
- The most important challenge being faced by many organisations is to understand how to integrate these evolving technologies into their business. The technology is changing faster than the needs of businesses; in this backdrop, finding the right application in the current business remains the key challenge. Some of the biggest technology influences includes—next-generation mobility, social media, cloud computing, and big data.

KEY TERMS

Artificial Intelligence
ATM
Batch Processing
Big Data
BPO
Business Models
CBIS
Cloud Computing
Data
Decision Support Systems
Demand Reports
Digital Economy
Disturbance Handler
Exception Reports
Executive Support Systems

Expert Systems
Figurehead
Global Work Groups
Globalisation
Goal-seeking
In-Memory Computing
Information
Information Systems
Information Technology
Internet of Things
Knowledge
Knowledge Economy
Knowledge Work Systems
LAN
Leader
Liberalisation
Management Information Systems
Media Tablets
Optimisation
Organisational Structure
Periodic Reports
Pod Casting
Privatisation
Push Reports
Real-time Processing
Resource Allocator
RFID
Sensitivity Analysis
System
Transaction Processing Systems
Virtual Organisation
What-if
Wi-Fi

SELF-STUDY QUESTIONS

1. An order quantity for a specific customer at retail store, number of hours an employee worked during the month, and marks scored by a student in a particular subject are all examples of:
   (a) Data (b) Information (c) Knowledge (d) Database
2. Which of the following systems helps in producing periodic summary reports meant to be used by middle level managers in an organisation?
   (a) Transaction Processing System (b) Management Information System
   (c) Decision Support System (d) Intelligent System
3. A set of procedures that collect, store, process and disseminate information to support-decision making at various levels in an organisation can be best defined as:
   (a) Management Information System (b) Expert System
   (c) Information System (d) Database System
4. _____ systems deal with the day-to-day operations of an organisation, such as assigning employees to tasks and recording the number of hours they work, or placing a purchase order.
   (a) Operational (b) Tactical (c) Strategic (d) Managerial
5. _____ systems deal with middle management activities such as short-term planning, organising, and control.
   (a) Operational (b) Expert (c) Strategic (d) Managerial
6. A _____ user interface is a set of software features that provides users with direct control of visible objects and actions on the screen to replace complex command syntax.
7. _____ provide stored knowledge of experts to non experts, so the latter can solve difficult problems.
8. A(n) _____ _____ system supports the monitoring, collection, storage, processing, and dissemination of the organisation's basic business processes.
9. _____ systems deal with decisions that significantly change the manner in which business is being done and are involved in long-range planning.
10. _____ is data that has been organised so that it has meaning and value to the recipient.

REVIEW QUESTIONS

1. Describe why organisation needs to integrate Information Technology.
2. Describe a Digital Firm.
3. List the reasons why information systems are important for businesses.
4. What is Information Technology and how is it different from Information Systems?
5. Differentiate between the key terms—Data, Information and Knowledge.
6. Explain the need to understand the organisational structure while building information systems solutions.
7. What are the different levels of management that exist in most organisations?
8. Describe virtual organisation.
9. List the management levels and the corresponding information systems solutions.
10. Explain how Decision Support Systems is different from Executive Support System.

QUESTIONS FOR DISCUSSION

1. Explain with an example, how IT helps in business transformation.
2. Identify the key technology that all levels of organisations need to implement in the era of Digital Economy.
3. Explain how flat organisational structure is more relevant in the current era of IT.
4. Majority of organisations worldwide have only TPS and MIS as part of their Information Systems. Discuss the reasons.

APPLICATION EXERCISES

1. Identify the examples of IT integrations that some of the leading Indian companies have adopted.
2. Search the Computer Journals and/or Internet to find information about:
   (a) Indian Organisations using Matrix Structure
   (b) Indian Organisations following Internet Models
   (c) Virtual Indian Organisations

GROUP PROJECTS

1. Identify an organisation. Study the Information Systems Solution that is being used by that organisation, structure being followed, level of management that exists in the organisation. Identify the types of information systems solutions that have been developed to meet various levels of management. Identify the input, process, and output requirements of each level of information systems.
2. Select a process from your college or university. Observe the process for couple of days and list the key activities that are being performed as part of the process. Construct an Input-Process-Output table from the activities identified by you. Suggest the type of information system that one needs for the said process.

Caselets

1. IT Lifeline of Timex

When the joint-venture between Titan and Timex came to an abrupt end after six long years of a strong relationship, all infrastructures that were created became non-functional. As a result, Timex had no distribution channels, no point of sale systems and even no databases in place to sustain business in the Indian continent. For the CIO of the Timex, it was a challenging task of setting the priority right and create a strong IT infrastructure to revive the business. The parent company in the US was using Oracle based ERP system to manage all its business transactions, so the Indian counterpart decided to build the system around the same solution. CIO set the first priority to create a strong network of POS, as the distribution was not much at that point of time. At the subsequent stage, the IT department decided to create inventory, billing and order management systems.

The various technological solutions were evaluated and tested to transfer the POS data back to the company's main data server for intelligent data processing. The watch industry is quite dynamic in nature as the styles, textures, and trends keep changing very fast. In order to keep analysing the buying patterns and demand analysis, the company needs the complete POS data on real-time basis for data analytics. In pursuit to achieve this, the company decided to implement the Power Builder software to connect its POS terminals with the central databases. The proposed system was e-mail based batch processing system, which will send an e-mail to the data centre at the end of the day. All e-mails received from various vendors are validated and uploaded into the Oracle ERP for managers to view and analyse.

The biggest challenge of implementing this system was to cut implementation and running costs as they had limited funds available for too many technological developments.

Questions for Discussion

1. What was the strategy being followed by CIO of Timex?
2. Was it a correct strategy to follow at this stage?
3. Why Timex concentrated on developing POS network?

Source: Adopted from *Dataquest*, January 15, 2007

2. IT Issues in the case of Merger

The Centurion Bank of Punjab is a private sector bank that offers retail, SME and corporate banking product and services. It was formed by the merger of Centurion Bank and Bank of Punjab in October, 2005. The RBI gave twelve months to complete the merger. But to complete the merger successfully, the two banks had a major problem with respect to the technology. The two banks had different technological setups. The architecture of the infrastructure was different, the data centre and disaster recovery centre were located in different cities and following different technologies. The banks were following different core banking solutions developed by two different vendors—the Centurion Bank was on Misys and the Bank of Punjab was on Finacle. The mailing solutions were also different; one was on Linux and the other was on Exchange. Both the banks were following different methods and topologies to connect their data centre and had five different service providers for the connectivity.

The major technological challenge was to bring the entire staff on to the same mailing platform from day one of operations, keeping the business transactions intact. The ATM network of the two banks needs to be interconnected without affecting the business and at no extra cost to the customer. The connectivity between the two data centres needs to be established. Moreover, flexibility to be provided to the customer, so that the account can be accessed from any bank branch, while maintaining total security. Also similar kinds of issues need to be addressed at the branch level.

Questions for Discussion

1. If you are a consultant, how would you approach this problem?
2. What are the precautions that you will consider while implementing the new proposed system?

Source: Adopted from *Dataquest Case book*, December 31, 2007

Answers to Self-Study Questions

1. (a)	2. (b).	3. (c)	4. (a)
5. (d)	6. Graphical	7. Expert Systems	8. TPS
9. Strategic	10. Information Systems		

The McGraw-Hill Companies

Chapter 2

Strategic Information Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What are strategic information systems and their advantages?
- What is the value chain model and how is it related to information technology?
- What is Porter's competitive forces model and how does information technology help companies improve their competitive positions?
- What are the several frameworks that show how IT supports the attainment of competitive advantage?
- How are strategic information systems built and implemented?

INTRODUCTION

With the ever increasing pressure to maximise operating efficiencies, increased business growth and enhance shareholder value, chief executives are rethinking and revisiting their business strategies and finding ways to integrate technology into businesses, as most of them subscribe to the view 'IT changes the way we do business'. But the reality is all about, how IT can be used to get strategic advantage. The organisations worldwide tried different approaches to leverage IT competencies. Some used the technology to turnaround the organisation, whereas others used it as a competitive tool. All these different approaches led to creation of the new concept called 'Strategic Information Systems' within the broader stream of Information Systems. The basic objective of strategic information systems is not merely to manage existing business functions efficiently or even somewhat effectively, but to offer a competitive edge to the organisation by meeting its strategic goals.

In the early phase of IT integration, organisations got strategic advantage by integrating technologies into their businesses to create proprietary solutions. For example, SABRE of

American Airlines, which created proprietary computer reservation systems for the airlines industry, forced agents to partner them and turnaround the industry. In today's era, computers and communication technologies have become a necessity, which may help any player in a particular industry to create their own solutions. For example, today the airlines ticketing has totally changed from agent driven model to online models. This happened only because of easy availability of information technology. Today, the reality is most of the organisations have outsourced their IT and IS operations to external vendors. Against this backdrop, one needs to address issues like:

- How important it is to align business strategies with IT?
- Has IT become a common utility for everyone?
- How will advances in information technology affect competition and the sources of competitive advantage?
- What strategies should a company pursue to exploit the technology?
- What are the implications of actions that competing organisations may have already taken?
- Of many technologies, which is the most important?

These are some of the issues that one needs to address, before implementing strategic information systems. This chapter presents a summary of different phases of information system; describes different models of strategic advantage to organisations suggested by different academicians and researchers; highlights the distinctive role of IT in shaping tomorrow's organisations; and outlines the implementation strategies.

USES OF INFORMATION SYSTEMS

In today's business environment, managers are always trying to find ways to add value to their organisation's bottom line. However, the business environment has changed the rules of management game because of real-time competition, globalisation and innovation in technology. Also, the growth in emerging technologies and new methods of doing business has forced managers to be more dependent on data for decision-making process. Now, organisations depend more on the seamless flow of information in order to remain competitive in the global economy. Organisations that operate at the global level use more of virtual organisation strategies to manage its relationships with its suppliers, distributors, retailers, customers, employees, and other business partners.

The role and objective of information systems kept on changing with times. The information revolution is changing the way we do our business and no organisation can escape its effects. The substantial reductions in the cost of obtaining, processing, and disseminating information are changing the methods of managing business. Today, organisations cannot survive without management of information that demands the use of information technology, but in the initial phases, information systems were developed by organisations only to manage the data.

- The First phase, which was roughly between 1950s and 1960s, information systems were required only for data processing activity. Then Transaction Processing System (TPS)

emerged as critical business application during that phase and number of organisations, used TPS for their strategic advantages. The key advantages that most of the organisations got by implementing the TPS was speed and accuracy. The TPS helped organisations to capture substantial business data and manage the routine operational activities. In that era, computer processing was driven by hardware developments. Gradually, organisations started using the TPS data for generating summary reports, which led to the second phase of information systems.

- The Second phase was from 1960s to 1970s, when organisations concentrated on developing management reporting without the TPS systems, which led to emergence of the Management Information Systems (MIS). Most organisations worldwide used the MIS to their strategic advantage by developing application oriented MIS systems like Accounting Information Systems, Sales Management Systems, Human Resource Information Systems and Manufacturing Information Systems, etc.

IT is Evolving with the Changing Enterprise Scenario

The evolution of the technology industry in India has happened over the last 2-3 decades, somehow we don't give due attention to the evolution of the IT function in Indian organisations. Most certainly, evolution has been keeping pace with global trends but in some cases, it has even outperformed its counterparts in the matured markets.

Looking back, the IT function was largely an EDP function, mainly responsible for MIS, traditional IT systems reporting into finance. That time Indian IT companies were also in the nascent stage and all needs were largely fulfilled by internal IT teams and some project/product work was given to the third party. This can really get classified as the in-sourcing period.

The next phase was when having computing facility, using email for regular communications and more so, connecting offices over some network became part of almost all enterprises. This phase brought IT in to the limelight. This just coincided with companies starting offshore development work in the disguise of body shopping. By now, EDP had become IT and the new IT heads started offloading work to third-parties.

This time two significant things happened – the dotcom boom and Y2K!! With this, the IT function became strategic for business. Organisations went beyond the humble IT heads, and a new progressive breed of CTO/CIOs took charge of the future of businesses. This also brought the concept of managed services. Now, the CTO/CIOs started to focus on strategic IT roles and also, adopted managed services like managed data center, managed infrastructure, managed network, etc. This was a radical change from erstwhile sourcing of humanpower. These arrangements were SLA and result-driven, and they were here to stay.

All IT functions which are commodities and not giving any competitive advantage could very well be outsourced to a third-party. Anything which is too core for a business and creates huge competitive advantage, for that knowledge should be retained internally. This way, CIO and his/her team can focus on the future and BAU can be managed through a partner.

One of the innovative and futuristic trends observed in some of the matured organisations is strategic outsourcing. This model is driven more by business strategy and delivers IT strategy. In this long-term

engagement, partner works on complete transformation with measurable deliveries. IT partner invests in automation and gets paid on success. The biggest driver for success of this arrangement is partners interest in your success!

Source: Adapted from http://dqindia.ciol.com/content/top_stories/2011/111073008.asp, accessed on July 30, 2011

- The Third phase of Information Systems evolution, during when organisations started looking at developing more of Management Support Systems, which included systems like Decision Support System (DSS) and Executive Support Systems (ESS). These developments happened from 1970s to 1990s. The Decision Support Systems became very popular as it started offering an opportunity to top level decision-makers to evaluate their decisions and also generate better alternatives. The growth in this field also happened because of introduction of Personal Computers in early 1980s and also because of the growth of the software applications industry which created an enterprise platform. This led to introduction of end-user computing. Some of the organisations in the same era also started integrating the concept of Artificial Intelligence into their business activities by introducing systems like Expert Systems. A concept of Strategic Information Systems (SIS) was for first time introduced in this era by number of organisations.
- The Fourth phase started in the early 1990s is of Internet and e-commerce. During this phase the organisations started integrating internet technologies into their businesses. The modern concepts like e-commerce, e-business and virtual business models emerged in this period. There are number of business models and businesses emerged during this period; industry structures were changed and the rules of the game were altered. All this created competitive advantage for the organisations by offering new ways to outperform their rivals by using the power of the technology. Organisations started integrating their suppliers, distributors, retailers and customers into one virtual chain to try to reduce the cost of obtaining, managing, and transmitting the information across the players.
- In the current century, major changes happened in the field of telecommunications and organisations started integrating technologies like e-commerce, mobile commerce (M-Commerce), Artificial Intelligence, and Virtual Enterprises. By doing so, organisations are trying to reach out to its customers anywhere, anytime in any form. These revolutions in technology are giving major strategic advantages to organisations that are implementing these concepts.

In the new economy, most organisations are implementing new e-strategies to remain competitive. The Chief Information Officers (CIOs) are exploiting the power of Internet and Mobile technologies to gain competitiveness. For example, business-to-business (B2B), business-to-consumer (B2C), customer-to-business (C2B), and other e-commerce strategies are implemented in conjunction with enhanced Management Support Systems (MSS). By using the e-commerce models, customers can place their orders directly with companies and the related information is automatically processed by the MSS. The competitive environment is forcing organisations to implement emerging technologies to remain competitive in the global marketplace.

The information revolution over the decades has started affecting competition in many ways:

- Industry structures are changed and, in doing so alter the rules of competition. For example, the newspaper industry and book retailers are shifting to online business models.
- By outperforming the rivals and by creating competitive advantage using the power of new technologies. For example, when traditional matrimonial service providers went online, they outperformed all their rivals.
- It spawns whole new businesses, often from within an organisation's existing operations. For example, when newspaper industry went online, they created multiple number of new business models. This is possible in three distinct ways:
  (i) IT makes new businesses technologically feasible.
  (ii) IT can also spawn new businesses by creating derived demand for new products.
  (iii) IT can also help in creating new businesses within old ones.

STRATEGIC INFORMATION SYSTEMS

A new concept called 'Strategic Information Systems' (SIS) has emerged to be one of the power concepts within the area of Information Systems. Initially, people thought that it to be a system meant for executives at the Strategic Level, but that was a myth. In reality, Strategic Information System (SIS) is

- any system that offers an organisation a competitive advantage over its competitors;
- a technological system at any level of the organisation, which changes the goals, operations, products, services, or environmental relationships to help the organisation to gain a competitive advantage; and
- a system whose importance within an organisation extends beyond merely management of its routine functions efficiently and/or effectively.

The role of Information Systems (IS) has evolved during the years. Originally, information systems were perceived as mere automation of existing manual processes. This was later changed to integration of systems. In that era, the both forms of IS was regarded essentially to be an operational support tool. Later, some of the organisations started using information technology (IT) to their strategic advantage. This lead to the emergence of 'Strategic Information Systems', which means an information system which supports an organisation in fulfilling its business goals. An alternative interpretation of the term is that it is not necessarily a particular Information System, but can be a combination of those parts of an organisation's information sub-systems, which provide information into its strategic planning processes.

> Strategic Information System (SIS) is any system that offers an organisation a competitive advantage over its competitors.

At the core of its nature the Strategic Information Systems (SIS) are those technology based systems that help in implementing business strategies of an organisation. The SIS is the systems solutions that are developed in response to organisations business initiatives. Most of the information systems are developed as support activity, which helps to automate the operational

activities of the organisation for better efficiency, control and effectiveness, but these systems were not developed to address the organisational profitability issues. These operational systems were developed with an objective to provide enough information to the management to keep the business running and help in the basic planning activities. The SIS, on the other hand, is developed as an integrated solution of the business and directly influence the market share and profitability. The SIS may also help the organisation in developing new products, new markets, and new methods of doing business. These systems also directly help in improving the competitiveness of the organisation by offering competitive advantage over its rivals. A well-designed and developed Transaction Processing System can also qualify to be a Strategic Information System, if it helps to improve profitability or competitiveness of an organisation.

There is a general belief that Strategic Information Systems are the ones that give the organisation competitive advantage. But the question is how one can measure the competitive advantage? The researchers worldwide have deliberated to come out with different methods to offer the competitiveness, some of which are given below:

- **Cost Leadership:** It means to deliver the product or service at a cheaper cost. This does not necessarily mean that the products or services are being offered at the cheapest cost, but at a lower cost in the marketplace as per the quality and attractiveness of the products or services.
- **Differentiation:** It means to deliver the differentiated product or services. Differentiation means adding value or unique features to a product or service, which makes the product or service attractive in the competitive market. Sometimes, one need to increase the cost to add new features, but it helps in attracting more customers. A strategic system helps the customer to perceive that they are receving some extra features at the same or at little extra cost which they are willing to pay.
- **Focused or Niche:** It means to identify and create niche markets, which have not been identified before or where few players exist. This Information Technology integration into business processes certainly helps the organisations to identify such niche segments.
- **Innovation:** It means developing products or service using new technologies. The introduction of ATM and Internet Banking has revolutionised the complete banking industry worldwide. The traditional banks are forced to integrate the technology into their business processes to remain competitive.

As indicated earlier, every information systems solution can be defined as 'Strategic Information System', if it aligns the information systems strategies with the overall business strategies of the organisation. There is a need to explicitly define a linkage between the organisation's business plan and its information technology plan to provide better support to the organisation's goals and objectives.

The number of organisation that have implemented information systems solutions in the first phase of IS implementation i.e. during 1950s, have used the term 'Strategic Systems' for all its IS solutions, as these systems were certainly giving the competitive advantage to these

organisations. Consider the SABRE system – an online airline reservation system, implemented by American Airlines, which offered a substantial competitive advantage to the American Airlines and also to the travel agents who implemented the system. The strategic systems, thus attempt to match information system resources to strategic business opportunities where technology will have an impact on the products or services and the business operations. Another way to look at strategic information systems is to consider the different models and ideas suggested by different researchers like Dr. Michael E. Porter, Charles Wiseman, etc.

Looking Beyond Design and Production

IT has played and will continue to play an important part in achieving the projected sales growth of Indian automotive industry.

An IMF report on the Indian automotive industry released last year said that in a few years time India will have 400 mn cars sold which will be 45 times that of today. At present, the annual sales of the overall automotive industry is touching around 5 mn units (5,553,844). The finding was corroborated by another report that mentioned that by 2016 India would be among the 7th largest automobile market globally. With the Indian automotive industry showing such aggressive growth figures, analysts obviously go gaga over the growth story, forgetting as to how the auto companies achieve this and how they are preparing themselves for it.

The growth can be attributed to production, planning, and IT. Ravi Pandit, CEO, KPIT Cummins had once said, way back in FY 2000, that on an average every car had around 1 mn lines of code and the cost on software worth 2% of that of the vehicle. By 2012, this would amount to around 100 mn lines of code and 13% of car cost in the software. This clearly indicates the increasing role of information technology in the automotive industry.

In fact, IT has always been an integral part of the automotive industry right from the design stage to the production stage extending to the final delivery to a customer. Interestingly, like many other verticals, automotive too leapfrogged in terms of technology advancement in its early days itself. And while many auto majors were talking about the legacy of in-house tools versus ERP, Indian OEMs were learning and adopting ERP solutions which brought in some kind of standardisation and simpler infrastructure right from the very early stage.

The design software, supply chain management tool, and CRM and ERP tools have now become traditional and legacy tools, thus forcing CIOs to look beyond these when it comes to improving customer experience, dealer management, shop floor practices, etc. The CIOs, therefore, are now investing in SCM solutions, dealer management system, CRM systems, advanced design solutions, PLM and MES solutions, and they are now predicting that the next step will be towards enhancing social media presence of the company, introducing mobility and deploying data analytics, and finally transitioning to cloud.

The outlook for CIOs changed from using IT merely as a support function to now using it to gain competitive advantage like reducing the time cycle of product development, procurement cycle, improving delivery, services, spare parts, inventory maintenance, cost, and many other criteria. In the automotive industry, the challenge ahead was to capture the market demand in terms of number and mind share. Apart from this, one also needs to monitor each dealer in terms of the sales cycle, ensure planning, and forecasting for the products that involves predictive analysis, ensuring timely delivery to customers, in short looking at dealer management.

Recent Implementations

As a leading auto major, Bajaj Auto implemented the SAP ERP applicationSAP service parts planning for its automotive package in partnership with HP India. According to SAP, software generates a deployment schedule that can be accessed by the managers for the updated order status. With this implementation, the production planning controllers were freed from their manual tasks, thereby improving their productivity by 80%.

Similarly, Tata Motors partnered with SAP for its MaxAttention services. According to the company, SAP MaxAttention supported both operational and strategic objectives at Tata Motors. Tata Motors IT project not only helped create a stronger relationship between the business and IT divisions, but also resulted in better disk management, disk optimisation while the CPU utilisation has been reduced by 20%, the response time of the production servers too went up by 20%.

Changing Trends

Starting with ERP, the trend moved to cost optimisation brought in by the slowdown, followed by other internal efficiencies from systems and processes. Lately, companies started looking at dealers management systems, new products developments, shop-floor practices. In the coming few years we would see them moving towards eco–sustainability, increased role of cloud and analytics for understanding the customers, greater involvement in social media and mobility.

While social media, BI/analytics are gaining traction in this vertical, outsourcing, and open standards are another major trends to watch out for. One can outsource everything else if one learn and just know how to control, manage, and regulate our processes better. Secondly, one needs to constantly driving capex reduction. Companies should work towards more interoperability to induce increased adoption of open platforms, which includes all hardware, software, operating systems, and platforms as well.

Source: Adapted from *Dataquest*, October 15, 2011

Value Chain Model

Information technology is changing in tune with organisations' operations. It is affecting the entire process by which organisations create their products and services that they offer to their customers. The 'Value Chain' is an important concept that highlights the role of information technology in competition. The context within which Strategic Information Systems (SIS) theory and 'Value Chain' emerged was the competitive strategy framework defined by Michael E. Porter in 1980 and 1985. Based on these ideas, Porter developed useful tools for analysing the organisation's competitive advantage. The basic concept is that to understand the competitive advantage of any organisation, one need not look at the organisation as a whole. Rather it is necessary to identify the key activities being performed by an organisation to do business transactions. Each organisation performs a collection of activities that add value to the final products or services being delivered to the customer. These activities are numerous and are unique to every industry. It is only these activities where cost advantage or differentiation can be gained.

As per Porter's Value Chain Model, the organisation's activities can be divided into nine generic activities. These nine activities are further classified as Primary and Support activities.

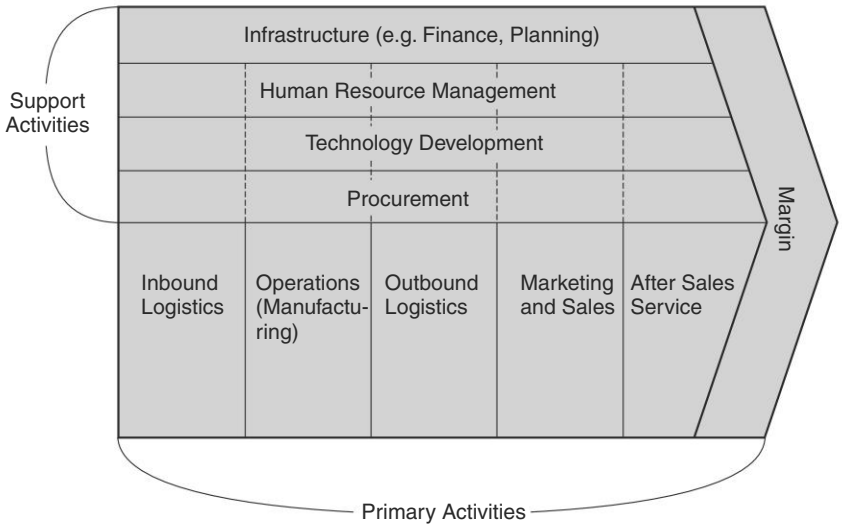


Figure 2.1 Porter's Value Chain Model

Figure 2.1 describes the Porter's Value Chain Model. The ***Primary activities are the activities that help the organisation in creating the product, marketing it, delivering it and servicing of the product.*** There are five primary activities, which directly add value to the organisation's factors of production they are linked, generally in a chain, and are together referred as 'Value Chain'. The five primary activities are:

- *Inbound Logistics:* This deals with receipt, storage and management of raw materials.
- *Operations:* This deals with manufacturing or service steps.
- *Outbound Logistics:* This deals with collection, storage and distribution of finished products.
- *Marketing and Sales:* This includes order booking, price management, and customer relationship.
- *After Sales:* This deals with the support of the products after the sale has been done. This may also include installation and customer training.

As per Value Chain Model, organisation activities are divided into five Primary activities and four Secondary activities.

The ***support activities include all those activities that are required to perform the primary activities.*** There are four support activities as defined in the Porter's model. The four support activities are:

- *Procurement:* This includes the procurement of raw materials required for the final product, or any other item required by the organisation. The procurement process is generally spread across the organisation.
- *Technology:* This deals with selection and utilisation of appropriate technology for product development and other activities.

- *Human Resource Management:* This deals with managing human resources in an organisation from recruitment to training to development of employees.
- *Infrastructure:* This is a major support function, which includes accounting, legal, planning, labour relations, and other departments in an organisation.

The competitive advantage grows out of the organisation's ability to perform these activities either at lesser cost than its competitors, or in a differentiated manner. The competitive advantage should also be linked to these specific activities, and not to an organisational level. As shown in Table 2.1, information technology is also pervasive at all parts of the value chain. Every activity that the organisation performs has the potential to integrate information technology solutions. As information technology moves away from repetitive transaction processing to integrate all activities in the value chain, it will be in a better position to be useful in gaining competitive advantage. It is also clear that information processing plays an important role in gaining the competitive advantage.

Table 2.1 Integration of IT to Value Chain

Value Chain Activity	*IT Integration*
Inbound Logistics	JIT, Automated SCM
Operations	CAD/CAM, Automated Manufacturing Process
Outbound Logistics	RFID, POS and Automated Order Processing
Marketing & Sales	Automated Order Processing, One-to-One Marketing using BI
Customer Service	CRM
Procurement of Resources	e-Procurement and Reverse Auction
Technology Development	Extranets and Collaborative Commerce
Human Resource Management	Human Capital Management using ERP
Administrative Coordination & Support Services	Groupware using Intranets

Porter also suggested an extended model of the 'Value Chain'. As in most industries, organisations interact with each other and also perform number of business activities together to complete a single business transaction. Porter suggested that an organisation's value chain for competing in a particular industry is embedded in a larger stream of activities being performed by number of organisations in that industry, that Porter defined its 'Value System'. This 'Value System' may include suppliers, distributors and retailers as depicted in Figure 2.2. The organisations can

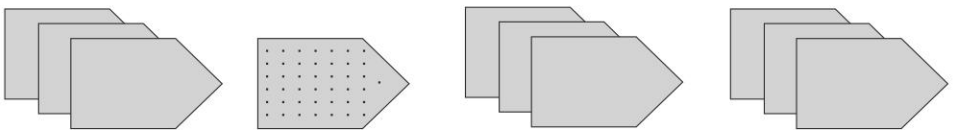


Figure 2.2 Porter's Value System

attain a competitive advantage by managing the entire value system effectively. A corporation can create competitive advantage by coordinating its links in that chain.

The linkages not only connect value activities inside the organisation but also create interdependencies between its value chain and those of its suppliers and channel partners. Organisations can create competitive advantage by optimising these links. For example, Dell splits the customer orders and pass them on to its suppliers to manufacture the parts and for the necessary qualities test, before these parts are supplied to Dell assembly line. The competitive advantage, which is a measure of either cost or differentiation, is a function of an organisation's value chain. Organisation's cost position reflects the collective cost of performing all its value activities, as compared to its competitors. Similarly, differentiation of an organisation product or service is reflected by the contribution of each value activity towards fulfilment of buyer needs.

Value Chain Transformation using IT

Information technology is permeating the value chain at every point, transforming the way value activities are performed and the nature of the linkages among them. It is also affecting competitive scope and reshaping the way products meet buyer needs. The competitive scope is a powerful tool for creating competitive advantage and normally has four key dimensions: segment, vertical, geographic and industry scope. These basic effects explain why information technology has acquired strategic significance. Every value activity consists of both physical and information processing components. For example, logistic activity uses information to track the supplies and plan production. The information revolution affects all the nine categories of value activities. The information technology is also transforming the physical processing component of activities. For example, CNC machines are more accurate and faster as compared to manual machines. The information technology also helps organisations to exploit linkages between activities within and/or outside organisations. Then there is an information system, which also allows organisations to coordinate value activities across the geographic locations.

Several developments in different business disciplines have been associated with the value chain concept. One such concept is of Information Value Chain as described in Figure 2.3 and other examples include activity-based costing and business process redesign/business process reengineering.

Competitive Forces Models

In order to create a competitive strategy for an organisation, as per Porter's model it is important for an organisation to understand—how structurally attractive is the industry in which the organisation exists and what is the organisation's relative position in that industry? These questions are subjective and dynamic, as these can also be influenced by the behaviour of the competitors. The competitive strategy is an organisation's plan for achieving sustainable competitive advantage over, or reducing the edge competitors. In Porter's model, the performance of an organisation is determined by the extent to which they manage and manipulate the five key 'forces' which make up the industry structure:

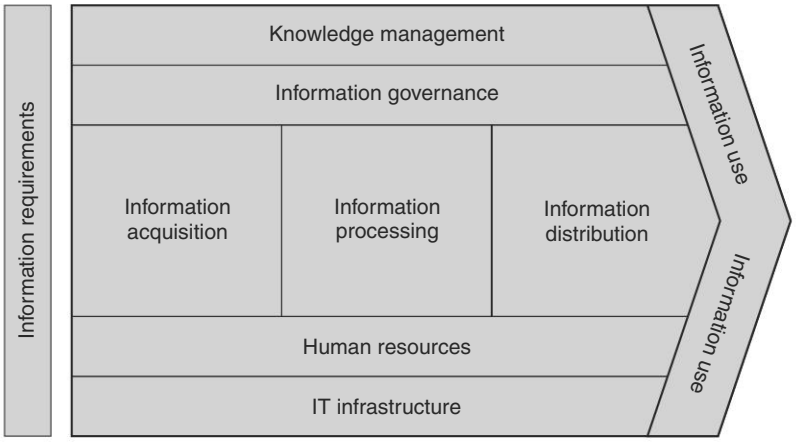


Figure 2.3 The Information Value Chain
Source: http://www.informationvaluechain.com/, accessed on November 23, 2011

1. The bargaining power of suppliers
2. The bargaining power of buyer
3. The threat of new entrants
4. The threat of substitute products, and
5. Rivalry among existing firms

Competitive strategy is an organisation's plan for achieving sustainable competitive advantage over, or reducing the edge of its competitors.

Porter's competitive force model is depicted in Figure 2.4. Organisations can influence the five forces and the industry structure, to some extent using their strategies. The understanding and analysis of each of these forces will help the organisation in estimating its relative position and competitive advantage. In any industry, the sustained average profitability of competitors varies widely and becomes a problem to determine how a business can outperform their rivals and attain a sustainable competitive advantage. This can be possible to an extent by integrating information technology solutions. The Porter's model can be understood better with the help of following description which is summarised in Figure 2.5.

1. The Bargaining Power of Suppliers (Input)

The suppliers of raw materials, components, and services to the firm can exercise power over the firm. The supplier switching costs is related to firm switching costs. The effects of the bargaining power may be visible in the following instances:

- Quantum of differentiation of inputs
- Existence of substitute inputs
- Supplier concentration to firm concentration ratio

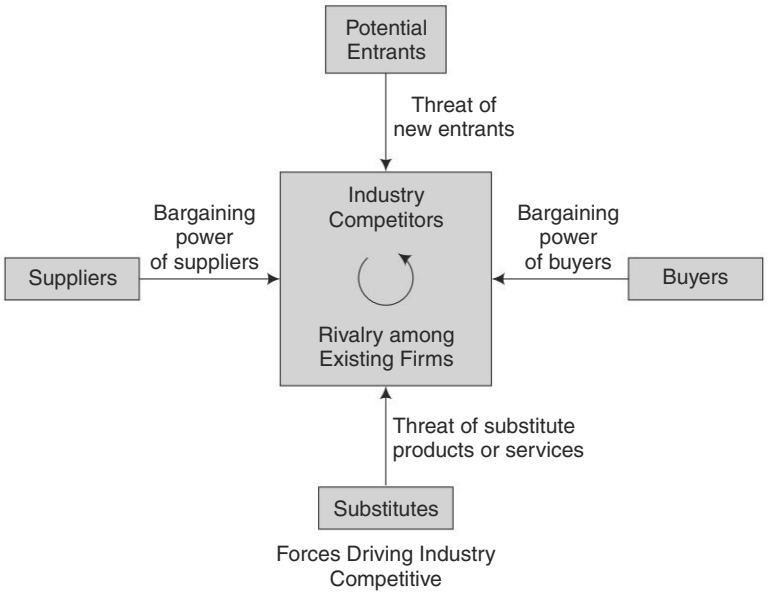


Figure 2.4 Porter's Competitive Five Force Model

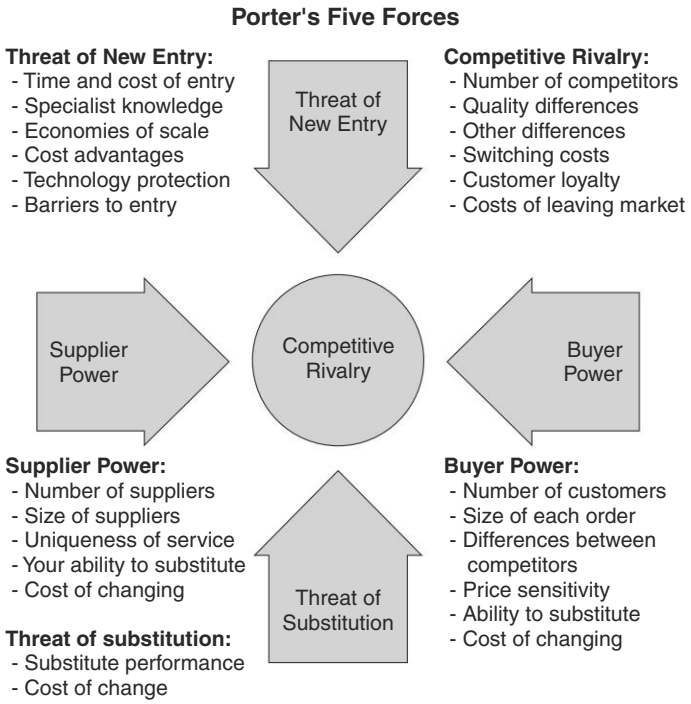


Figure 2.5 Summary of Porter's Competitive Forces Model

- Threat of forward integration by suppliers relative to the threat of backward integration by firms
- Cost of inputs relative to selling price of the product.

2. The Bargaining Power of Buyer (Output)

The ability of customers to put the firm under pressure which also affects the customer's sensitivity to price changes. The effects of buyer's bargaining power may be seen as follows:

- Buyer concentration to firm concentration ratio
- Bargaining leverage, particularly in industries with high fixed costs
- Buyer volume
- Buyer switching costs relative to firm switching costs
- Buyer information availability
- Ability to integrate backward
- Availability of existing substitute products
- Buyer price sensitivity

3. The Threat of the New Entrants

The profitable markets that yield high returns will draw firms, resulting in many new entrants, which will effectively decrease profitability. If the entry of new organisations can be blocked by incumbents, the profit rate will fall towards a competitive level, which would be an example of perfect competition. The threat of the new entrant may be seen as follows:

- The existence of barriers to entry
- Economies of product differences
- Brand equity
- Switching costs or sunk costs
- Capital requirements
- Access to distribution
- Absolute cost advantages
- Learning curve advantages

4. The Threat of Substitute Products

The existence of close substitute products increases the propensity of customers to switch to alternatives in response to price increases, which means high elasticity of demand. The threat of substitute products is to be evaluated as follows:

- Buyer propensity to substitute
- Relative price performance of substitutes
- Buyer switching costs
- Perceived level of product differentiation

5. The Rivalry Among Existing Firms

For most industries, this is the major determinant of the competitiveness of the industry. Sometimes, rivals compete aggressively and sometimes, rivals compete in non-price dimensions such as innovation, marketing, etc. One needs to evaluate the rivalry as follows:

- Number of competitors
- Rate of industry growth
- Exit barriers
- Diversity of competitors
- Informational complexity and asymmetry
- Economies of scale
- Sustainable competitive advantage through improvisation

The impact of the five forces varies from industry to industry, as does the average profitability. The strength of each of the five forces can also change as per the attractiveness of an industry. Information technology can be used to alter each of the five competitive forces and hence, industry attractiveness as well. The technology is changing the structure of many industries, creating the need and opportunity for change. For example:

- The e-procurement systems increase the power of buyers in industries that are based on component assembly.
- Banking and airlines industry integrated Information Technology solutions which are mostly proprietary software solutions, which raised barriers to entry.
- Flexible CAD/CAM systems have influenced the threat of substitution in many industries by making it faster, easier and cheaper to incorporate enhanced features into products.
- The automation of POS, customer billing and order processing has increased rivalry in many distribution industries.

Information technology has had a strong impact on bargaining relationships between suppliers and buyers, since it affects the linkages between companies and their suppliers, distributors, and buyers. So, information technology is altering the relationships among scale, automation, and flexibility with potentially strong consequences.

Role of Internet and Competitive Forces

- For most organisations, the Internet increases the threat that new competitors will enter a market.
- Internet impact is mixed. Buyers can find alternative suppliers and compare prices more easily, reducing power of suppliers.
- On the other hand, as organisations use the Internet to integrate their supply chains, suppliers can lock in customers.
- Internet increases buyers' access to information, increasing buyer power.
- Internet reduces switching costs, which are the costs, in money and time, to buy elsewhere. This also increases buyer power.
- Information-based industries are in the greatest danger from this threat (e.g., music, books, software). The Internet can convey digital information quickly and efficiently.

The Porter's model define that the organisations can adopt two strategic methods to gain competitive advantage—one, they can be low cost producer and the second they can be focused or may follow differentiation.

- **Low-Cost Producer:** An organisation has a competitive advantage if it is able to produce and deliver its product or service at a lower cost than its competitors. If the quality is comparable, this strategy will translate into higher margins and higher returns.
- **Differentiation:** Another advantage is achieved if the organisation is able to differentiate its products and services. This differentiation means offering something that is both unique and desirable. It always leads to higher price, meaning higher margins and better performance.

It is clear that the two strategies—low cost and differentiation are mutually exclusive. In order to get lower cost, one need to sacrifice the uniqueness of the features and to get the premium price, there must be extra cost involved in the process. And to be a leader in the industry, one needs to follow one of the two strategies. In the long run, organisations if they possess sustainable competitive advantage in either of these two, subject to reaching some threshold level would succeed relative to their competitors. The competitive advantage is usually gained through strategy, and often also based on its scopes. It is necessary to look at the breadth of an organisation's activities and narrow the competitive scope to gain focus in an industry segment, or geographic area, or customer type, or distribution channel being followed. The competitive advantage is mostly gained by defining the competitive scope in which the firm is operating and concentrating on.

As per Porter's defined model, organisations have four generic strategies available to them whereby they can gain above average performance. They are discussed below.

- **Cost Leadership:** The cost leaders deliver a product at the lowest possible price to its customers, while maintaining the quality. It attempts to create a significant cost gap over all its competitors. The cost leadership translates into above average profits, if they can command the average prices in the industry. This is possible only if they are able to maintain the quality equivalent to that of their competitors. Porter suggested five steps to achieve cost leadership:
  - Identify the appropriate value chain and assign cost to each activity.
  - Identify the cost drivers for each value activity and see how they interact.
  - Determine the relative costs of competitors and the sources of cost differentiators.
  - Develop a strategy to lower relative cost position through controlling cost drivers or by redefining the value chain.
  - Test the cost reduction strategy for sustainability.
- **Differentiation:** The differentiation is the second strategy suggested in the Porter's Competitive Strategic Model, in which, one or more unique features are added to a product or service. These features are selected keeping the customer needs in mind with a basic purpose to achieve and sustain a performance on various value added parameters as compared to any of its competitors. While following this strategy, an organisation must

add costs only in those areas which are important to the customer. In order to achieve this, organisations must adopt efficient forms of differentiation while reducing the cost in those areas that are irrelevant to the buyer needs. In the value chain, buyers also play an important role, which is same as sellers. The differentiation may help in lowering the buyer's cost by improving its performance, and thus create value or competitive advantage for the buyer. There are few typical factors that may help in reducing the buyer's costs, which include reduction in idle time, reducing failure rate, easy and simplified installation process, faster processing time and reduced labour costs, etc. The differentiation is achieved by enhancing the sources of uniqueness, which can be found throughout the value chain. The differentiation may not work, if there is too much of uniqueness that is being offered or when the customers do not value that uniqueness. It is important to understand the needs of the customer in terms of uniqueness criteria, premium price, and segmentation, etc. Porter also listed seven steps to achieve the differentiation:

- Identify the real customer.
- Understand the customer's value chain and impact of seller's product on it.
- Identify the customer's buying criteria.
- Identify the possible sources of uniqueness.
- Identify the cost associated with these sources of uniqueness.
- Select the value activities that create the most important differentiation for the customer relative to costs incurred.
- Test the selected differentiation strategy for sustainability.

- **Cost Focus and/or Focused Differentiation:** Porter further defined that the organisation that attempts to satisfy each and every customer does not have any strategy to remain competitive. The focus strategy means defining targets or segments and optimising the strategies for those defined targets or segments. It is true for the cost leadership as well as for the differentiation strategies, which are redefined as Cost Focus and Focused Differentiation respectively. Porter's suggested strategies are given in Figure 2.6. The complete theory is directed towards competitive advantage in general and is not specific to strategic information systems, but these models play an important role while creating the SIS.

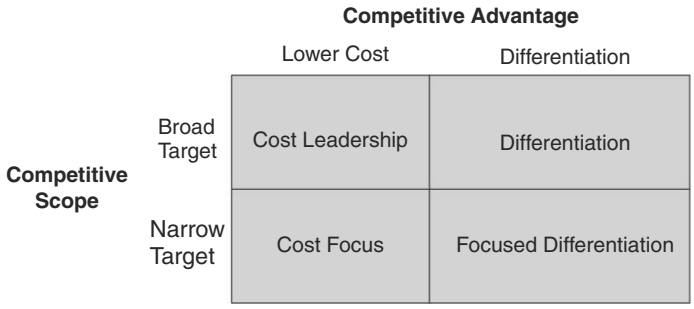


Figure 2.6 Porter's Four Generic Strategies

The idea to connect the rural areas of developing countries through Wi-Fi by using the existing transportation infrastructure was conceived by Amir Alexander Hassan, Founder and CEO of United Villages. As per Amir, "We were looking to leverage existing transportation infrastructure in rural areas of developing countries to create a zero-cost, store-and-forward, driven by Wi-Fi network that can bridge the digital divide and provide 2 billion villagers with a digital identity in a commercially viable way." Under this innovative scheme, the villagers access the services through a village kiosk that is run by a local entrepreneur who is trained in using the PC and deliver the services. The kiosk operator needs to either have some grid based electricity or solar panels and a UPS power backup.

A proprietary Wi-Fi device, a 'mobile access point' (MAP) is installed on a vehicle that is already travelling to and from the villages everyday. This MAP is wired into the vehicle battery and an antenna is secured on the roof. The company recruits and trains the entrepreneurs to operate kiosks installed with Wi-Fi antennas along the vehicle's route where villagers can go to send and receive emails, SMS, voicemails, web searches and other services. When the vehicle with MAP drives past each kiosk, it automatically picks up all of the kiosks outgoing data and drops off all incoming data at wireless broadband speed. The MAP does this for 10 kiosks per route on an average and when it comes within the range of either a cellular data network or a real time Internet Wi-Fi network, it transfers all that data for and from the kiosks to and from the Internet. This technological innovation (called DakNet) is already benefiting thousands of villagers in India, Cambodia, Rwanda, and Paraguay. Currently in India, it is being pilot tested in the villages of Orissa. The company has plans to set up 90,000 DakNet service providers in India by 2012.

Source: *Dataquest*, June 22, 2007

The growth in competitive advantage may vary as per the organisations strategy to organise and manage its various activities. The sales transaction in any organisation may lead to a series of activities and each one of them creating value for their customers. The ultimate value an organisation creates is measured by the amount customers are willing to pay for its product or services. An organisation is profitable if this value exceeds the collective cost of performing all of the required activities. In order to gain competitive advantage over its rivals, an organisation must either provide better product/or service as compared to its competitors or perform its activities more efficiently and effectively. IT can be used to support or sharpen the organisation's products or services through these various activities.

Wiseman's Strategic Model

Charles Wiseman emphasised that since the organisations have started using information systems for managing their business activities, it is important for these organisations to use the information system for gaining the desired competitive advantage. Wiseman also stressed that the significance of information system does not lie only in the technological sophistication, but upon the role that they play in gaining and maintaining the competitive advantage for the organisations. It is also true that one may not get the competitive advantage all the time by implementing information systems solutions, but it certainly can serve as an important tool in organisation's strategic plan. Add to that, Wiseman suggested that while developing a strategic plan, both business and information management people must be involved, as this will help in better integration of technology into the business.

As per Wiseman, organisations must develop a complete framework for identifying the strategic information systems opportunities. He emphasised on developing a complete information systems architecture, which ultimately helps the organisation to identify the key business processes and key decision points. The two popular methodologies for developing information systems architecture are Business System Planning (BSP) and the Critical Success Factors (CSF). These are the two methodologies that are widely used by the organisations for building their information systems. In order to build strategic information systems, organisations need to adopt new methods or new models. Further ***in order to develop a Strategic Information System, one needs to look at planning, response management, innovation, and integration of technology***. This kind of approach is quite difficult to attain and can only be possible because of the complete involvement of the top management.

Wiseman further suggested that the conventional information system thrust is mainly on automation of processes of the organisation and also to some extent to fulfil the information needs of the user at various levels in the organisation. Instead, the Strategic Information Systems (SIS) should focus more on understanding the needs of business managers (or key managers) and satisfying their information needs. The strategic information systems are not about mere automation, but integrating technology into business processes to meet the information needs of key managers of the organisation.

IT FOR COMPETITIVE ADVANTAGE

An organisation can get a competitive advantage over its competitors by implementing the competitive strategy. The competitive strategy of an organisation defines its engaging rules in terms of organisational goals, future plans and policies to gain competitive advantage which can be measured in terms of cost, quality, speed or any other value-added parameters. A strategic information system helps the organisation to achieve its goal and future plans while trying to maintain the competitive advantage. The strategic information system uses the power of technology to increase productivity and performance.

Airline industry is one of the most competitive industries within the economic environment. Within industry's boundaries actors have more or less recently and with significantly different patterns of action undertaken efforts to achieve an integration of the internet platform and its applications. The effects of electronic commerce and its potential for competitive advantage for airline industry by using Porter's competitive model are explained below.

Airlines do conform to those which Porter described as per Figure 2.6 (Cost Leadership, Differentiation and Focus). The proposition is that airlines can successfully work in one of these areas will be able to establish and sustain a competitive advantage.

Cost Leadership: Airlines are generating significant cost savings by sending tickets, newsletters, quotes, and other documents via Internet or email, rather than by post. Airlines are using Web site to publish - in a cost-effective way - public domain documents such as annual reports, product brochures, positions vacant, contact details and other important Airline information. Airline can save on the cost of running 'bricks and mortar' outlets and can reach global markets without having to develop a physical global

distribution network. Most importantly, Airline can save on customer service costs by enabling customers to serve themselves. Massive investment in both business-to-business (B2B) and business-to-customer (B2C) information systems is expected to translate into important cost savings in procurement, sales, billing and other support activities.

Differentiation: E-ticketing, the issue of a booking code at the conclusion online transition that replaces the traditional airline ticket. E-ticketing seems to be a 'win-win' solution for the airline business. It offers the airline the chance to make considerable savings in both trade terms as well as in invoicing and internal accountancy procedures.

Focus: The airline industry gives us a perfect example of successful Focus strategies - that is the so-called 'Integrated Operators' of the air freight business. FedEx, the integrated cargo carrier, was the pioneer. Having developed a very efficient and fully computerised system for tracking individual parcels anywhere on its network it took the next logical step. In 1994, through its Website, it allowed its customers to book and pay for its services without restriction via the Internet. The e-commerce infrastructure developed by airlines allows collection and central storage of sales and marketing data. Airlines use this data to drive decision support tools for planning and marketing.

Porter's models proposed that the organisation's value chain can be used as a framework for identifying opportunities for competitive advantage, which can in either be cost or for differentiation. Information technology is spreading through the value chain. It enables an enterprise to better coordinate its activities and thus gives it greater flexibility in deciding its breadth of activities. Information technology can be used for strategic purposes not only in the external marketplace, but also in internal operations. Most models overlooked the potential strategic impact of applying information technology to traditional products and processes, or to transform the firm's current way of doing business.

Porter and Miller then proposed the use of an '**information intensity matrix'** to assess the role of information technology. The matrix helps in evaluating the information intensity of the value chain against that of the product. They suggested that information technology will play a strategic role in a high information intensity oriented industry. Their representation of the matrix is reproduced in Figure 2.7.

Wiseman broadened the scope of Porter's model and defined competitive advantage as 'the dominance of one competitor over another or others in an arena, with factors conducive to its

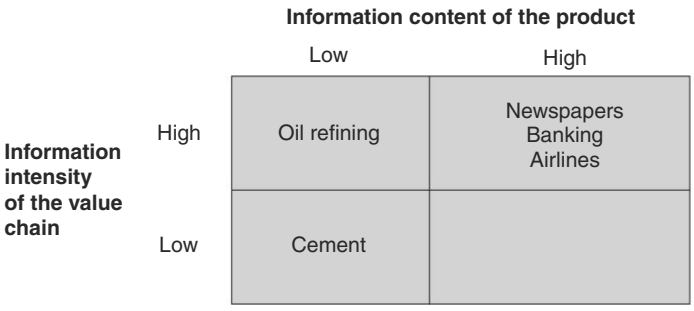


Figure 2.7 Porter and Miller's Information Intensity Matrix

success over a period of time'. An organisation's competitive space generally comprises many different arenas, which may be independent or linked. Again, an organisation may possess multiple competitive advantages or disadvantages within or among its arenas.

Wiseman combined his generic strategies with Chandler's growth strategies to produce a **'strategic thrusts'** framework intended as a means of identifying strategic IS. The ***strategic thrusts are major competitive moves made by an organisation.*** The five strategic thrusts identified are differentiation; cost; innovation; growth; and alliance. These thrusts which are described below are targeted at suppliers, customers and/or competitors. IT can be used to support the organisation's competitive strategy by supporting or shaping competitive thrusts.

- **Differentiation:** As described earlier, in differentiation, one or more unique features are added to a product or service.
- **Cost:** The strategic cost thrusts are measures intended to reduce the organisation's cost profile, by reducing or avoiding specific costs; or help suppliers, distribution channels, customers reduction or cost emission, so that the organisation receives preferential treatment or other benefits.
- **Innovation:** It is the adoption of the new products or processes using new features, techniques or methods. The **Product innovation** involves the creation of new products, or existing product with new features, in order to satisfy customer needs. The **Process innovation**, on the other hand, improves the efficiency or effectiveness of a process involved in the production or delivery of a product. An innovation thrust can be aggressive, or employed defensively to imitate or neutralise a competitor's innovation.
- **Growth:** There are several ways in which an organisation can grow—product growth; functional growth; geographical growth; and lateral growth. The growth of any kind tends to be associated with the economies of scale.

  The **product growth** may involve the following:

  - **'Length'**, i.e. new products of the same kind as existing ones (e.g. a PC supplier may add laptops and palmtops to its desktop lines).
  - **'Depth'**, i.e. variants to existing products (e.g. additional options which can be selected by customers when buying a desktop).
  - **'Width'**, i.e. new products which complement existing ones (e.g. modems, printers and accessories).
  - **Functional growth**, by performing additional business functions. Often this is through 'vertical integration' along the industry value chain, which may provide benefits from direct control over supply, distribution or service, such as cost reduction, quality assurance or reliability. Sometimes, the new functions are support services, such as the gathering and delivery of industry statistics.
  - **Geographic growth**, by acquiring from additional locations, or selling at additional locations.
  - **Lateral growth**, by applying excess capacity, by products or expertise, in order to address new marketplaces.

- **Alliance:** By an alliance, Wiseman means a combination of two or more groups or individuals, whether intra- or supra- to the organisation, which works together to achieve a common objective. The four types of alliance identified are: product integration; product development; product extension; and product distribution.

Wiseman also combined these strategic thrusts framework with an analysis of competitive targets to produce a **'strategic option generator'**, depicted in Figure 2.8. The competitive targets are divided into two groups. The system (user) targets are those entities involved with *using* the application; whereas the competitive arena targets are those competitors of the organisation (suppliers, customers, distribution channels, or rival arenas) whose competitive position is *affected* by the organisation's use of Information Technology and the thrust it supports or shapes.

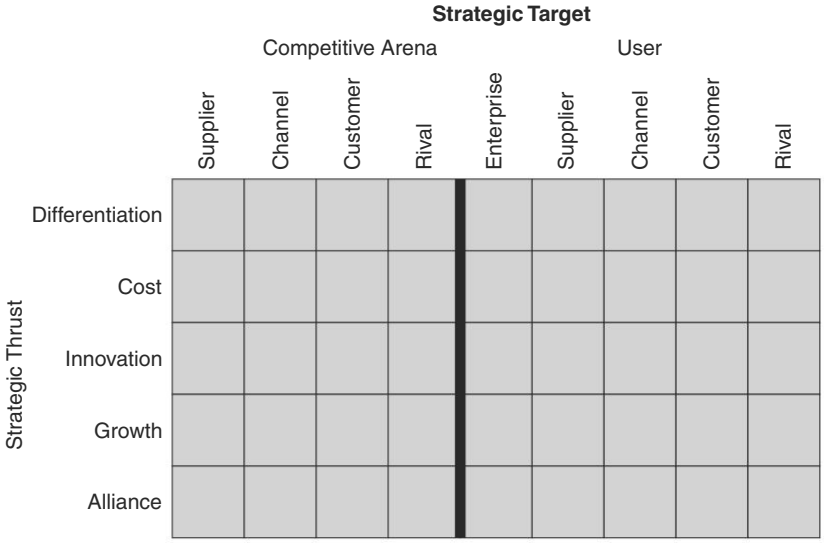


Figure 2.8 Wiseman's Strategic Option Generator

The competitive strategies can be generated through the procedure shown in Figure 2.9. In addition to Porter's and Wiseman's contributions, Earl opines the notions of offensive move and defensive reaction; and use of the strategic measures by the organisation itself or provision to the target.

Implementing Strategic Information Systems

IT is a critical enabler of the re-creation of the organisation. The recognition and exploitation of IT capabilities is fundamental to strategic choices of business scope, governance mechanisms, organisational reconfiguration, and competitive actions in the marketplace. Approached from a different perspective, IT can be used to create an opportunity for change in organisations, whether or not the technology is actually central to the delivery of the benefits sought. The business process redesign and '**business process re-engineering' (BPR)** movements became highly influential during the early 1990s. The BPR is a further development of the organisation value

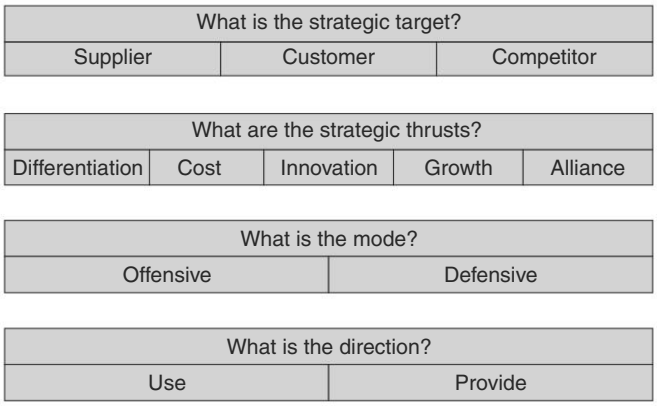


Figure 2.9 Earl's Procedure for Generating Competitive Strategies

chain models. What it essentially does is to re-assert that organisational process is more important than organisational structure, and that organisational structure (form) must be determined by what it is that the organisation does (function). IT is an enabler for BPR, because information systems support data flows, and hence are intrinsically oriented towards function rather than form, and because IT requires re-conception and re-development periodically. Such re-developments cause considerable upheaval and can therefore be used as a catalyst or opportunity for greater change than mere re-automation of existing arrangements.

> Business Process Re-engineering is fundamentally rethinking and radically redesigning business processes, in order to achieve dramatic improvements in quality, cost, speed and service.

The Strategic Planning Process, which is a very important phase of SIS implementation involves brainstorming and systematic search for the SIS opportunities. Wiseman suggested a five-stage process for effective SIS Planning.

- Introduce the Information Service Management to the SIS concept, which helps in describing the complete process using round-robin technique of idea generation to lower level management. Once the ideas are generated, it helps in taking approval to proceed with a defined set of ideas for meeting the needs.
- Conduct an SIS idea-generation meeting with middle level management. Test the SIS idea-generation methodology. Identify significant SIS areas for the senior management level consideration.
- Conduct an SIS idea-generation meeting with the senior management. Identify ideas and evaluate them together with the ideas generated by the lower and the middle level executives.
- Introduce the SIS concepts to the top level management. Discuss the ideas that were considered for the business. Take the approval of the top management and proceed with SIS idea-generation meetings with the business planners.
- Lastly, conduct the SIS idea-generation meeting with the corporate planners. Compare and match the ideas generated at various levels.

Wiseman points out that the whole idea is designed to introduce the strategic perspective on information systems which should match with the business strategies of an organisation. Under these idea-generation meetings, numbers of explicit steps that are being followed are:

- Competitive strategies being followed by the organisation is explained. Participants are introduced to the concepts of strategic thrusts, strategic targets and competitive strategy.
- Develop an understanding of the SIS possibilities and their strategic thrusts and targets.
- Review the organisation's competitive position by understanding its present business position and its strategies.
- Identify the SIS opportunities by generating the SIS ideas in smaller groups.
- Discuss the SIS opportunities with management to correlate and condense the ideas by using rich experience of the management.
- Evaluate the SIS opportunities by considering the competitive significance of the ideas.
- List out all the SIS ideas, select the best ideas and detail their competitive advantages and key implementation issues.

Generic ERP Selection Parameters

Integrate Business Planning: Does software requirements reflect needs driven by business strategy? Plan for IT alignment and define business benefits of IT projects. Also, inputs for business planning aids hardware sizing for the project.

Proactive needs Assessment: Are business needs well articulated in functional requirements? Do you need to outsource, use software as a service, or implementation in-house?

Seek Professional Advice: An adviser can make profound difference to the selection process, especially when you are unsure of priorities and of the available options.

Plan, Plan, Plan: Decide critical success factors. Develop a project plan considering these factors. Assess project risks and adjust project plans based on situations to arrive at defined budgets and time schedules, while meeting project success factors.

Total Cost of Ownership: Do not underestimate hidden costs. These include costs of training, maintenance, facilities management, hardware, planning for and performing data conversion.

Partner Selection: The choice of implementer is more important than the choice of software. Manage vendor risk—will the vendor be around when needed the most? What is the financial stability of the implementation vendor? What is the common experience on service and support from others who have worked with the vendor?

Change Management: This is the key to any software implementation, plan for change. Develop change management and communication plan as part of project charter.

Technology: Are we investing into the right technology? Do the vendors have a defined roadmap for the project? Does it support the latest trends and have a sustainable future?

Assess the Intangibles: What is the vendor's organisation culture? Are they open to business partnerships? What third party alliances do they have?

Source: *Dataquest*, April 30, 2007

Once an organisation is able to identify the SIS idea successfully, it is easier for the organisation to implement these systems. Organisations of all sizes are searching for new ways to successfully deploy complex, mission-critical, and often costly IT initiatives for the SIS. How do you build a company capable of changing as quickly as the marketplace it serves? How do you enhance customer satisfaction without overburdening employees? Raise productivity without increasing costs? There will always be plenty of healthy debate on how to fulfil these and other critical business imperatives, but no one would argue that any of it can be done without IT playing some role.

Another approach that the senior executives in an organisation may follow to compete in the age of information technology is to:

- Access information intensity.
- Determine the role of information technology in industry structure.
- Identify and rank the ways in which information technology might create the competitive advantage.
- Investigate how information technology might spawn new business.
- Develop a plan for taking advantage of information technology.

In today's competitive environment, organisations cannot afford to apply anything less than the same level of commitment to IT that they devote to other critical areas in the enterprise. It includes an unwavering dedication to finding and implementing strategies for success. The seven leadership strategies can improve the chances of success for every technology project: align IT to business strategy; make IT governance a priority; use metrics, but do not let them dictate strategy; commit a unified information infrastructure; create a shared CEO and CIO vision; develop CIO skills beyond the technology; and know when and how to partner.

SUMMARY

- A strategic information system is a topic which is very important, and highly dynamic. This chapter has outlined the emergence and development of theory in the area of management strategies and strategic information systems. With the change in business environment, the information needs of managers kept on changing. Organisations started using information systems for business purposes way back in 1950s for data processing activities and Transaction Processing Systems (TPS) emerged as a Strategic Information System as it started giving competitive advantage to the organisations. Later in 1960s, organisations started using the data generated by TPS for the purpose of management reporting and hence Management Information Systems (MIS) became critical applications for business organisations. No doubt, organisation got significant advantage from TPS and MIS systems, but these systems were too structured and never supported decisions of real-time changing needs of managers. From 1970s onwards, organisations started developing Management Support Solutions like DSS and ESS.
- With the emergence of Internet as the main business communication tool, organisations started looking at new methods of doing business to gain competitive advantage. Organisations implemented business models to support e-commerce, e-business and virtual organisation using

Internet as the main communication and networking technology. Today, most of the organisations are building M-commerce, AI and many other emerging technological solutions for their business.

- Strategic Information Systems (SIS) is an Information Systems solution implemented at any level that offers an organisation competitive advantage over its competitors. The SIS is concerned with a system which contributes significantly to the achievement of an organisation's goals and objectives.
- The SIS that helps the organisation to achieve competitive advantage can be achieved by Differentiation, Cost Leadership, Focused or Niche and Innovation. Organisations seek to gain significant advantages by implementing the SIS to alter the internal structure or the entire industry structure. Several frameworks exist which are intended to assist an understanding of the use of SIS based on the industry organisation, value chain, and strategic thrusts. Organisations seek competitive advantages over other rivals along the whole industry value chain.
- The Value Chain Model suggests that each organisation's activities can be divided into nine value based activities and are broadly categorised as primary and support activities. The primary activities include inbound logistics, operations, outbound logistics, marketing and sales, and after sales support. The support activities include procurement, technology, human resource management, and firm's infrastructure. Organisation's competitive advantage grows out of its ability to perform these activities either in a cost-effective manner or in a differentiated manner as compared to its competitors. None of these activities are independent. Information technology solutions are implemented for each of these activities in such a manner that overall optimisation of the product is done.
- Porter also suggested that an organisation's value chain for competing in a particular industry is embedded in larger stream of activities being performed by number of organisations in that industry which is defined as 'Value System'. The Value System may include suppliers, distributors and retailers.
- Porter's Competitive Forces Model suggests that the performance of the organisation is determined by the extent to which they cope with, and manipulate, and the five key forces which make up the industry structure. The five key forces defined are the bargaining power of suppliers; the bargaining power of buyers; the threat of new entrants; the threat of substitute products; and the rivalry among existing firms. Organisations, in general, tend to follow one of the four generic strategies to gain above-average performance over its competitors. The four generic strategies are: cost leadership; differentiation; cost focus; and focused differentiation.
- Charles Wiseman emphasised that organisations must start using information technology based solutions to gain competitive advantage. Wiseman suggested that the significance of the technology is more on its implementation to gain competitive advantage. An organisation must draw a complete IS plan as it helps the organisation to identify the key business processes and key decision points. The IS plan of an organisation must also match with the organisation plan.
- Despite the usefulness of these frameworks applied to the search for competitive advantages, these frameworks are market-oriented, and are not suitable to explain SIS developed in other non-market oriented industries, such as government. Another deficiency of these frameworks is the concentration on the competitive advantage to the exclusion of other perspectives. Owing to the wide adoption of SIS in the industry, the questions of sustainability of competitive advantage and of competitive necessity arise. This in turn leads to cooperative arrangements, including alliances, and at a more abstract level, collaboration.
- IT has become a significant factor in the operation and planning of information based enterprises. The strategic information systems theory has done much to enable the description, explanation and

prediction of behaviour. Porter and Miller suggested the use of an information intensity matrix to assess the role of information technology for strategic advantage. The strategic thrusts, which have been identified as a means of identifying strategic IS are differentiations; cost; innovation; growth; and alliance. IT can be used to support the organisation's competitive strategy by supporting competitive thrusts.

- In order to implement the strategic information system, organisations need to develop a complete strategic planning process. Wiseman suggested a five stage process for effective SIS planning under which SIS idea generation meetings are held at various levels in an organisation. The basic objectives of these meetings are to introduce the strategic perspective on information systems, which should match with the business strategies of an organisation.
- The importance of the information revolution is not whether it will offer a significant impact on organisation's competitive position or not, but when and how it will strike. Organisations that anticipate the power of information technology will be in control of challenges. Organisations that do not respond will be forced to accept changes that others have initiated and will find themselves at a competitive disadvantage.

KEY TERMS

After Sales
Alliance
Automation
B2B
B2C
Business Process Re-engineering (BPR)
C2B
Competitive Advantage
Competitive Forces Model
Cost Focus
Cost Leadership
Decision Support System
Differentiation
E-Business
E-Commerce
Executive Support System
Expert Systems
Focused Differentiation
Growth
Inbound Logistics
Information Intensity Matrix
Information Systems
Innovation
Internet
Just in Time (JIT)
Management Information Systems
Management Support System (MSS)
Marketing
M-commerce
Operations
Outbound Logistics
Primary Activities
Procurement
Strategic Information System
Strategic Thrusts
Support Activities
Transaction Processing System
Value Chain
Value Chain Model
Value System

SELF-STUDY QUESTIONS

1. Which of the strategic model identifies five forces that must be evaluated to understand organisation's competitive position in the industry?
   (a) Porter's Value Chain Model
   (b) Charles Wiseman Model
   (c) Porter & Miller Model
   (d) Porter's Competitive Forces Model

2. As per _____, Organisation activities are divided into five Primary and four Secondary activities.
   (a) Porter's Value Chain Model (b) Charles Wiseman Model
   (c) Porter & Miller Model (d) Porter's Competitive Forces Model
3. Which of the following NOT one of the support activities is as defined in the Porter's Value Chain Model?
   (a) Inbound logistics (b) Procurement
   (c) Human Resource Management (d) Technology Development
4. Information System solution that supports organisations competitive strategy is known as:
   (a) Transaction Processing System (b) Decision Support System
   (c) Expert Systems (d) Strategic Information System
5. Which one of the following is the popular methodology for developing Information Systems Architecture?
   (a) Business System Planning (BSP) (b) Porter's Value Chain Model
   (c) Business Process Re-engineering (BPR) (d) Charles Wiseman Model
6. _____is any system that offers an organisation a competitive advantage over its competitors.
7. _____ means to deliver the products or services at a cost-effective possible cost.
8. Business Process Re-engineering (BPR) is _____ rethinking and radically redesigning of business processes, in order to achieve _____ improvements in quality, cost, speed and services.
9. _____ is the way an organisation defines the strategy for the future.
10. Being unique in the industry by providing high-quality products at a competitive price, is an example of the _____ strategy.

REVIEW QUESTIONS

1. Define Strategic Information Systems.
2. List five Primary activities and four Support activities.
3. Name the five forces that an organisation needs to cope with or manipulate to remain competitive.
4. List the different phases of Information system.
5. Identify the era when organisations started using the power of Internet to manage their business.
6. Define the concept of Value system? How is it different from value chain?
7. How do you define competitive strategy?
8. List out the Strategic Information System planning stages.
9. How Internet technologies help organisations in gaining competitive advantage?
10. List the two commonly used Information Planning techniques.

QUESTIONS FOR DISCUSSION

1. Create a Value Chain model for a service sector organisation. How is this going to be different from a manufacturing organisation?
2. What do you mean by a Virtual organisation? Give examples of some of the Indian Virtual organisations.
3. List the advantages and drawbacks of RFID technology.
4. How can one measure the competitive advantage?
5. Identify two organisations that are following the differentiation and focused differentiation strategies.
6. 'The lifespan of SIS is short.' Comment.
7. How IT helps the organisations in gaining competitive advantage? Explain with examples.

APPLICATION EXERCISES

1. Search the Internet to identify two Indian organisations that are using RFID technology for their business. Study the application for which the RFID is being used by these organisations. List out the competitive advantages that these organisations have achieved after implementing the RFID solution.
2. Search for an online travel agent and compare its strategic model with one of the traditional travel agent in your locality.
3. Apply the Porter's Value Chain and also the competitive forces model on the online travel agent.

GROUP PROJECTS

1. Select rival car manufacturers and assign one each to a group. Study their offline as well as their online models to identify the broader strategies being followed by each company towards attracting new customers and retaining the existing customers. Prepare a report and make presentations.
2. Travel industry has adopted the Internet technology in a big way in India. Number of travel websites exists. Each group may select one travel site and develop the success and failure parameters. Compare this with any other industry that has moved to online space.

Caselets

1. IT—the Change Agent

The Indian insurance market is witnessing a phenomenal growth. This massive growth means that most Indian insurance companies are struggling to keep pace with this development. Since most Indian companies are spread across the length and breadth of India, managing data and analysing it in order to provide insurance policies suited to the requirements of the customers remains major task.

Technology is an extended capability to capture, store, process, develop, analyse, reformulate, comprehend and transmit data, events, ideas, knowledge, and wisdom. Aviva Insurance exploited IT as a change agent with an aim to be adaptive and agile, making the most of the opportunity of the current business environment. At Aviva, they have applied a portfolio framework to IT, driven by two key variables: business criticality and newness or innovation. The new products introduced are designed differently, so the back office operations differ. The main challenge was to offer flexibility and yet offer uniformity in the operational processes. In order to meet these challenges, they developed a system that offered the desired flexibility in launching customised products and campaigns for specific markets; that in turn helps them to accelerate the time to market.

Questions for Discussion

1. Study Aviva's IT integration model and suggest what level of innovation they have achieved by integrating technology into their business.
2. Why have they referred to IT as 'Change Agent'? What change they have attained by integrating the technology?

2. IT Innovations in Retail

Norbert Segers is a cautious decision maker, specially when it comes to his $5 billion Belgian supermarket chain Colruyt's IT outsourcing decision. Being guarded does not mean he is against the organisation's outsourcing policy. In fact Colruyt started outsourcing retail applications in a small manner about three years back. A majority of IT applications and maintenance in the retail space are outsourced to TCS and NIIT in India. This was done because of lack of resources and talent in Belgium. The cost advantages were also the factor but they decided to outsource primarily because of the resource constraints.

A majority of retailers worldwide are changing their mindset when it comes to integrating technology. For example, Biz-2-me, a New York based Product Company tied up with Aspire Systems in India to develop retailing products to manage customer loyalty programs. Wal-Mart, who is a leader in the retail industry, created patterns which are being followed by other retailers in more innovative manner. Larger retailers like Target and Tesco have opted to set up captive IT centers, while others such as JC Penny, Marks & Spensers, Carrefour and Office Depot have been outsourcing work to companies in India and China.

The competitive challenge lies in understanding the customer needs and developing an innovative experience that enables customers to buy what they want, where they want and from whichever channel they want. Each customer is equipped with better information about products, pricing and promotion, has more options than ever before and expects a seamless multichannel experience.

Today, the retailers find themselves challenged as they use Information technology not just to cut cost, but to make money through multi-channel customer experiences. In-store technologies like self-checkouts, point of sales and wireless devices present opportunities for retailers to address consumer needs to some extent. Integrating fulfilment, merchandising and marketing across all channels are some of the other crucial concerns one needs to concentrate upon.

Questions for Discussion

1. Study some of the Indian retailers and identify the technological innovations that they have adopted.
2. Identify the key challenges of the Indian retailer apart from what has been highlighted in the case.
3. Large foreign retailers are dependant on IT outsourcing, what about the Indian retailers?

Answers to Self-Study Questions

1. (d)
2. (a)
3. (a)
4. (d)
5. (a)
6. Strategic Information Systems (SIS)
7. Cost Leadership
8. Fundamental, Dramatic
9. Strategic Management
10. Differentiation

The McGraw·Hill Companies

The McGraw-Hill Companies

Section II

Technology Infrastructure

CASE II: IT Innovations

The rapid developments in IT and information management have left senior managers uncertain about their strategy. They want to know how to compete with IT to improve business performance. The problem is broken into four main challenges. First, senior managers must develop the right mindset to manage business change; they must realise that adjustments to strategy, organisational structure, processes and culture needs to be supplemented with knowledge management, information management, and an understanding of the critical role of IT. Second, they must also understand how information creates value—through risk management, more efficient processes, better products and services, and innovation. The third challenge is to use IT to build organisational competencies that will enable a company to operate more efficiently, perform alongside competitors and provide distinctive value to customers. Finally, managers need to be able to balance flexibility in local markets with cost reducing standardisation of IT infrastructure, and processes.

Introducing new IT is a risky business. But failure is not inevitable; as a number of success factors can be identified. One of the most important success factors is that technical innovations need to be applied to new business ideas to produce significant benefits. Such ideas usually come either from recognition of a business opportunity by executives, or from identification of customer requirements by those at the 'sharp end'. When it comes to implementation, it is important to involve users throughout the organisation rather than just specialists, especially when technology is immature. The external suppliers must remain under the company's direction. A high-level sponsor and a 'project champion' are also required, as is strict time management. However, companies must be prepared to accept that a system may provide just 80 per cent of desired functionality to begin with.

The impact of technology on organisations will be enormous. In order to benefit, organisations will need the skill and expertise of all their people; technical or managerial competence on its own will simply not suffice. Yet managers and IT professionals continue to compete with each other. The solution is scenario thinking, in which managers and technologists work together to construct plausible strategic scenarios. Since this process involves challenging old assumptions and developing new ones, the two sides together create a shared language. The internet technology will enable more employees—and suppliers, and customers—to participate in a continuous process of environment development.

The major IT change programme often run into serious difficulties. Yet even as things fall apart on the ground, the view from the top remains rosy. Technology's advocates may characterise 'non-believers' as simply resistant to technology, and use measurements systems with too narrow a focus. This is just one way in which IT projects, like other organisational improvement initiatives overlook opportunities for building an organisation's learning capabilities. One usually thinks of introducing new IT as a one-time opportunity for change. But if we consider the use of the technology as an opportunity for learning, we can continually improve the organisation's functioning. The learning implies engaging people at all levels in the change process, not just requiring new behaviours in the traditional 'top-down' way. The organisations that can overcome the challenges of continuous learning-driven change will escape the 'gaps'—between different perspectives at different corporate levels, between aspirations and results, and between experience and learning—that mean they are keen to adopt too many IT initiatives.

Owing to modern communications technology, decentralised organisation becomes possible; control is being passed down to workers or outsourced to external companies. In fact, companies are moving towards an economy, which will be characterised by shifting coalitions of freelancers and small firms. Although this recalls pre-industrial economic models, dominated by large numbers of competing micro businesses, a critical difference is that these small, agile companies will enjoy the information resources traditionally associated with large corporations. The power of these type of organisations can be seen in the explosive growth of the internet, which is taking place without any overall management. The role of the manager will change dramatically as companies see the virtue of achieving results by allowing them to emerge rather than by controlling them at all stages.

The linux operating system is one such popular example, which was made available in the open source. The programmers were encouraged to download free of cost and are allowed to use it, test it, and modify it as they found fit. Some programmers fixed bugs, tinkered with the original code, and added new features, and they too posted their work on the Internet. As the Linux kernel grew, it attracted the attention of more and more programmers, who contributed their own ideas and improvements. The Linux community soon encompassed thousands of people around the world, all sharing their work freely with one another. Within three years, this informal group, working without managers and connected mainly through the Internet, had turned Linux into one of the best versions of UNIX ever created.

In a traditional software development company, the software project development would have taken a more structured process with time lines defined, project team defined, fund allocations for each activity, etc. The software project in traditional manner would have cost an enormous amount of money, taken years to complete, and quite possibly produced a system less valuable to users than Linux.

What the Linux story really shows is the power of a new technology—in this case, electronic networks—to change fundamentally the way work is done. The Linux community, a temporary, self-managed gathering of individuals engaged in a common task, is the model for a new kind of business organisation that could form the basis of a new kind of economy.

Similarly, another kind of example in this space is that of Wikipedia. The customers or the users are the content providers and are responsible for the development of the directory. One may find number of similar examples on the Internet space. The fundamental unit of this economy is not the corporation but the individual. The tasks are not assigned and controlled through a stable chain of management but rather are carried out autonomously by independent contractors. These electronically connected freelancers—join together into fluid, temporary networks to produce and sell goods and services.

The evolution of the Internet itself followed the same concept. One also sees it in the emergence of virtual companies, in the rise of outsourcing and telecommuting, and in the proliferation of freelance and temporary workers. Even within large organisations, importance of ad hoc project teams, are in the rise as 'entrepreneurs', and in the formation of independent business units.

With the introduction of powerful personal computers and broad electronic networks—the economic equation has changed. Since information can be shared instantly and inexpensively among many people in many locations, the value of centralised decision-making and bureaucracy decreases. The individuals can manage themselves to coordinate their efforts through electronic links with other independent parties.

A shift to a freelance economy would bring about fundamental changes in virtually every business function, not just product design. The supply chains would become ad hoc structures, assembled to fit the needs of a particular project and disassembled when the project ends. The manufacturing capacity would be bought and sold in open markets. Independent, specialised manufacturing companies would undertake small batch orders for a variety of brokers, design shops, and even consumers.

The Internet is the greatest model of a network organisation that has emerged and it reveals a startling truth in a freelance economy; the role of the traditional business manager changes dramatically and sometimes disappears completely. The work of the temporary company is coordinated by the individuals who compose it with little or no centralised direction or control. Of course, this kind of coordination occurs all the time in a free market and one usually takes for granted that it is the most effective way for companies to interact with one another. But what if this kind of decentralised coordination were used to organise all the different kinds of activities that today go on inside companies?

One of the things that allow a free market to work is the establishment and acceptance of a set of standards—that governs all transactions. These standards can take many forms—contract systems of ownership and procedures for resolving disputes. Similarly, for a freelance economy to work, whole new classes of agreements, specifications, and common architectures will need to evolve. We see this already in the Internet, which works because everyone involved conforms to certain technical specifications. But standards do not have to take the form of technical specifications. They may also take the form of routine processes such as

those which allow a group of doctors and nurses to collaborate in an operating room.

To meet the challenges of the future, it will be essential for us to recognise and to question the biases of our existing mindset. A freelance economy might well lead to a blossoming of wealth, freedom and creativity but it might also lead to disruption and dislocation. Free agent workers, separated from the community safety nets of today may find themselves lonely and alienated and separated into 'haves' and 'have-nots'. In order to seize the opportunities of this possible golden age of business—and to avoid the potential problems—we need to think as creatively and as wisely as we possibly can.

Questions to Think About

1. Study some of the IT innovation projects and highlight how they are driving these projects.
2. What is the role of customers/users of the projects that you identified above?

Chapter 3

Computer Hardware and Number Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What computers are all about?
- How did computers evolve?
- How are computers categorised into broader classifications?
- How is the architecture of a computer?
- What are the various components of a computer?
- What are the number systems, Boolean algebra and logic gates?
- What are the emerging trends in the world of computers?

INTRODUCTION

The information technology has changed manifold in last two decades. In order to remain competitive, organisations need to keep pace with these changes in computing and communication technologies which are the main constituents of information technology. This chapter will focus on the computer hardware part of information technology from a historical perspective starting from the critical days to the current trends and also the number systems on which these computers work.

The twenty-first century is the century that is driven by information technology. People have already started experiencing the new ways of living and working. The technology has started playing a vital role in our lifestyle; the way we work, the way we communicate, the way we shop, the way we enjoy, all has dependence on information technology. The key to succeed in this

information technology driven environment is to manage the information, which is the most vital resource. The only way one can take advantage of and manage the immense available information is through proper understanding of how computers work and through the ability to use computers. Most people believe that the ability how to use a computer is a basic skill necessary to succeed in life and to function effectively in society.

This chapter will help to join the *Information Age* by facilitating the learning of the definition and characteristics of computers, and computer systems. Even if one does not have a home computer or use a computer at workplace, computers are still being used in one form or other. Many of the routine activities in today's society are being performed by computers. For example, when we plan our holiday—rail/plane seats are often reserved with the help of computers; many of the bills we pay (electricity, telephone, insurance, etc.) are calculated and printed by the computer. World-wide computers are used in many more areas like traffic control, space research, hospitals, etc. There are three basic concepts that one needs to know in order to be able to think sensibly and talk intelligently about computers in today's technology driven society—What are computers? What can they do? How can one communicate effectively with computers?

WHAT ARE COMPUTERS?

A computer is an electronic device that manipulates data. It has the ability to store, retrieve, and process data.

Before we define the term 'Computer', let's understand the genesis of computing – which means something to do with calculation, but man has been using his brain to do just that for centuries. The Egyptians built the pyramids; whoever built Stonehenge left a calendar which can still accurately predict eclipses; and even radio and television were invented—all without computers! What is so special about them that we need computers today? It cannot simply be because they are calculating devices. We have many forms of such devices—the Abacus (still used in the Far East), pocket and desk calculators, even POS (point of sale) at supermarket—all of which are cheaper and easier to use than computers. So why was the computer invented?

The scientists and researchers found that this machine can be used for many other applications other than the fast calculating machine. The real need was felt during World War II and slowly the computers have moved from scientific laboratories to offices, homes, schools and are now an integral part of every day life. After number of research results, a computer named 'ENIAC' had a formal dedication ceremony on 15th February, 1946. The problems which early computers had to solve were mostly mathematical. Today, computers are used to:

- forecast the weather;
- operate machines;
- cut shapes out of metal sheets;
- even guide spacecraft to the moon;
- set and print newspapers and books;
- help in diagnosing diseases;

- find out obscure documents in archives;
- manage any business application like accounting, invoicing, stock control, payrolls, research and development, and business; intelligence, etc.

The original objective for inventing the computer was to create a fast calculating machine. But in over 80 per cent of computing today, the applications are of a non-mathematical or non-numerical nature. To define a computer merely as a calculating device is to ignore over 80 per cent of its work. If not as a calculating device, then how are we to define a computer? Basically, computers act upon information—in computing terminology, this is called 'data'.

What is a computer system? ***A computer is an electronic device that operates under the control of a set of instructions that is stored in its memory unit.*** A computer accepts data from an input device and processes it into useful information which it displays on its output device. Actually, a computer system is a collection of hardware and software components that help to accomplish many different tasks. The hardware and software in a computer system are tightly integrated; software drives the hardware, which in turn provides the computational tools. A typical computer system is shown in the figure below.

- ***The Hardware*** *consists of the computer itself, and any equipment connected to it. The Hardware includes all of the physical, tangible parts of a system—such as central processor, memory, display devices, storage media, and printer, etc.*
- ***The Software*** *is the set of instructions for controlling the hardware devices, instructing computers to transform data into information and many other information processing tasks. The Software can also be defined as written programs or procedures or rules and associated documentation pertaining to the operation of a computer system and that are stored in a storage device.*

TYPICAL COMPUTER OF TODAY

Evolution of Computers

The Computer Hardware is all the physical components of a computer.

The history of computers dates back to 500 BC, when the 'ABACUS', a device of counting beads and string, was used to do calculations. The abacus is still widely used in many countries, but does not offer long-term storage of information. In 1614, John Napier developed logarithm tables, which provided the methods by which multiplication and division could be achieved through addition and subtraction. In 1620, William Oughtred developed the 'Slide-Rule' based on the concept of logarithms. Both these inventions were widely used until the development of small electronic calculators in late 1960s.

The two other important developments that took place in the Seventeenth Century, were the production of a mechanical calculator—Pacaline by Blaise Pascal in 1642 and more powerful calculator by Gottfried Leibnitz in 1694. This calculator could perform addition, subtraction, multiplication, and division and was called the 'Leibntiz Wheel'.

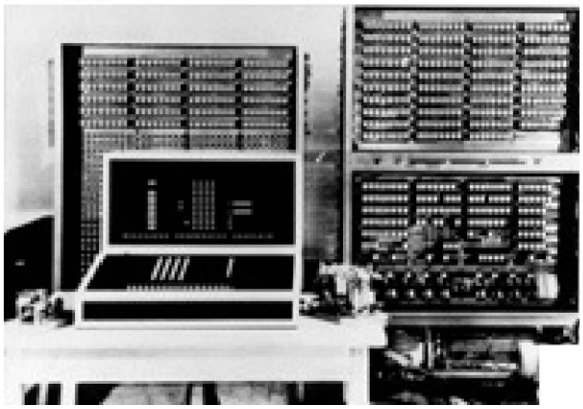
The Computer Software is set of instructions that are used to direct the operation of a computer.

Typical Computer of Today

In 1832, Charles Babbage, thought of building a general purpose computing machine and planned for 'Analytical Engine', a steam driven calculator which was able to perform calculation upto 60 decimal digits, and to handle any type of mathematical problem. The input to these machines was based on punched cards. Charles Babbage has defined the path for the modern digital computers, because the Analytical Engine was built around the same five components (Input, Control, Store, Arithmatic and Logic Unit (ALU) and output) used in modern digital computers. Hence, he is known as the Father of Modern Computer Science. His disciple, a brilliant mathematician, Lady Augusta Ada, developed the binary number system for Babbage machine. She is considered to be the first programmer in the world, and the programming language ADA is named after her. In 1890, Herman Hollerith developed the punch card tabulator to analyse data. In 1954, an English mathematician, George Boole, developed two stage algebra called 'Boolean Algebra', which is binary in nature.

The first digital Computer 'Z_1', using binary arithmetic and program use control was built by Konrad Zuse of Germany in 1935. This was a mechanical machine. After that 'Z_2 machine' using electromagnetic relays was developed. In 1943, Harvard University, in conjunction with IBM, produced their 'Mark I Computer' based on electromagnetic relays. During 1943–46, John William Mauchly and J.P. Eckert, developed the first large general purpose computer at the University of Pennsylvania, the 'ENIAC'—the Electronic Numerical Integrator and Computer.

Z2 Zuse Computer



Z2 Zuse Computer

Developments followed rapidly, but perhaps the next most significant event was the production of a paper in 1945. John Von Neumann, who introduced the concept of stored program use control, included the following architecture:

- An Arithmetic and Logic Unit handles mathematical and logic operations.
- A Control Unit directs the proper sequencing of a computer's instructions.
- An internal, or primary memory, temporarily holds data and program.

- The Input and Output devices move into and from the computer systems.
- An outside recording, or secondary storage devices, permanently hold data and program.

ENIAC Computer

The above architecture led to the design of 'EDVAC'—The Electronic Discrete Variable Automatic Computer. In the meantime, Maurice Wilkes at Cambridge University had developed 'EDSAC'—The Electronic Delay Storage Automatic Computer. EDSAC became operational in 1949 and was the first machine to have an operating system. From that electronic EDSAC started the era of the first generation computers.

ENIAC Computer

In 1951, John Mauchly and J.P. Eckert formed their own company to create a commercially usable general purpose computer, the UNIVAC I. It was the first general purpose computer, designed specifically for business data processing applications. In the late 1950s, both Jack Kilby at Texas Instruments and Robert Noyce at Fairchild Semiconductor discovered that registers, capacitors, and transistors could be made from the same semiconductor material at the same time. Any number of transistors could be etched on silicon and thus the integrated circuit was born and refined. It was also during the same time that the integrated circuit was christened as a 'chip'.

UNIVAC Computer

Gene Amdahl's revolutionary IBM System/360 series of mainframe computers was also introduced in the 1960s. They were the first general purpose digital computers using integrated circuit technology. The coupled with the commercial success of computers, miniaturisation, which had come about through various technological innovations, led Ken Olsen and his Digital Equipment Corporation (DEC) to produce first commercial minicomputer.

UNIVAC Computer

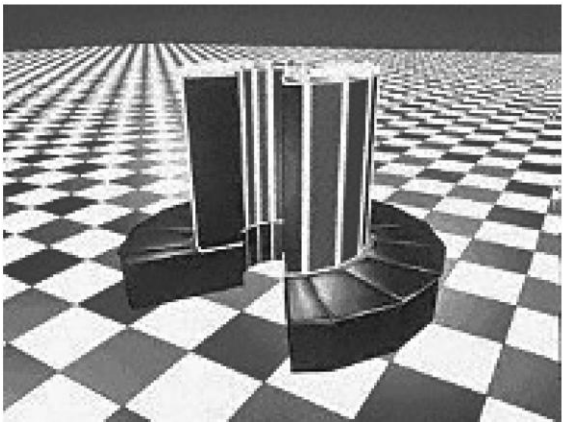
In 1970, Intel created a memory chip that could store a kilobit of information. Another innovation at Intel came from Ted Hoff, who further improved the integrated circuit by compressing 12 chips into four.

The arithmetic and logic functions of several chips could be contained on one chip called a microprocessor. This microprocessor, known as Intel 4004 made the development of the small computer, or microcomputer, a possibility. However, this chip could handle only four bits of data at a time. Eventually, eight-bit microprocessor chips were developed and were used in the early microcomputers.

The earliest microcomputer, the 'Altair 8800', was developed in 1975 by Ed. Roberts, called the father of the microcomputers. This computer used an early Intel microprocessor and had less than 1 K of memory.

At the same time supercomputers were being developed. In 1976, Seymour 'Cray's Cray-1 supercomputer' was delivered to Los Alamos Scientific Laboratory in New Mexico, and a Control Data Corporation CYBER-205 was used by the Meteorological Services in the United Kingdom for weather forecasts.

The market for software was also growing. In 1974, Bill Gates and Paul Allen developed Microsoft BASIC, a high-level language for microcomputers and later went and developed the most popular 'DOS operating system'. In 1981, IBM presented their first Personal Computer, using 16-bit microprocessor. This introduction helped legitimise the microcomputer's use in business.



Cray-1 Supercomputer

Adam Osborne introduced a truly portable microcomputer in 1981, the Osborne I. It could be manufactured in just over an hour's time, using only 40 screws to put together the easy-to-find parts. By 1984 the IBM PC had become the industry standard with hundreds of companies designing software for it. Another benchmark in the microcomputer revolution was the introduction of the Apple Macintosh in the early 1980s. The Macintosh was visually oriented, and its mouse made it remarkably easy to use.

In 1986, the 'Compaq Deskpro 386' computer, the first to use the powerful 32-bit Intel 80386 microprocessor, was introduced. In 1987, IBM introduced its new line, the PS/2 series, which was based on a new architecture called micro channel architecture. Apple made its move into the business world with the introduction of the powerful Macintosh II computer. The Microsoft Corporation also introduced a new operating system for microcomputers, called OS/2 that allows application program to take advantages of the newer computers' multitasking techniques. In 1988, IBM introduced a major new series of mainframes for business users called the AS/400 series. In 1989, Intel introduced 25 MHz 80486 chipset and Apple introduced its Macintosh Portable. The decade of 90s was full of inventions and introduction of new technologies from leaders like Microsoft, Intel, Apple, IBM, etc. with substantial power and miniaturisation. Netscape Navigator and Internet Explorer were introduced for internet browsing. By the end of the century

and the beginning of the new century, AMD came up with 1 GHz Athlon processor; and Intel introduced a 1.5 GHz Pentium IV processor. Microsoft captured the PC Operating system market with Windows OS and launched Windows 2000. In 2002, Apple introduced iMac with flat panel screen. Microsoft launched Windows Vista in 2007 and later Windows 7 and Developer Previews are available for Windows 8.

COMPUTER GENERATIONS

Over time, computer is characterised by a major technological development that fundamentally changed the way computers operate, resulting in increasingly smaller, cheaper, more powerful and more efficient and reliable devices. These changes are recognised as a progression of generations, each characterised by specific developments. Generations of computers and their characteristics are given below:

First Generation—Vacuum Tubes (1939–1959)

The first generation computers were powered by thousands of vacuum tubes for circuits and magnetic drums for memory. These computers were large because of the massive number of vacuum tubes that were required. The tubes themselves were very large in size similar to the size of electric bulb. They required lot of energy, and in turn generated much heat. The first generation computers were very slow, consumed huge amount of power with poor reliability and low accuracy. First generation computers relied more on machine language to perform operations and inputs were based on punch cards and paper tapes. Z1, Z3, and UNIVAC I are some of the examples of first-generation computers.

Univac I Computer

Second Generation—Transistors (1959–1965)

The transistors replaced the vacuum tubes in the second generation computers. The transistors controlled the flow of electricity through the circuits. The use of transistors was a breakthrough in technology that allowed computers to become physically smaller, more powerful, more reliable, and even faster. The transistor was developed at Bell Labs in 1947 by William Shockley, J. Bardeen, and W.H. Brattain.

The transistors were less expensive and smaller, required less electricity, and emitted less heat than vacuum tubes. In addition, fewer transistors were required to operate a computer; they were not as fragile as vacuum tubes, and lasted longer. As the components were substantially smaller,

the size of the computer itself could be reduced considerably. These computers used magnetic core as main memory and used card readers and printers for input and output. The second generation computers moved from machine language to assembly language, which allowed the programmers to write instructions in words rather than binary digits as in machine language. Some examples of the second generation computers are:

- IBM 70, 1400, 1600 series
- Honeywell 400 800 series
- Burroughs B 5000, 200 series
- GEC's GE 645, 200 series
- UNIVAC's Univac III

Third Generation—Integrated Circuits (1965–1971)

Third generation computers used integrated circuits (ICs). These integrated circuits were smaller, more efficient, and more reliable as compared to vacuum tubes and transistors. Also, the memory technology was improved and by 1969 as many as 1,000 transistors could be built on a chip of silicon.

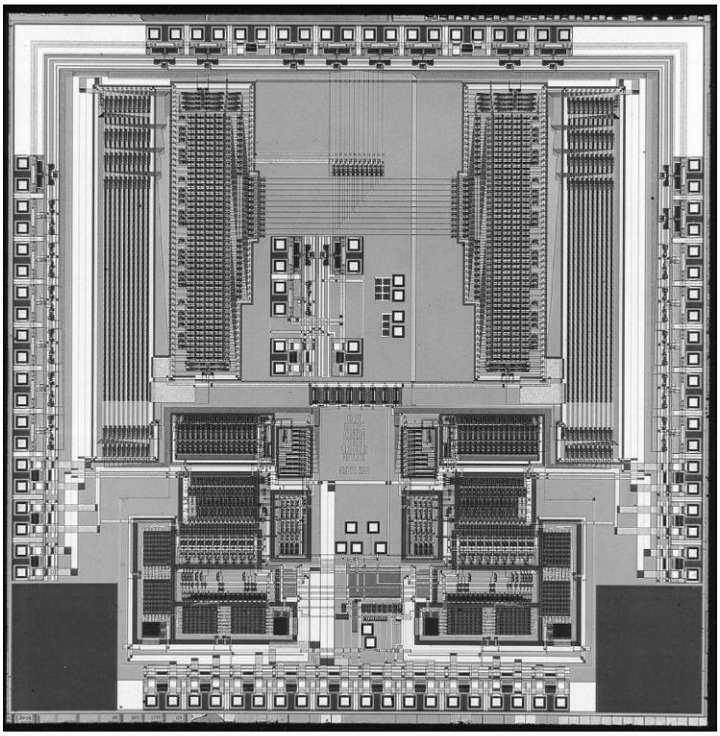
The concept of operating system was introduced which meant that human operators were no longer required and processing could be done at computer speeds rather than human speeds. Another phenomenon that was introduced in this generation was that of families of computers. As a result, the same program could be used with other computers of the same family.

The Third generation computers used secondary storage devices, such as magnetic tapes and magnetic disks, which are located outside the computer. The use of faster input/output devices like keyboards and monitors contributed to the enhanced utility of these computers for multiprogramming, wherein a number of programs could be executed simultaneously by a single computer. Some of the third generation computers are:

- IBM 360, 370 series
- PDP—8 series
- UNIVAC 1108, 9000 series, etc.

Fourth Generation—PCs and VSLI (1971–1991)

The fourth generation is the generation of Large-Scale Integration (LSI) of chips with several thousand transistors and microprocessors (based on **Very-Large-Scale Integration (VLSI)**). The development of VLSI made the development of the microcomputer possible; this was followed by the Intel series of microprocessors. The application programs for microcomputers were developed, which allowed home and business users to adapt computers for word processing, spreadsheet, file handling, graphics, and much more. The VLSI allowed lakhs of transistors to be placed on one chip. The **Ultra Large-Scale Integration (ULSI**) allowed over 100 million transistors embedded on a single chip.



Integrated Circuit of Early Days

The input/output devices used in fourth generation computers are very advanced such as: audio terminals, graphics terminals, optical readers, etc. The fourth generation computers also introduced concept of Graphical User Interface (GUI), Mouse operation etc.

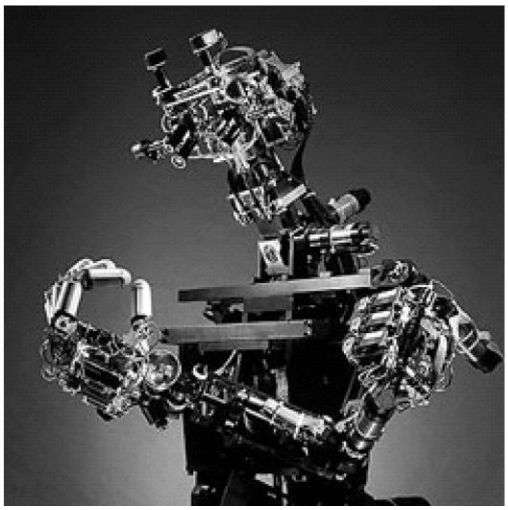
Microprocessor based Personal Computer

Fifth Generation—Artificial Intelligence and Internet (1991 Till Date)

The fifth generation computers are more intelligent and have 'thinking' power and capacity to take decisions. The concept of **Artificial Intelligence (AI)** is being used in these computers and the processors used are known as 'Knowledge Processors'. The automatic programming, computational logic, pattern, recognition, and control of robots are the processes, which require skill and intelligence. These are some of the applications of Artificial Intelligence. Although expert systems are already being used for specialised applications, true artificial intelligence, or computers that can think, are still concepts of the mind. **The grand scale integration (GSI)**

happened, which allowed over thousand million transistors to be embedded on a single chip. The GSI, allowed the computer to perform teraflop (trillion floating point processing per second) of data. The fifth generation also introduced the concept of parallel processing, which was necessary for AI to happen. The goal of the fifth generation computing is to develop devices that respond to natural language input and are capable of learning and self-organisation.

Another important facet of the fifth generation computer is the evolution of Internet for the business applications. The World Wide Web was developed and the first internet browser called 'Mosaic' was introduced. The mobile technology revolutionised this era.



AI Based Robot

CLASSIFICATION OF COMPUTERS

The computers are available in different shapes, sizes, processing capacities, and weights. Owing to these different shapes and sizes they perform different types of jobs and have different functionalities. A computer that is used in a home differs in size and shape from the computer being used for business purpose. Here, we are going to introduce different classifications of computers one by one. However, the categorical distinctions among these groups are becoming blurred as technology progresses. Today, many of the new, smaller machines have the characteristics and capabilities of the larger machines of yesterday.

In addition to relative computing power, other factors are also used to categorise computers and these are:

1. **Architecture:** The architecture refers to the design of the computer circuits. It includes the number and type of the central processing units. The architecture also includes the number and size of the processing registers.
2. **Processing Speed:** It is the number of instructions that a computer can process per second. It is usually measured in millions of instructions per second (MIPS). An instruction specifies the computer operation to be performed and the data to be used. Generally, the higher the classification, the more MIPS the computer will have and the faster it will process data.
3. **Primary Storage:** The amount of primary storage that the CPU can access and use is also important. It provides the CPU with temporary storage for instructions and data.
4. **Secondary Storage:** Generally, the higher the computer classification, the larger will be the capacity of the secondary storage device. The secondary storage permits permanent storage of instructions and data.

5. **Output Speed:** Typically, this factor describes the speed at which output can be printed. Generally, the larger the system, the faster the output devices will be.
6. **Multi-user:** The number of users that can simultaneously access the computer is also an important factor.
7. **Cost:** The price is usually a reflection of the power of a computer system. Therefore, the higher the classification, the larger the price tag will tend to be. The price of a computer also depends on the options that are purchased.

It is very difficult to exactly draw a line of demarcation between categories of computers. We have tried to define here the classification of computers as follows:

1. According to function
2. According to purpose
3. According to capabilities

According to Function

According to Function, computers can be classified into three types. These classification of computer based on principle of operation and hardware structure.

(a) Digital Computer
(b) Analog Computer
(c) Hybrid Computer

Digital Computer. A digital computer works with data in term of discrete number or digit. These numbers are used to perform, arithmetic calculations, and also make logical decision to reach a conclusion depending on the data they receive from the user. All the expressions are coded into binary digits (0 and 1) inside the computer and it manipulates them at very fast speed. The instructions and data are fed to the computer in the form of discrete electrical signals. The digital computers are easy to program and are in general purpose use. Almost all personal computers (PCs) are best examples of this category.

The digital computers are programmable electronic devices that perform mathematical calculations, compare values and store results. They recognise data by counting discrete signal representing either a high or low voltage state of electricity.

Analog Computers. The analog computers actually are a measuring device. An analog computer measures continues type of data and use a physical quantity, such as electric current, speed, weight etc. Analog Computers are the first computers being developed and provide the base for the development of modern digital computers. These computers are mainly made of electrical devices like resisters, amplifiers & transistors. Analog machine has a very limited memory and can perform only certain type of calculations, which make it specialised machine, suitable for engineering & scientific calculations. In general, Analog computers are very fast in processing because all the operations performed in this

The analog computers recognise data as a continuous measurement of a physical property like voltage, pressure, speed and temperature.

machine are parallel but accuracy of these machines is quite low. The speedometer and millimeter (used in vehicles), Electric meter & Gas meter (fixed on the supply line of the house) Pressure gauges & Thermometers are the general example of the analog devices.

Hybrid Computers. A hybrid computer is one which combines the analog & digital capabilities in the same computer system. The hybrid computers help the user to exploit the machine's ability to process both continuous and discrete data. These machines are generally used for scientific applications and it is also used as a controlling device in an industrial process. The results can be obtained either as analog signal or discrete signal. The example of a hybrid system is an electronic device 'MODEM'. A modem is a device which can transform analog signals to digital signals and vice versa.

The hybrid computer is one that processes both analog and digital data.

According to Purpose

The computer can be classified according to purpose in two ways.

(a) General Purpose
(b) Special Purpose

General Purpose. These computers are designed to solve wide variety of problems from different fields. The hardware and the software of such system are adaptable as per different environments. These computers are used for different purposes like inventory control, record keeping, accounting, payroll etc.

A 'General Purpose Computer' is a machine that is capable of carrying out some general data processing under program control.

Special Purpose. As the name suggests these computers system are used only for specific purposes or application. These special purpose computer systems may be defined as a stored programme computer, whose architecture is oriented towards one or more specific applications. These computers handle very narrow categories of data processing activities. Some example of special purpose computer with their area of application is as follows:

A special purpose computer is designed to operate and solve restricted class of problems.

(i) Computer used for Process Control in an industry.
(ii) Bio-medical X-ray instrument used only for X-ray.
(iii) ECG machine which is used for ECG test
(iv) Computer used for air-traffic control.
(v) Computer system which is used in Robots.

According to Capabilities

According to capabilities computers could easily be classified into minis, micros mainframes and super by considering their size, performance, and cost. However, today these definitions are not so clear, due to the ever increasing pace of common usage altogether. These are obviously

terms used to describe the approximate position in the hierarchy to which the products belong. In order To understand this mass of jargon, it is still necessary to understand the older definitions of the terms:

(a) Super-computer
(b) Mainframe-computer
(c) Mini-computer
(d) Micro-computer

Supercomputers. The largest computers are **supercomputers**. They are the most powerful, the most expensive, and the fastest. They are capable of processing trillions of instructions per second. The examples of users of these computers are governmental agencies, the National Weather departments, the Defence Agency, etc. The Cray supercomputer is nicknamed 'Bubbles', because of its bubbling coolant liquids. The Cray supercomputers, the first of which was invented by Seymour Cray, now maintains 75 per cent of the supercomputer market. The supercomputers are used for tasks that require mammoth data manipulation. The Multiple number CPUs are used in these computers to achieve high processing speed. The high storage densities are achieved by using magnetic bubble memories and charge couple devices. The other computers in this category are CRBER 810 and 830, Appro Xtreme-X1, and NEC SX3.

The supercomputers are the most powerful computers and are widely used in scientific applications such as aerodynamic design simulation, processing of geological data etc.

Mainframe-Computers. These are the largest of computer systems, not necessarily the fastest or most powerful. The mainframe computers process data at very high rates of speed, measured in millions of instructions per second. They are quite expensive, and truly powerful. The mainframes are designed for multiple users and process sizeable data quickly. Banks, insurance companies, manufacturers, mail-order companies, and airlines are typical users of mainframe computers. The mainframes often act as 'servers'—computers that control the networks of computers for large companies.

The Mainframe Computers are usually slower, less powerful and less expensive than supercomputers and can support hundreds or thousands of users, handling massive amounts of input, output, and storage.

Mini-Computer. Thin is a medium-sized computer and can vary in power from a very large and powerful micro to small mainframes. A small minicomputer might be able to support between ten & twenty users. It is, therefore, ideal for use-within a single department, within a college or university, or for use in a medium size business. They are really mini versions of the mainframe computer, and this is where the term mini was originally coined. The mini has been designed with multi-user access in mind and is therefore usually easy to expand up to maximum possible numbers of users.

The Minicomputers are smaller version of mainframe computers and are general purpose computers that support multiple users.

Micro-Computers. The microcomputer is another category of computers that can be divided into two groups—personal computers and workstations. The workstations are specialised computers that approach the speed of mainframes. Often microcomputers are connected to networks of other computers. Almost all the computer users are familiar with the personal computers. The personal computers are the desktops that are preferred by the home users. These computers are cheaper and have all the functionalities of a computer required by the common users.

The Workstations are powerful single-user computers. The Workstations are often used as network and Internet servers.

Another classification of computer is the **'notebook or laptop'** computer. A notebook computer can fit into a briefcase and weighs less than a kilogram, yet it can compete with the microcomputer. The notebooks generally cost more than microcomputers but can run most of the microcomputer software and are more versatile. Like other computers, notebook computers are getting faster, lighter, and more functional.

The Desktop computers are the most common type of Personal Computer.

The smallest computer is the handheld computer called a **'Personal Digital Assistant' (PDA)**. The PDAs are used to track appointments and shipments as well as names and addresses. The PDAs are called 'pen-based' computers because they utilise a pen-like stylus that accepts handwritten input directly on a touch-sensitive screen. One has probably noticed delivery employees using these gadgets.

The Notebook or Laptop computers are the portable micro-computer.

Another category of computers that has emerged in last couple of years is **Tablet PC**. It is a portable PC that is a hybrid between a personal digital assistant (PDA) and notebook PC. Equipped with a touch screen interface, a tablet PC usually has a software application used to run a virtual keyboard. However, many tablet PCs support external keyboards. Tablet PCs have built-in Web browsing capabilities, multiple connectivity options, and multimedia.

The Tablet PC is a kind of mobile computer having a touch-screen or pen-enabled interface.

COMPUTER ARCHITECTURE

We have been using the term computer as if it refers to a single electronic device, but computers are actually composed of many electronic and electro-mechanical devices. The combination of all these electro-mechanical and electronic devices are referred to as Computer Hardware. But hardware, by itself is useless. The hardware must be directed by information processing instructions, called Computer Software.

When people refer to a computer, they are usually referring to a set of hardware and software systems used as a single unit. It is more appropriate to use the phrase 'Computer System'. A wide variety of computer systems exists. The common link of all these computer systems is, however, that they are composed of the same basic set of hardware and software components.

The basic structure of a Computer System consists of five parts as described in Figure 3.1. These five parts are found, in one form or another, in every digital computer, whether it is a

main-frame computer system used by an insurance company to keep track of its premiums, or a personal computer that is used for simple business applications. The five main constituents of a computer system are:

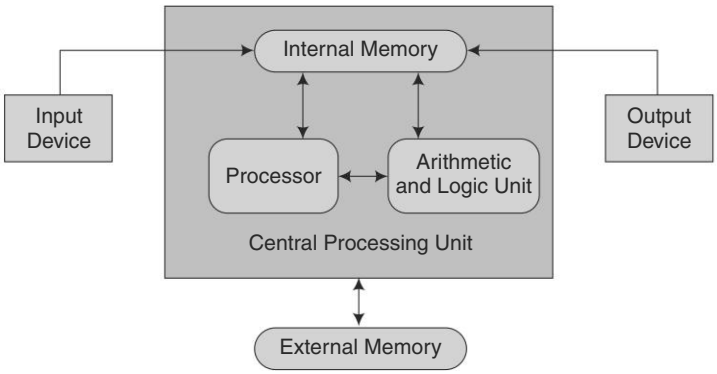


Figure 3.1 The Computer Schematic

1. Central Processing Unit (CPU)
2. Memory
3. Input/Output Devices
4. Input/Output Interfaces

   These are 'middlemen' between the CPU and the I/O devices. They provide the actual hard wired control of the I/O devices, according to the commands that are issued by the CPU.
5. Program (Software)

   Without the program, a computer is a dumb machine that occupies space and consumes power. The program coordinates the operations of the computer in order to perform some desired process. This is explained in more details in next chapter.

The figure above illustrates the basic architecture that is common to all computers, large and small. The most important unit in computer hardware is the '**central processing unit'** or CPU. This includes a storage unit called '**primary storage'**, often called main memory. The primary storage contains both the data being processed and the program instructions. The '**control unit'** causes all of the units to work together as a system, and the '**arithmetic and logic unit'** (ALU) is used to perform the calculations and logical operations.

One or more '**input'** devices are used to enter data into primary memory, the most common device being the keyboard. Since the primary memory has a limited capacity to store information, an additional storage devices, called '**secondary memory'** or '**auxiliary memory'** is used quite often. The secondary storage is also used to store data on permanent basis. The commonly used secondary storage devices are magnetic disks and tapes. The result of the processing are recorded on the **output** devices. The commonly used output devices are printers and monitors.

Central Processing Unit

The central processing unit is the most important part of a computer system. It is also referred to as the 'brain' of the computer. The CPU consists of electronic circuits that manage and control all other hardware components and also carry out detailed sequences of instructions that perform the actual computation. The central processing unit (CPU) comprises the arithmetic and logic unit (ALU), the control unit, and the primary storage unit. Some sources define that it consists of only the ALU and the control unit. However, because the ALU, the control unit, and primary storage are closely related and function as a whole, the CPU is defined here as a unit consisting of all three elements as described in Figure 3.2 and Figure 3.3 These figures give the detailed view of the CPU and its interrelationships with other hardware units.

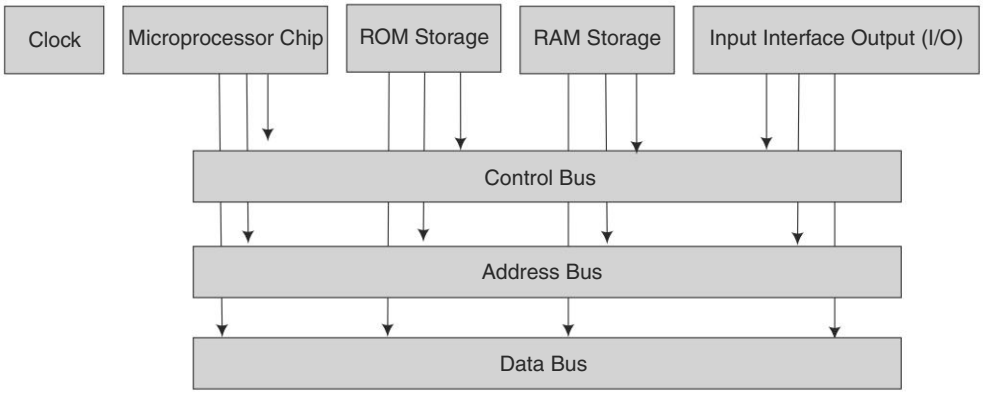


Figure 3.2 Central Processing Unit (CPU)

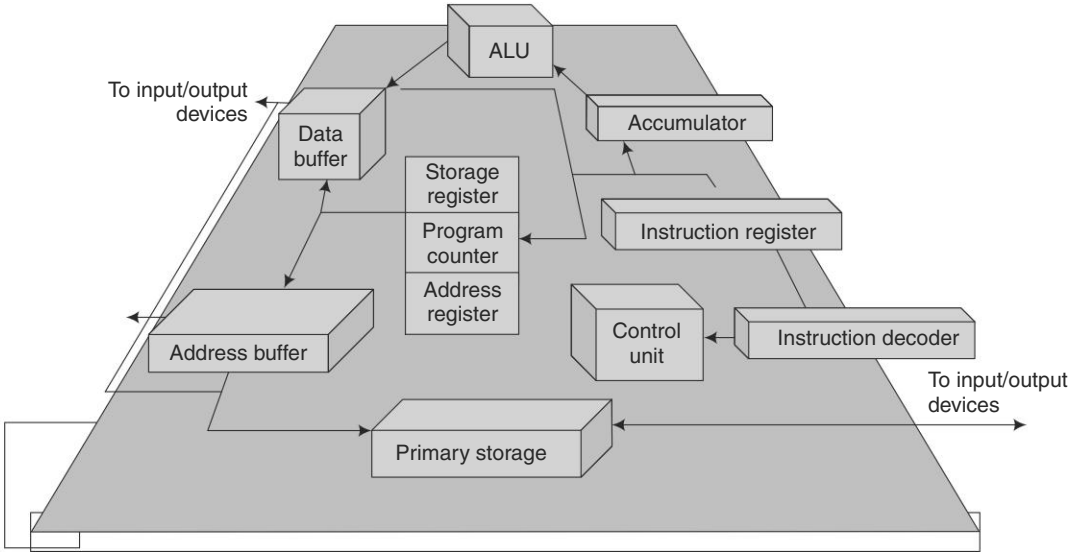


Figure 3.3 Data Movement between different parts within Central Processing Unit (CPU)

The unbelivable advances in semiconductor technology have reduced the size of the CPU. Depending on conditions, a semiconductor can serve as a conductor (allowing the transmission of electricity) or an insulator (inhibiting the transmission of electricity). This ability is ideal because data are represented by combinations of high voltage states (conductor) and low voltage states (insulator).

The CPU is the 'brain' of the computer—this is where the actual computing is done. The CPU usually controls all the operations of the computer.

The CPU works as a very fast series of switches—collecting data, transforming data, and then generating output; one computational cycle at a time. The speed of a CPU is determined by how much data it can process in an individual cycle and the number of computational cycles it can complete in a minute. The size of the data bus, actually determines how much data can move through the CPU in an individual computational cycle. Intel's core 2 Duo processor runs at 1.66 GHz to 3.96 GHz with 2 to 6 MB of L2 Cache memory. The four main components of CPU are:

(a) Arithmetic and Logic Unit (ALU)
(b) Control Unit (CU)
(c) Registers
(d) Buses

Arithmetic and Logic Unit: ***The arithmetic and logic unit (ALU) is the part of the CPU, where all mathematical and logical functions are performed.*** The basic mathematical functions include addition and subtraction; multiplication and division; are achieved by continuous addition or subtraction operations. The software can be used to combine these basic mathematical functions to perform logarithmic, trigonometric, and other mathematical functions. A logic function is one in which numbers or conditions are compared to each other. The logic functions include concepts like greater than, less than, equal to, not equal to, greater than or equal to, and less than or equal to.

The ALU does the actual arithmetic and logical comparisons that need to be processed.

Control Unit. ***The control unit interprets any instruction it receives from memory and directs the sequence of events necessary to execute the instruction***. The control unit also establishes the timing of these events, acting like the traffic cop of the system. In order to control all that is going on in the CPU, the control unit uses a system clock, which synchronizes all tasks by sending out electrical pulses. The number of pulses, or cycles, per second is the main element in determining the speed of the processor. The clock speed is measured in megahertz (MHz). The hertz is the unit of frequency that measures the number of cycles per second in a periodic signal.

The Control Unit can execute or store the results coming out of the ALU.

Registers. *A register is a very small amount of very fast memory that is built into the CPU in order to speed up its operations by providing quick access to commonly used values*. The registers are the top of the *memory hierarchy* and are the fastest way for the system to manipulate data. Below them are several levels of *cache memory*, at least some of which is also built into the CPU

and some of which might be on other, dedicated chips. The cache memory is slower than registers but much more abundant. Below the various levels of cache is the main memory, which is even slower but vastly more abundant. The registers can also be classified into:

(i) **General purpose register:** The **general purpose registers** serve as temporary holding places for data that is being manipulated by the CPU. That is, they hold the inputs to the ALU and store the results produced by that circuitry.

(ii) **Special purpose registers:** They store internal CPU data, such as the *program counter* (also termed *instruction pointer*), *stack pointer* and *status register*. **Program counters** contain the address of the next instruction to be executed. **The instruction registers** hold the instruction being executed by the CPU, **address registers** hold memory addresses and are used to access memory, and **data registers** are used to store integers.

The Register temporarily stores the data that is to be executed next.

Buses. *The buses are used to transmit data and control signals from one point to another*. The buses provide standardised way of inter-connecting modules. A bus has slots into which modular components are placed. The modules are standard components, which can be combined together in variety of ways. A bus is characterised by the amount of information that can be transmitted at once. This amount, expressed in bits, corresponds to the number of physical lines over which data is sent simultaneously. A 32-wire ribbon cable can transmit 32 bits in parallel. The term '**width**' is used to refer to the number of bits that a bus can transmit at once. In reality, each bus is generally constituted of 50 to 100 distinct physical lines, divided into three subassemblies:

(i) **Address Bus:** The address bus, also known as the *memory bus* transports memory addresses which the processor wants to access in order to read or write data. It is a unidirectional bus.

(ii) **Data Bus:** The data bus transfers instructions coming from or going to the processor. It is a bidirectional bus.

(iii) **Control Bus:** The control bus or *command bus* transports orders and synchonisation signals coming from the control unit and travelling to all other hardware components. It is a bidirectional bus, as it also transmits response signals from the hardware.

The BUS is a physical set of connections used to transmit data and instructions. A bus is simply an electrical path on which data can flow from point to point within a circuit.

Other factors, such as the instruction set, also affect processing speed. An **instruction** set is the group of commands available to the CPU. It determines the basic computer operations (arithmetic, logic, and storage, and retrieval) that can be performed and the commands that the control unit can use to direct and coordinate the computer's operations.

The computer speed is also measured by the number of instructions completed in one second, or **millions of instructions per second (MIPS)**. This designation is usually used in comparing large computer systems, such as minicomputers, mainframes, and supercomputers.

Although the basic elements of the computer system are essentially the same for almost all computers, but there are slight variations in construction. The style of organisation and construction

of the elements within the computer systems is known as architecture of the computer. **The modular construction** and **bus structure** are the two major features of today's computer architecture. The three bus paths are shown in Figure 3.4 given below.

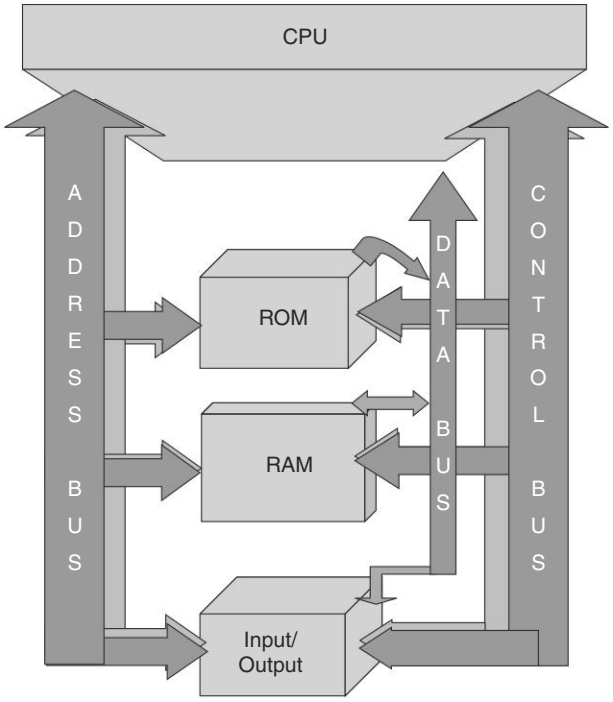


Figure 3.4 BUS Architecture

Memory

The computer memory stores data temporarily for fast retrieval. Every computer comes with a certain amount of physical memory, usually referred to as Main Memory or Primary Memory or Random Access Memory (RAM). ***The primary storage unit refers to the internal storage of the computer, where program and their data are stored.*** The primary storage, or primary memory or simply the memory, provides temporary storage during program execution. The part of primary storage may also contain permanently stored instructions that tell the computer what to do when it is switched on. Most primary storage today depends on semiconductor technology. **The Semiconductor memory** is made by etching electronic circuits onto a silicon chip. There are several different types of memory:

The Memory is an electronic storage medium used to hold the program which instructs the CPU and other components of the computer.

(i) Random Access Memory (RAM). The RAM is that part of primary storage where data and program instructions are held temporarily while being manipulated or executed. This is the same as main memory. When used by itself, the term *RAM* refers to *read and write* memory.

This type of memory allows the user to enter data into memory (write) and then retrieve it (read). The RAM depends on supply of electricity to maintain data storage. When the power to the computer is switched off, everything stored in RAM is lost. In other words, RAM is volatile. The main RAM can be divided into Static RAM (SRAM) and Dynamic RAM (DRAM), which are explain as follows:

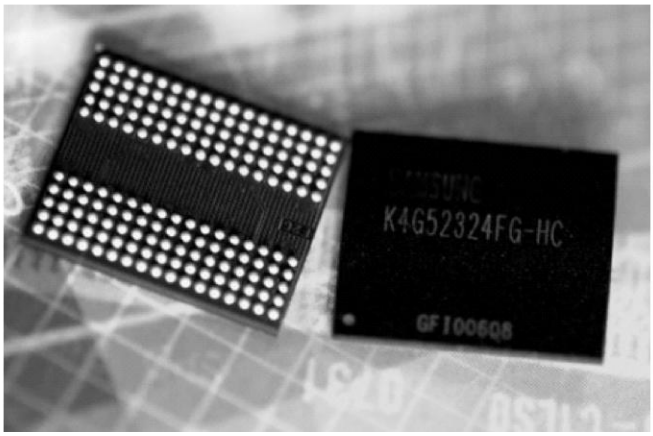
(a) Static RAM (SRAM). The static RAM is more expensive, requires four times the amount of space for a given amount of data than dynamic RAM, but, unlike dynamic RAM, does not need to be power-refreshed and is therefore, faster to access. One source gives a typical access time as 25 nanoseconds in contrast to a typical access time of 60 nanoseconds for dynamic RAM. (More recent advances in dynamic RAM have improved access time.) The static RAM is used mainly for the level-1 and level-2 caches that the microprocessor looks in first before looking in dynamic RAM.

(b) Dynamic Random Access Memories (DRAMs). The DRAMs are the most widely used RAM chips. These are known to be volatile. The DRAM stores data electrically in a storage cell and refreshes the storage cell every few milliseconds.

(c) Extended Data-Out RAM (EDO RAM). The EDO RAM is faster than DRAM. EDO RAM has also been replaced by SDRAM. The EDO RAM is an improvement on DRAM because it has advanced timing features. The EDO extends the amount of time data is stored and has a reduced refresh rate. This alleviates the CPU and RAM from timing constraints and improves also performance.

(d) Synchronous DRAM (SDRAM). **The SDRAM** is a relatively new and different kind of RAM. The reason is that its synchronised design permits support for the much higher bus speeds. The SDRAM is an improvement because it synchronizes data transfer between the CPU and memory. The SDRAM allows the CPU to process data while another process is being queued.

(e) Nonvolatile RAM (NVRAM). The NVRAM is a special kind of RAM that retains data when the computer is turned off or there is a power failure. Like the computer's read-only memory (ROM), it is powered by a battery within the computer. It can also work by writing its contents to and restoring them from an EEPROM.



Memory Chip

(ii) Read Only Memory (ROM). The ROM as the name implies, the contents of ROM can be read only; data cannot be written into it. The ROM may contain information on how to start the computer and even instructions for the entire operating system. The actual contents of ROM are usually set by the computer manufacturer; they are unchangeable and permanent. Because the contents cannot be altered and are not lost when the electric current is switched off, ROM is non-volatile. The basic set of instructions required for switching on the computer and system diagnostics are usually located in ROM. This part of the memory is not available for software processing. The ROM memories have gradually evolved from *fixed read-only memories* to memories than can be programmed and then re-programmed. The different types of ROMs are explained as follows:

(a) PROM (Programmable Read Only Memory). The PROM are chips comprising thousands of fuses (or diodes) that can be 'burnt' using a device called a '*ROM programmer*', applying high voltage (12V) to the memory boxes to be marked. The fuses thus burnt correspond to 0 and the others to 1. But once the PROM has been used, you cannot wipe it clean and use it to store something else. Like ROMs, PROMs are non-volatile.

(b) EPROM (Erasable Programmable Read Only Memory). The memories are PROMs that can be deleted. These chips have a glass panel that lets ultra-violet rays through. When the chip is subjected to ultra-violet rays with a certain wavelength, the fuses are reconstituted, meaning that all the memory bits return to 1. This is why this type of PROM is called *erasable*.

(c) EEPROM (Electrically Erasable Read Only Memory). The memories are also erasable PROMs, but unlike EPROMs, they can be erased by a simple electric current, meaning that they can be erased even when they are in position in the computer. There is a variant of these memories known as **flash memories.** Unlike the classic EEPROMs that use 2 to 3 transistors for each bit to be memorised, the EPROM Flash uses only one transistor. Moreover, the EEPROM may be written and read word by word, while the Flash can be erased only in pages. EEPROMs are thus used preferably to memorise configuration data and the Flash memory is used for programmable code.

(iii) Cache Memory. The Cache Memory is a high-speed access area that can be either a reserved section of main memory or a storage device. The RAM that is available in the computer works comparatively at slower speed as compared to the processor. In order to bridge the speed, the modern computer has **Cache Memory**, as cache memory operates at a much higher speed than conventional memory (i.e., RAM). This technique greatly increases the speed of processing because it reduces the number of times the program has to load instructions and data from RAM and secondary storage. The two main cache types are: Memory cache and Disk cache. The memory cache is a portion on memory of high-speed static RAM (SRAM) and is effective because most programs access the same data or instructions over and over. By keeping as much of this information as possible in SRAM, the computer avoids accessing the slower DRAM. There are two types of cache memory: Level 1 and Level 2 or Level 3. The Level 1 (L1) cache is located in the processor, and Level 2 (L2) or Level 3 (L3) cache is located on the motherboard but not actually in the processor. The L1 cache is smaller and faster than L2 cache. Some of the computers have L1 cache and L2 cache in the processor and Level 3 (L3) cache on the motherboard.

The amount of primary storage is very important in determining the capabilities of a computer. The more primary storage means that more instructions and data can be loaded into the computer. Many program require a specific amount of memory and cannot be used if the computer does not have that amount. Most computers have provisions for incorporating additional RAM chips to the main circuit board.

Middleware and Firmware

Every software application in use today relies on some level of middleware and firmware to deliver the functionality, the user eventually sees. This places middleware and firmware in a very important, yet often overlooked, layer of architecture.

Middleware

The middleware is the layer that resides between the hardware layer and the application layer to provide services such as database management. the Middleware is a software that manages the communication between a client program and a database. For example, a Web server connected to a database can be considered middleware--the Web server sits between the client program (a Web browser) and a database. The middleware allows the database to be changed without necessarily affecting the client, and vice versa. The Middleware can also be defined as the connectivity software that consists of a set of enabling services that allow multiple processes running on one or more machines to interact across a network. The Middleware is essential to migrating mainframe applications to client/server applications and to providing for communication across heterogeneous platforms.

Firmware

The firmware can take on many forms, but is basically the embedded software that is stored in hardware memory to control hardware functions. The firmware is a software program or set of instructions programmed on a hardware device. It provides the necessary instructions for how the device communicates with the other computer hardware. The firmware controls PCs, printers, and every other electronic device. The firmware can be thought of as 'semi-permanent' since it remains the same unless it is updated by a firmware updater.

Input/Output Devices

A number of different input and output methods are used to transfer data between the CPU, secondary storage devices, and various other devices. All of these devices use standard data bus architecture for transferring data within the computer system. The input/output device interfaces are created for human beings to interact with computer systems in a seamless manner. The most natural way for humans to communicate with computers is to use the same techniques that people use to communicate with each other. For example, entering data into a computer might be accomplished by speaking, writing, or physically pointing to specific objects on the screen. The speech, written text and visual images such as colour graphs are output forms that humans find easier to interpret and use. The voice recognition and speech synthesis are becoming quite popular in daily business applications.

(a) Input and Input Devices. The input is the process of entering and translating incoming data into machine-readable form so that they can be processed by a computer. The data to be entered are also often referred to as input. Any hardware item that is attached to the main unit of a computer is referred to as a peripheral device. An **input device** is a peripheral device through which data are entered and transformed into machine-readable form. The most commonly used input devices are keyboards and mouse. The keyboards includes alpha, alpha-numeric, special character keys and function keys. The mouse is an input device that allows input of data or instruction to a computer program by just pointing and clicking. Some of the commonly used input devices are:

The Input/Output devices are the link between man and machine. They depend on the processing requirements.

- Keyboards
- Mouse
- Light Pens and Digitisers
- Voice Recognitions
- Magnetic Ink Character Recognition–Optical Scanners
- Web Camera
- Secondary Storage media like CD, DVD, etc.

Keyboard

Mouse

Mobile Communicator

Touch Screen Phone

(b) Output and Output Devices. The output is the process of translating data from machine-readable form to a format that can be understood by humans or read by other machines. An output device is a peripheral device that accepts data from a computer and transforms them into a usable form, thus allowing the computer to communicate information to humans or other machines. The most common output devices include printers and display screens. A printer is a machine that helps in generating output on a paper. The printer varies in size, speed, and features. The most commonly used type of printers is laser printers. The monitors or screens have changed from Cathode Ray Tube (CRT) technology to Liquid Crystal Display (LCD) technology over the last two decades. The commonly used output devices are:

- Printers
- Plotters
- Monitors and Terminals
- Speakers
- Secondary Storage media like CD, DVD, etc.

Secondary Storage

The modern computer systems use a number of different memory and storage devices in order to accomplish their tasks. In most of the applications, computer's primary storage capabilities are so expensive that they are of limited practical value in handling the instructions and data needed for processing. Another limitation of primary storage is its volatility. In many cases a particular set of data is required quite often, which is erased when the power is turned off from the primary storage. It needs to be re-entered for each usage, which is a time-consuming and costly way to process data. In addition, it is often desirable to save the results of processing for use as input in further processing or for printing purposes later. The solution to these is the secondary storage.

Bajaj Allianz: Insuring Business

Bajaj Allianz Life Insurance, a leading company in the Indian insurance domain is a JV between two leading conglomerates—Allianz AG, one of the world's largest insurance companies, and Bajaj Auto, one of the biggest two-and three-wheeler manufacturers in the world. Bajaj Allianz is one of the fastest growing private life insurance companies in India with a customer base of over 400,000 supported by customer care centres in 155 cities and supplemented by 35,000 insurance consultants.

In an industry where efficient information access plays a crucial role, Bajaj Allianz is under constant pressure to provide its users with a robust computing environment. With a requirement of over 1,000 concurrent users, efficient storage and data retrieval was the key. Lowering the overall infrastructure cost and ensuring sustained investment protection—while simultaneously energising performance and optimal storage management—were some of the challenges that Bajaj Allianz was grappling with.

'Our earlier storage environment was inadequate. For instance, when more than 100 users accessed the database, performance exponentially deteriorated. Thus, time and accessibility parameters became contentious issues. Furthermore, the inflexible storage box design of the database server meant that accessibility problems got compounded during year end and other peak periods, leading to major I/O problems,' says JB Bhaskar, head of IT, Bajaj Allianz Life Insurance.

It was performance issues like these that prompted Bajaj Allianz to scout for a storage solution that could mitigate storage and access risks efficiently, without compromising on cost and performance parameters. After several rounds of intense discussions, the company zeroed in on the HP 9000 servers, based on PA 8800 RISC processors, and the HP StorageWorks EVA 3000 SAN for the primary site, with no single point failure configuration.

With a high level of redundancy at the hardware and at the OS levels, the storage solution at Bajaj Allianz moved from a static and reactive state to a proactive, dynamic and intelligent state. The transition from the previous environment was seamless, and was completed in 15 days. Bajaj Allianz was the first enterprise in India to go in for PA-RISC 8800 technology.

HP's StorageWorks EVA 3000 SAN addressed the I/O problems through its technology of virtualisation. Database accessibility concerns have dropped substantially for Bajaj Allianz Life Insurance. The company now has the required scalability and storage virtualisation to ensure the smooth running of critical business operations. The storage solution has ensured that the data required for processing is accessed quickly and delivered swiftly to applications. More importantly, the solution addresses Bajaj Allianz's unique needs and removes the cost constraints and the manageability and scalability issues associated with traditional storage solutions.

The performance related issues, particularly with the throughput for data transfer (I/O) between the server and storage, have been eliminated. Not only did the storage solution enable Bajaj Allianz to scale up their storage four times at a cost that was competitive, it also allowed the seamless management of the SAN configuration, thereby lowering administration costs and freeing up resources.

At a Glance

Challenges

- Need to enhance performance and enable higher throughput for data transfer (I/O) between the server and storage
- Need to lower storage administration cost and increase performance and availability

Solution

- PA-8800 RISC technology based HP rp4440 and rp3440 servers; HP Storage Works EVA 3000 SAN

Benefits

- Improved I/O performance
- Low pressure on resources thereby lower administration costs
- 99 per cent uptime unparalleled business continuity

Source: *Dataquest*, 28 Feb, 2007, Vol. XXV No. 04

The **Secondary storage** is the non-volatile memory that supplements main memory by providing data storage that is permanent and typically of much greater capacity than main memory. It is less expensive, as compared to the primary storage and is usually used for storage of large amounts of data for permanent storage. The secondary storage is also used for storing backups, or copies of data and program that are frequently required at a later date. Most secondary storage devices are based on some form of magnetic or optical recording technologies, similar to those used for recording cassette tapes, video tapes or audio/video

The Secondary storage is an external data storage device, which is not part of main memory.

compact disks. The two key factors determining the performance of secondary storage devices are the amount of data that can be stored and the speed with which data can be retrieved. There are three secondary storage media that are used with all sizes of computers are magnetic tapes, magnetic disks, and optical media. Although these media are cheaper and can hold much more data than primary storage can, access to the data is slower as compared to primary storage.

(a) Magnetic Tape. *Typically,* ***magnetic tape*** is an 1/2-or 1/4-inch ribbon of mylar (a plastic-like material), coated with a thin layer of iron oxide. An I/O device, the tape drive, reads and writes the data as the tape passes by a read/write head, the electromagnetic component in the drive. The magnetic tape stores data sequentially, that is, one after another. In order to access a data record, one must read every record preceding it. The tapes can store large quantities of data inexpensively and thus are often used as backup storage media. The magnetic tapes are erasable, reusable, and durable. However, magnetic tape is not well suited to data files that are revised or updated often. Such files should be stored on a medium that allows faster and more direct access to data.

(b) Magnetic Disk. A magnetic disk is a mylar or metallic platter on which electronic data can be stored. Although disks resemble phonograph records, they do not have a record's characteristic spiralling groove. A magnetic disk consists of a series of magnetic platters that spin rapidly in a sealed container, together with associated electronics for controlling the flow of data. A read/write head slides just above each platter with a microscopic precision, detecting the polarity of individual magnetic bits (to read data) or altering the polarity (for writing data). Nonetheless, data are accessed in much the same way that an individual song is selected on a long-playing record. The ***magnetic disk allows*** accessing any data immediately without having to start at the beginning; it holds more data in a smaller space; and attains faster data transfer speeds. The different types of magnetic disks include Floppy disks, Hard disks, and disk racks.

Magnetic Disk Hard Disk

Magnetic Disks

(c) Optical Disks. The optical technology involves the use of lasers beams. This technology has created new types of secondary storage media for computers, including optical laser disks, optical cards, and optical tape. The optical laser disks are commonly known as CD-ROM. They

were originally developed as compact disks for video and audio applications. The optical storage technique provides alternatives to magnetic storage media and is capable of storing massive amounts of data on removable media. The same method of using laser beams to encode binary data (by burning microscopic pits on audio and video disks to represent 1s and 0s) is used to encode the data stored on optical laser disks. A single optical disk can store about 600 MB of data, and much higher densities are possible. The disks do not need protection from the environment and can be stored like other items. Other forms of optical disk are DVD, which are faster and have much larger storage capacities. From portability perspective, we also have Flash or Pen drives, which can store data upto 64 GB.

NUMBER SYSTEMS

The number systems are used to describe the quantity of something or represent certain information. The number system that we all use is the decimal system having ten symbols from 0 to 9. Therefore, decimal is said to be **Base Ten**. By describing systems with bases, one can gain an understanding of how that particular system works.

These number systems refer to the number of symbols used to represent numbers. In the decimal system, we use ten different symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 with these ten symbols, we can represent any quantity. When we run out of symbols, we go to the next digit placement. In order to represent one higher than 9, we use 10 meaning one unit of ten and zero units of one. This may seem elementary, but it is crucial to understand our default number system if you want to understand other number systems. There are binary, hexadecimal, octal and other types of number systems. The binary is a base 2, octal is base 8 and hexadecimal is base 16 number systems.

The number systems are any system of naming or representing numbers, as the decimal system or the binary system. This is also called numeral system.

For example, when we consider a binary system which only uses two symbols, 0 and 1, when we run out of symbols, we need to go to the next digit placement. So, we would count in binary 0, 1, 10, 11, 100, 101, and so on.

Characteristics of Number System

- The digits are consecutive.
- The number of digits is equal to the size of the base.
- Zero is always the first digit.
- The base number is never a digit.
- When 1 is added to the largest digit, a sum of zero and a carry of one result.
- The numeric values determined by the implicit positional values of the digits.

Binary Number System

The Digital Computers are electronic circuits which exist in only one of two states – ON or OFF, which can be best represented by binary number system which has only two digits 0 and 1. The

binary simplifies information processing. Because there must always be at least two symbols for a processing system to be able to distinguish significance or purpose, binary is the smallest numbering system that can be used. Some of the characteristics of Binary System are:

- Also called the **"Base 2 system";**
- The binary number system is used to model the series of electrical signals computers use to represent information;
- 0 represents the no voltage or an **off state;**
- 1 represents the presence of voltage or an **on state.**

The Binary number system is a method of representing numbers that has 2 as its base and uses only the digits 0 and 1.

Following table shows Binary equivalent of Decimal number system:

Binary	0	1	10	11	100	101	110	111	1000	1001	1010
Decimal	0	1	2	3	4	5	6	7	8	9	10

In Binary number system, each successive digit represents a power of 2. For example,

10011 is represented as $(1 \times 2^4) + (0 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0)$

or $16 + 0 + 0 + 2 + 1$ equal to 19 in decimal system.

Octal Number System

The octal is another number system with fewer symbols to use than the conventional decimal number system. The octal is Base Eight number system, which means eight symbols are used to represent all the quantities. They are 0, 1, 2, 3, 4, 5, 6, and 7. When we count up one from the 7, we need a new placement to represent what we call 8 since an 8 doesn't exist in Octal, so, after 7 it is 10. Some of the characteristics of Octal System are:

- Also known as the Base 8 System;
- Uses digits 0 – 7;
- Readily converts to binary;
- Groups of three (binary) digits can be used to represent each octal digit;
- Also uses multiplication and division algorithms for conversion to and from base 10.

The Octal numeral system is the base-8 number system, and uses the digits 0 to 7.

Following table shows Octal equivalent of Decimal number system:

Octal	0	1	2	3	4	5	6	7	10	11	12…	17	20…	30…	77	100
Decimal	0	1	2	3	4	5	6	7	8	9	10…	15	16…	24…	63	64

In octal numerals each place is a power with base 8. For example:

$112_8 = 1 \times 8^2 + 1 \times 8^1 + 2 \times 8^0$

$= 64 + 8 + 2 \quad = 74$ in decimal system.

Hexadecimal Number System

The hexadecimal system is Base Sixteen. As its base implies, this number system uses sixteen symbols to represent numbers. Unlike binary and octal, hexadecimal has six additional symbols that it uses beyond the conventional ones found in decimal. In Hexadecimal, the convention is that alphabets are used after the normal ten digits. So, in hexadecimal, the total list of symbols that are used are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. In a digital display, the numbers B and D are lowercase.

The Hexadecimal system is a base sixteen and uses numbers from 0 to 9 and then uses the letters A-F.

- Base 16 system
- Uses digits 0-9 & letters A, B, C, D, E, F
- Groups of four bits represent each base 16 digit

Following table show Hexadecimal equivalent of Decimal number system:

Hexadecimal	9	A	B	C	D	E	F	10	11…	19	1A	1B	1C…	9F	A0
Decimal	9	10	11	12	13	14	15	16	17	25	26	27	28	159	160

CONVERSION OF NUMBER SYSTEM

From Decimal to Binary

The conversion of a decimal number to a binary number system follows a straightforward method. It involves dividing the number to be converted, say N, by 2. Why the decimal number is to be divided by 2 as the binary number system is a base 2. After dividing the decimal number by 2, one has to make note of the remainder. Continue dividing the quotient (N/2) by 2, until one reach the division of (1/2) and afterwords it needs the noting of all the remainders.

Example 1 Convert 98 from decimal to binary.

1. Divide 98 by 2, we make note of the remainder. The continuing dividing quotients by 2, making note of the remainders.

Division	*Remainder, R*
98/2 = 49	R = 0
49/2 = 24	R = 1
24/2 = 12	R = 0
12/2 = 6	R = 0
6/2 = 3	R = 0
3/2 = 1	R = 1
1/2 = 0	R = 1*

2. Starting from the last remainder (1*) we create a sequence of remainders, which will give 1100010. Therefore, 98 in decimal is equal to 1100010 in binary.

Example 2 Convert 23 into binary.

Division	*Remainder, R*
23/2 = 11	R = 1
11/2 = 5	R = 1
5/2 = 2	R = 1
2/2 = 1	R = 0
1/2 = 0	R = 1

Therefore, 21 in decimal is 11101 in binary.

From Binary to Decimal

The conversion from binary number system to decimal number system follows the same steps as decimal to binary, except in reverse order. In this case, begin by multiplying zero with two and adding 1. Then continue to multiply the numbers in the 'results' of the previous step by 2 again and add the binary digit from left side of the binary number that is being converted.

Example 3 Convert 11101 from binary to decimal.

Operations	*Result*
0 x 2 + 1	1
1 x 2 + 1	3
3 x 2 + 1	7
7 x 2 + 0	14
14 x 2 + 1	29

Therefore, 11101 in binary is 29 in decimal.

Exercise 1

Convert Binary To Decimal

a. 1010100 _____
b. 1010 _____
c. 110011 _____
d. 101111 _____
e. 10001 _____
f. 1111 _____
g. 10000111 _____

Convert Decimal To Binary

h. 5 _____
i. 9 _____
j. 19 _____
k. 22 _____
l. 31 _____
m. 32 _____
n. 46 _____

From Decimal to Octal

The conversion of a decimal number to an octal number system follows the same steps as it is done in decimal-binary conversion.

- We divide the decimal number by 8 (base 8 of Octal) and note the remainder.
- Continuing dividing the quotient by 8 and keep noting the remainders.

Example 4 Convert 427 decimal to octal

1. We divide 427 by 8, making note of the remainder. Continuing dividing quotients by 8, making note of the remainders.

Division	*Remainder, R*
427/8 = 53	R = 3
53/8 = 6	R = 5
6/8 = 0	R = 6*

2. Starting from the last remainder (6*) we create a sequence of remainders, which will give 653. Therefore, 427 in decimal is equal to 653 in octal.

Alternatively, one can also convert the Decimal number to an Octal number system. Follow the following steps:

- Convert to binary.
- Split up in parts of 3 digits, starting from the right side.
- Convert each part to an octal value from 1 to 7

Example 5 Convert 25 decimal to octal

- First, convert the 25 decimal to binary as per example 1.
- The binary equivalent of 25 decimal is 11001
  Next, split up 011001 in a pair of 3 as 011/001
- Conversion to octal is 31

From Octal to Decimal

To convert the octal number to the decimal number system, follow the following steps:

- Multiply the right most octal number digit with 8^0
- Multiply the next digit from the right side with 8^1
- Multiply the next digit from the right side with 8^2 and so on
- Add the sum of the products to get the final number as per decimal number system.

Example 6 Convert octal 653 to decimal

Step 1: Multiply 3 with $8^0 = 3*1 = 3$

Step 2: Multiply 5 with $8^1 = 5*8 = 40$

Step 3: Multiply 6 with $8^2 = 6*64 = 384$

Step 4: Add the sum of above three products = 3 + 40 + 384 = 427

So 653 in octal is equivalent to 427 in decimal.

From Decimal to Hexadecimal

The conversion of a decimal number to an hexadecimal number system follows the same steps as it is done in decimal-binary conversion.

- We divide the decimal number by 16 (base 16 of Hexadecimal) and then note the remainder.
- Continuing dividing the quotient by 16 and keep noting the remainders.

Example 7 Convert 830 decimal to hexadecimal

1. Divide 830 by 16, making note of the remainder. Continue dividing quotients by 16, making note of the remainders.

Division	*Remainder, R*
830/16 = 51	R = 14, equivalent to E in Hexadecimal
51/16 = 3	R = 3
3/16 = 0	R = 3*

2. Starting from the last remainder (3*) create a sequence of remainders, which will give 33E. Therefore, 830 in decimal is equal to 33E in hexadecimal.

From Hexadecimal to Decimal

To convert the hexadecimal number to the decimal number system, follow the following steps:

- Multiply the right most hexadecimal number digit with 16^0
- Multiply the next digit from the right side with 16^1
- Multiply the next digit from the right side with 16^2 and so on
- Add the sum of the products to get the final number as per decimal number system.

Example 8 Convert octal 3B4F to decimal

Step 1: Multiply F with $16^0 = 15*1 = 15$

Step 2: Multiply 4 with $16^1 = 4*16 = 64$

Step 3: Multiply B with $16^2 = 11*256 = 2816$

Step 4: Multiply 3 with $16^3 = 3*4096 = 12288$

Step 5: Add the sum of above three products = 12288 + 2816 + 64 + 15 = 15183

So octal 3B4F is equivalent to 15183 in decimal.

BINARY ARITHMETIC

The arithmetic operations are possible on binary numbers just as they can be done on decimal numbers. In fact the procedures are quite similar in both systems. The multiplication and division are not really difficult, but unfamiliarity with the binary numbers causes enough difficulty.

Binary Addition

The binary addition works in the same way as the decimal addition, except that only 0's and 1's can be used, instead of the whole range of 0-9. This actually makes binary addition much simpler than decimal addition, as we only need to remember the following:

$0 + 0 = 0$, with no carry
$0 + 1 = 1$, with no carry
$1 + 0 = 1$, with no carry
$1 + 1 = 10$ (0 and with 1 carry forward)

Example 9 Let us add two binary numbers:

$$\begin{array}{r} 101 \\ +101 \\ \hline \end{array}$$

(a) To add these two numbers, first consider the 'ones' column and calculate 1 + 1, which (in binary) results in 10. We 'carry' the 1 to the 'tens' column, and leave the 0 in the 'ones' column.

(b) Moving on to the 'tens' column, we calculate 1 + (0 + 0), which gives 1. Nothing 'carries' to the 'hundreds' column, and we leave the 1 in the 'tens' column.

(c) Moving on to the 'hundreds' column, we calculate 1 + 1, which gives 10. We 'carry' the 1 to the 'thousands' column, leaving the 0 in the 'hundreds' column.

$$\begin{array}{r} 101 \\ +101 \\ \hline 1010 \end{array}$$

Example 10 Add the following two binary numbers:

$$\begin{array}{r} 1011 \\ +1011 \\ \hline 10110 \end{array}$$

Note that in the 'tens' column, we have 1 + (1 + 1), where the first 1 is 'carried' from the 'ones' column. Recall that in binary,

$$\begin{aligned} 1 + 1 + 1 &= 10 + 1 \\ &= 11 \end{aligned}$$

Binary Subtraction

The binary subtraction is also simple as long as you remember how subtraction happens in the binary system. The rules for binary subtraction are:

- $0 - 0 = 0$
- $0 - 1 = 1$, and borrow 1 from the next more significant bit
- $1 - 0 = 1$
- $1 - 1 = 0$

Example 11 Let's subtract two binary numbers:

$$\begin{array}{r} 111 \\ -\ 10 \\ \hline 101 \end{array}$$

One can note that the difference is the same if this was decimal subtraction. Also similar to decimal subtraction is the concept of 'borrowing.' Watch as 'borrowing' occurs when a larger digit, say 8, is subtracted from a smaller digit, say 5, as shown below in decimal subtraction.

$$\begin{array}{r} 35 \\ -\ 8 \\ \hline 27 \end{array}$$

For 10 minus 1, 1 is borrowed from the 'tens' column for use in the 'ones' column, leaving the 'tens' column with only 2. The following examples show 'borrowing' in binary subtraction.

$$\begin{array}{rrr} 10 & 100 & 1010 \\ -\ 1 & -\ 10 & -\ 110 \\ \hline 1 & 10 & 100 \end{array}$$

Exercise 2 (Binary Arithmetic)

(a) $\begin{array}{r} 1\,0\,1 \\ +\ \ 1\,0 \\ \hline \end{array}$ (b) $\begin{array}{r} 1\,1\,1 \\ +\ \ 1\,0 \\ \hline \end{array}$ (c) $\begin{array}{r} 1\,0\,1\,0 \\ +\ \ 1\,1\,0 \\ \hline \end{array}$

(d) $\begin{array}{r} 1\,0\,1\,0 \\ +\ 1\,0\,1\,0 \\ \hline \end{array}$ (e) $\begin{array}{r} 1\,0\,1\,0 \\ +\ 1\,1\,1\,1 \\ \hline \end{array}$ (f) $\begin{array}{r} 1\,0\,1\,1 \\ +\ \ 1\,0\,1 \\ \hline \end{array}$

(g) $\begin{array}{r} 1\,1\,1\,1\,0 \\ +\ \ 1\,1\,1\,0 \\ \hline \end{array}$ (h) $\begin{array}{r} 1\,0\,0\,1\,1\,0 \\ +\ \ \ \ 1\,1\,0\,1 \\ \hline \end{array}$ (i) $\begin{array}{r} 1\,0\,1\,1\,1\,0 \\ +\ \ \ \ \ \ 1\,0\,1 \\ \hline \end{array}$

Binary Multiplication

The binary multiplication is much easier than decimal multiplication. In the case of decimal multiplication, we need to remember the multiplication tables like 3 x 9 = 27, 7 x 8 = 56, and so on. In binary multiplication, we only need to remember the following:

$$\begin{aligned} 0 \times 0 &= 0 \\ 0 \times 1 &= 0 \\ 1 \times 0 &= 0 \\ 1 \times 1 &= 1 \end{aligned}$$

The note that since binary operates in base 2, the multiplication rules we need to remember are those that involve 0 and 1 only.

Example 12 Let us multiply the two binary numbers 101 and 11

$$\begin{array}{r} 101 \\ \times\ 11 \\ \hline \end{array}$$

First we multiply 101 by 1, which produces 101. Then we put a 0 as a placeholder as we would in decimal multiplication, and multiply 101 by 1 again, which produces 101.

$$\begin{array}{r} 101 \\ \times\ 11 \\ \hline 101 \\ 1010 \end{array} \leftarrow \text{the 0 here is the placeholder}$$

The next step, as with decimal multiplication, is to add. The results from our previous step indicate that we must add 101 and 1010, the sum of which is 1111.

$$\begin{array}{r} 101 \\ \times\ 11 \\ \hline 101 \\ 1010 \\ \hline 1111 \end{array}$$

Binary Division

The binary division is also simple to use and involves the knowledge of binary multiplication and subtraction.

Example 13 Let us divide the binary number 1011 by 11.

$$\begin{array}{r} 11 \text{ R} = 10 \\ \hline 11\overline{)1011} \\ -11 \\ \hline 101 \\ -\ 11 \\ \hline 10 \end{array} \leftarrow \text{remainder, R}$$

To check our answer, we first multiply our divisor 11 by our quotient 11. Then we add its product to the remainder 10, and compare it to our dividend of 1011.

$$\begin{array}{r} 11 \\ \times\ 11 \\ \hline 11 \\ 11 \\ \hline 1001 \end{array} \leftarrow \text{product of 11 and 11}$$

$$\begin{array}{r} 1001 \\ +\ \ 10 \\ \hline 1011 \end{array} \leftarrow \text{sum of product and remainder}$$

As the sum is equal to our initial dividend, our solution is correct.

BOOLEAN ALGEBRA AND LOGIC GATES

The logic circuits are the basis for modern digital computer systems. In order to appreciate how computer systems operate, one needs to understand digital logic and boolean algebra. The Boolean logic forms the basis for computation in modern binary computer systems and one can represent any algorithm, or any electronic computer circuit, using a system of boolean equations. The digital logic is a rational process for making simple 'true' or 'false' decisions based on the rules of Boolean algebra. The Boolean algebra is a study of mathematical operations performed on binary variables. It provides a set of rules called Boolean logic that are indispensable in digital computer-circuit and switching-circuit design. The Boolean operation are carried out with algebraic operators called Boolean operators, the most basic of which are NOT, AND, and OR. This concept is named after its inventor, the UK mathematician and computer pioneer George Boole (1815-65).

The Boolean Algebra is the study of mathematical operations performed on binary variables following a Boolean logic.

Functions Performed by Logic Circuits

In this case 'True' can be represented by a 1 and 'false' by a 0, and in logic circuits the numerals appear as signals of two different voltages. The logic circuits are used to make specific true-false decisions based on the presence of multiple true-false signals at the inputs. The signals may be generated by mechanical switches or by solid-state transducers. Once the input signal has been accepted and conditioned (to remove unwanted electrical signals, or 'noise'), it is processed by the digital logic circuits. The various families of digital logic devices, usually integrated circuits, perform a variety of logic functions through logic gates, including 'OR,' 'AND,' and 'NOT,' and combinations of these (such as 'NOR,' which includes both OR and NOT).

Logical Gates

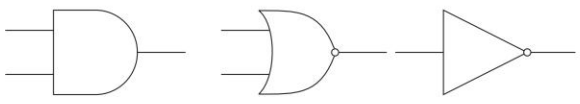
The elemental blocks in a logic device are called digital logic gates. The package Truth Tables and Boolean Algebra set out the basic principles of logic. Any Boolean algebra operation can be associated with an electronic circuit in which the inputs and outputs represent the statements of Boolean algebra. Although these circuits may be complex, they may all be constructed from three basic devices. These are the AND gate, the OR gate and the NOT gate.

The truth value TRUE is written as 1 (and corresponds to a high voltage), and FALSE is written as 0 (low voltage).

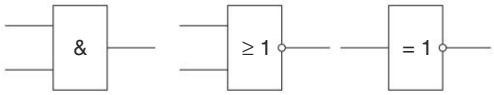
Logic Gate Symbols

There are two series of symbols for logic gates:

- The **traditional symbols** have distinctive shapes making them easy to recognise so they are widely used in industry and education.

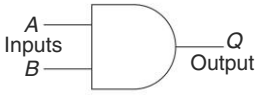


- The **IEC (International Electrotechnical Commission) symbols** are rectangles with a symbol inside to show the gate function. They are rarely used despite their official status, but you may need to know them for an examination.



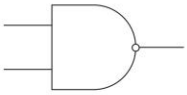
Inputs and Outputs

The gates have two or more inputs, except a NOT gate, which has only one input. All gates have only one output. Usually the letters *A*, *B*, *C* and so on are used to label inputs, and *Q* is used to label the output.



The Inverting Circle (o)

Some gate symbols have a circle on their output which means that their function includes **inverting** of the output. It is equivalent to feeding the output through a NOT gate. For example, the NAND (Not AND) gate symbol shown on the right is the same as an AND gate symbol but with the addition of an inverting circle on the output.



Truth Tables

A truth table is a good way to show the function of a logic gate. It shows the output states for every possible combination of input states. The symbols 0 (false) and 1 (true) are usually used in truth tables. The example of truth table on the right shows the inputs and output of an AND gate.

1	0	0
1	1	1
0	1	0

AND Gate

An AND gate has two or more inputs and a single output. The output of an AND gate is true only if all the inputs are true. **Q = A AND B**.

Traditional symbol IEC symbol

Input *A*	Input *B*	Output *Q*
0	0	0
0	1	0
1	0	0
1	1	1

Truth table

OR Gate

An OR gate has two or more inputs and a single output. The output of an OR gate is true if any one of the inputs is true and is false if all of the inputs are false The output *Q* is true if input *A* OR input *B* is true (or both of them are true): **Q = A OR B**

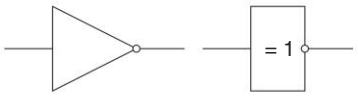
Traditional symbol IEC symbol

Input *A*	Input *B*	Output *Q*
0	0	0
0	1	1
1	0	1

Truth table

NOT Gate (Inverter)

A NOT gate is also called an 'INVERTER' and has a single input and a single output terminal, and can change a true signal to a false signal, thus performing the NOT function. The output *Q* is true when the input *A* is NOT true, the output is the inverse of the input: **Q = NOT A**



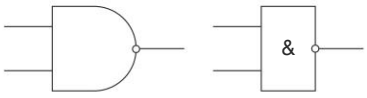
Traditional symbol IEC symbol

Input *A*	Output *Q*
0	1
1	0

Truth table

NAND Gate (NAND = Not AND)

An NAND gate has two or more inputs and a single output. The output of an NAND gate is true if any one of the inputs is false and is false if all the inputs are true. This is an AND gate with the output inverted. The output is true if input *A* AND input *B* are NOT both true: **Q = NOT (A AND B)**.



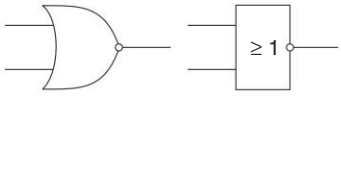
Traditional symbol IEC symbol

Input *A*	Input *B*	Output *Q*
0	0	1
0	1	1
1	0	1
1	1	0

Truth table

NOR Gate (NOR = Not OR)

An NOR gate has two or more inputs and a single output. The output of an NOR gate is true if all the inputs are false and is false if the inputs are different. The output *Q* is true if NOT inputs *A* OR *B* are true: **Q = NOT (A OR B)**



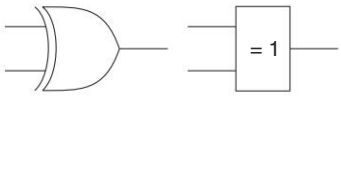
Traditional symbol IEC symbol

Input *A*	Input *B*	Output *Q*
0	0	1
0	1	0
1	0	0
1	1	0

Truth table

EX-OR (EXclusive-OR) Gate

An EXclusive OR gate has two or more inputs and a single output. The output of an EXCLUSIVE OR gate is true if the inputs are different and is false if the inputs are the same. The output *Q* is true if either input *A* is true OR input *B* is true, **but not when both of them are true**: **Q = (A AND NOT B) OR (B AND NOT A)**.



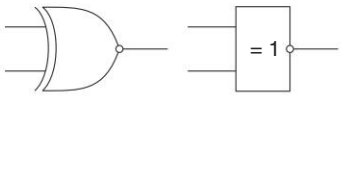
Traditional symbol IEC symbol

Input *A*	Input *B*	Output *Q*
0	0	0
0	1	1
1	0	1
1	1	0

Truth table

EX-NOR (EXclusive-NOR) Gate

This is an EX-OR gate with the output inverted, as shown by the 'O' on the output. The output *Q* is true if inputs *A* and *B* are the **SAME** (both true or both false): **Q = (A AND B) OR (NOT A AND NOT B)** EX-NOR gates can only have 2 inputs.



Traditional symbol IEC symbol

Input *A*	Input *B*	Output *Q*
0	0	1
0	1	0
1	0	0
1	1	1

Truth table

In order to perform a desired overall function, large numbers of logic elements may be connected in complex circuits. In some cases microprocessors are utilised to perform many of the switching

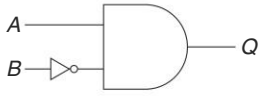
and timing functions of the individual logic elements. The processors are specifically programmed with individual instructions to perform a given task or tasks. An advantage of microprocessors is that they make possible the performance of different logic functions, depending on the program instructions that are stored. A disadvantage of microprocessors is that normally they operate in a sequential mode, which may be too slow for some applications. In these cases, specifically designed logic circuits are used.

Combining Logic Gates

The logic gates can be combined to produce more complex functions. They can also be combined to substitute one type of gate for another.

For example, to produce an output Q which is true only when input A is true and input B is false, as shown in the truth table one can combine a NOT gate and an AND gate as shown below:

Input A	Input B	Output Q
0	0	0
0	1	0
1	0	1
1	1	0

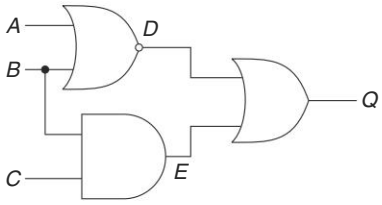


Q = A AND NOT B

Creating a Combination Function of Gates

The truth tables can be used to work out the function of a combination of gates.

For example, the truth table on the right show the intermediate outputs D and E as well as the final output Q for the system as shown below.



Inputs			Outputs		
A	B	C	D	E	Q
0	0	0	1	0	1
0	0	1	1	0	1
0	1	0	0	0	0
0	1	1	0	1	1
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	0	0	0
1	1	1	0	1	1

D = NOT (A OR B)

E = B AND C

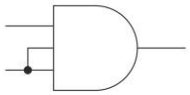
Q = D OR E = (NOT (A OR B)) OR (B AND C)

Substituting Gates

The logic gates are available on ICs which usually contain several gates of the same type, for example, four 2-input NAND gates or three 3-input NAND gates. This can be wasteful if only a few gates are required unless they are all the same type. In order to avoid using too many ICs one can reduce the number of gate inputs or substitute one type of gate for another.

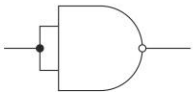
Reducing the Number of Inputs

The number of inputs to a gate can be reduced by connecting two (or more) inputs together. The diagram shows a 3-input AND gate operating as a 2-input AND gate.



Making a NOT Gate from a NAND or NOR Gate

Reducing a NAND or NOR gate to just one input creates a NOT gate. The diagram shows this for a 2-input NAND gate.



Any Gate can be Built from NAND or NOR Gates

As well as making a NOT gate, NAND or NOR gates can be combined to create any type of gate! This enables a circuit to be built from just one type of gate, either NAND or NOR. For example, an AND gate is a NAND gate then a NOT gate (to undo the inverting function). One can note that AND and OR gates cannot be used to create other gates because they lack the inverting (NOT) function.

Boolean Algebra Rules

Like normal algebra, the Boolean algebra also uses alphabetical letters to denote variables. If variable x has a value 0, then the complement of x (x') has a value of 1.

Like ordinary algebra, the Boolean algebra has its own unique identities. The first Boolean identity is that the sum of variable with zero is the same as the original variable. So

$$x + 0 = x$$

The next identity is that the sum of any variable with one is always one. So

$$x + 1 = 1$$

Next, the effect of adding x and x together will give x:

$$x + x = x$$

Some of the other Boolean algebra rules are:

1. $x * y = y * x$
2. $x + y = y + x$
3. $x * (y * z) = (x * y) * z$
4. $x + (y + z) = (x + y) + z$
5. $x * (y + z) = (x * y) + (x * z)$
6. $x + (y * z) = (x + y) * (x + z)$
7. $x * x = x$
8. $x + x = x$
9. $x * (x + y) = x$
10. $x + (x * y) = x$
11. $x * x' = 0$

12. $x + x' = 1$
13. $(x')' = x$
14. $(x * y)' = x' + y'$
15. $(x + y)' = x' * y'$

These rules are a direct translation into the notation of logic gates of the rules derived in the package Truth Tables and Boolean Algebra. We have seen that they can all be checked by investigating the corresponding truth tables. Alternatively, some of these rules can be derived from simpler identities derived in this package. Here x' represents the NOT x.

Nipuna Services: Streamlining the Backbone

Nipuna Services, the BPO arm of Satyam, provides end-to-end services from five centres, three in Hyderabad and one each in Bangalore and Chennai. Its service offerings include IT help desk, engineering services, finance and accounts, animation, customer contact, KPO and data management.

Nipuna's IT services for its 2,000 employees ran on a mixture of platforms, which included Linux and Sun Solaris. Due to increased WAN traffic, unorganised directory objects and centres without directory servers, this existing IT infrastructure failed to provide the systems necessary to establish the framework for cementing best practices. Hence, Nipuna decided to migrate to a single platform infrastructure. "We were keen to operate on just one platform across the business and therefore decided to restructure our IT infrastructure. This included careful consideration of the cost upgrading the existing systems management product versus switching products altogether," says Debashish Singh, vice president, Network and Systems.

After extensive evaluation, Nipuna decided to install a new technology environment based on the Microsoft platform. "Microsoft is strong on information management, collaborations and solutions for geographically dispersed companies," explains Singh, about choosing the Microsoft platform.

For implementation, Nipuna chose Microland, an IT infrastructure management and technical support services outsourcing firm, after assessing various implementation partners.

As part of the new solution, several Microsoft products and technologies were identified. This included Active Directory Service (component of Windows Server 2003), Exchange Server 2003, Systems Management Server (SMS) 2003, Internet Security and Acceleration (ISA) Server 2004 and Internet Information Services (IIS) 6. Active Directory, SMS 2003 and ISA 2004 were implemented at Nipuna's Hyderabad and Bangalore offices. This deployment happened in three phases.

The Phase I saw Active Directory migration at Hyderabad and Bangalore. The Active Directory technology provides a central location for managing and securing user accounts, computers and applications. In the second part of Phase I, Microsoft Exchange Server 2000 was upgraded to 2003 at Hyderabad enabling laptop users to access mail from anywhere.

Under Phase II, SMS 2003 was deployed for effectively administering patch management, software and hardware inventory management, OS deployment and remote administration.

In Phase III, ISA 2000 and IIS 5 were upgraded to ISA 2004 and IIS 6 respectively. The new solution was implemented in four months with zero down time," says Singh.

"The Microsoft solution was more scalable and cost-effective than other similar solutions. It helped Nipuna control costs, improve security, optimise bandwidth and enhance productivity," adds

Singh. Standardised, integrated components gave Nipuna a more centralised and simpler to manage IT infrastructure. the Data security also improved with the use of Active Directory Service to manage permissions for users on the network, password protection at the application and document level, etc.

Most importantly, Nipuna saw a significant reduction in costs, from initial purchase of licences to cost of ownership and management.

At a Glance

Challenges

- IT services ran on heterogeneous platforms, which included Linux and Sun Solaris
- The existing IT infrastructure failed to provide the systems required to establish framework for cementing best practices

Solution

- Installed a homogenous technology environment based on Microsoft platform
- New Microsoft products and technologies installed. Active Directory Service, Exchange Server 2003, Systems Management Server 2003, Internet Security and Acceleration Server 2004 and Internet Information Services 6

Benefits

- Better cost control, improved security, optimised bandwidth, and enhanced productivity
- Centralised and easy to manage IT infrastructure
- Improved data security.

Source: *Dataquest*, 28 Feb. 2007, Vol. XXV No. 04

INDUSTRY TRENDS

Bill Gates said in the Road Ahead, "We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next 10". It is very difficult to predict the trends in the Computer System Industry from a long-term perspective. One may try listing some of the things that will surely happen in the coming years.

DNA Computing

The DNA computer technology is based on the human being genetic algorithms. The ***DNA computing is a form of computing, which uses DNA, biochemistry and molecular biology, instead of the traditional silicon based computer technologies.*** The DNA computing is a fast developing interdisciplinary area. The DNA computing is fundamentally similar to parallel computing in that it takes advantage of the many different molecules of DNA to try many different possibilities at once. A DNA computing is done by coding a problem into the alphabet and then creating conditions under which DNA molecules are formed that encode all possible solutions of a problem. Our modern storage media store information at a density of one bit per 1,012 nanometres (One nanometre (nm) is one billionth, or 10^{-9}, of a metre), whereas the DNA computers have storage densities of one bit per cubic nanometre, a trillion times less space.

Nanotechnology

The **Nanotechnology** refers to a field whose theme is the control of matter on an atomic and molecular scale. The Nano means tiny. Generally nanotechnology deals with structures of the size 100 nanometres or smaller, and involves developing materials or devices within that size. It is a hybrid science that refers to the modelling, measurement, and manipulation of matter on the nano scale.

Wearable Computing

The **Wearable computers** are computers that are worn on the body. They have been applied to areas such as behavioural modelling, health monitoring systems, information technologies, and media development. The Wearable computers are especially useful for applications that require computational support while the user's hands, voice, eyes or attention are actively engaged with the physical environment. The wearable computing is quite similar to mobile computing, pervasive computing, ambient intelligence, and ubiquitous computing research communities, including power management and heat dissipation, software architectures, wireless and personal area networks. The wearable computing is about consistency, as there is a constant interaction between the computer and its user. Still the application of the wearable computing is in the niche areas of business.

Other Hardware Technologies

Other new hardware technologies include **Embedded computers, Optoelectronic computers and Quantum computing. The Embedded computers** mean embedding the computer inside a product. This helps in monitoring the performance of the product. For example, an aircraft has number of embedded computers which keeps monitoring the function of each components to which it is embedded. **The Optoelectronic computers** is a machine that uses light beams instead of electrons. The name itself 'Opto' is derived from the concept of light. These machines are expected to process information at much faster speed as compared to current computers. **The Quantum computing** is based on using the basic quantum states of matter as a fundamental unit of computing. If successful, quantum computers will be millions of times faster than the supercomputers of today.

Componentware

The Componentware is a software development process in which the software project is divided into independent components and each component is developed independent of each other. Each component because of its characteristics can be used by the different applications again and again. A single software project may contain hundreds of components, each providing specific business logic or user-interface functionality. For example, every e-commerce website needs a shopping cart. One may develop a shopping cart component and keep using it with all the e-commerce websites.

Services Oriented Architecture (SOA)

A service oriented architecture is essentially a collection of services. These services communicate with each other. The communication can involve either simple data passing or it could involve two or more services coordinating some activity. Some means of connecting services to each other is needed. The Service Oriented Architecture is a framework for constructing and interlinking a company's back end systems in order to make the computing systems more flexible and cost-effective.

Autonomic Computing

The Autonomic computing is a self managing computing model created by IBM. It is patterned on the human body's autonomic nervous system. An autonomic computing system would control the functioning of computer applications and systems without input from the user, in the same way that the autonomic nervous system regulates body systems without conscious input from the individual. The goal of autonomic computing is to create systems that run themselves, capable of high-level functioning while keeping the system's complexity invisible to the user.

Grid Computing

The grid computing is a concept that is quite similar to power grid concept, in which the resources of many computers in a network are shared. The grid computing requires the use of software that can divide and farm out pieces of a program to as many as several thousand computers. The grid computing can be thought of as distributed and large-scale cluster computing and as a form of network-distributed parallel processing. It can be confined to the network of computer workstations within a corporation, or it can be a public collaboration.

Cloud Computing

The cloud computing is a computing, in which tasks are assigned to a combination of connections, software, and services accessed over a network. This network of servers and connections is collectively known as 'the cloud'. The computing at the scale of the cloud allows users to access supercomputer-level power. The cloud is available everywhere and can be accessed by any computing device.

Increased Storage and Network Bandwidth

The storage and the network bandwidth to store and access information is growing much faster than computing causing an explosion in content creation. This will make content management one of the most important information technologies and new technologies will emerge to automatically find, organise, verify and visualise content.

Appliances and Online Services

The content and content management will increasingly be delivered in two main forms—appliances and online services. Extremely simple and user-friendly household and office appliances will

capture and organise documents, photos, music and video. The software appliances, configured as virtual machines for specific tasks, will be downloaded from the Internet to generic hardware that will come in small, medium or large sizes.

Online Collaborative and Content Services

The online collaborative and content services will extend from Web 2.0 to the community developing sites and user experience with open source will accelerate their rate of evolution. The mash-up technology will replace web services and will blur services as it blends internal and external services. These services will start to spill over into the physical world as shops and delivery become more integrated into requests from the Internet.

Revolution in user Interface Design

A new revolution in user interface design is just beginning as designers move from physical to soft design. This gesture control will make its way into handheld and notepad devices. The user interfaces will move from 2D to 3D as gamers influence work habits and one may see the first holographic interfaces. The Avatars will begin to replace dialogs as the request-response metaphor and one may see practical voice recognition and language understanding.

Business Computing

The business computing will shift significantly from PCs to mobile devices as Blackberry-size devices capture more business activities and form factors improve. Today's Ubiquitous Internet access and informality espoused by blogs and instant messaging will lead to simpler forms of communication. The content will be consumed on something probably closer to a Playstation Portable and to very thin mobile phones.

SUMMARY

- The computer is an electro-mechanical device that helps in storing and processing data for business purpose. The computers come in all sizes, shapes and powers. The most powerful computers are 'supercomputers', which are used for very specific applications by large organisations. The supercomputers are primarily used for research and development, data mining, and heavy processor centric applications. The mainframes have been around the longest, and are being used by the large organisations, which have lot of data processing and data management activities.
- The recent trend has not been for larger computers, however, but for smaller ones. This trend started in the 1970s with minicomputers, or minis. These computers were smaller than the mainframes but in many cases outperformed the larger units. The minis were received so well that computer manufacturers produced even smaller designs—called microcomputers or micros. Most of the microcomputer's main circuitry is in the form of a small silicon chip, called a 'microprocessor'.
- The personal computers were introduced in 1980s. A personal computer is a micro that is used by only single user or perhaps a few people working in the same area. The personal computers have become so popular that they found a place everywhere—in large organisations, in small ones and even in homes. The trend to smaller size has been accompanies by reduced costs, but not by reduced performance.

- All computers, irrespective of size and power, include a CPU, one or more input units and output units, secondary storage and software. A central processing unit (CPU) is comprised of an arithmetic and logic unit (ALU), a control unit, and a primary storage unit. Our modern technology has put the ALU, the control unit, and in some cases, the primary storage unit onto one integrated circuit called a microprocessor.
- There are several forms of primary storage, including semiconductor memory. The semiconductor memory is the most common and is of two basic types: RAM and ROM. The RAM is a volatile memory and are used primarily for temporary storage. The ROM is non-volatile and is used for permanent storage.
- The data are transferred out of memory and into the ALU for processing by way of the control, address, and data buses. The process of executing an instruction involves both an instruction cycle and an execution cycle. Before the CPU can process data and make the results available, there must be a way of communicating data to and from the computer. The process of entering and translating it into machine readable form is called input. The process of translating machine-readable data into a human readable format is called output.
- The primary storage is often inadequate because of its limited size and its volatility. In order, to supplement primary storage, secondary storage, which is a memory that is external to the computer and non-volatile are applied. There are three types of secondary storage media: magnetic tapes, disks, and optical media. The magnetic tape is a ribbon of mylar, coated with a thin layer of iron oxide. The magnetic disks are metallic platters coated with iron oxide. The optical technology involves the use of lasers to store data on various media.
- The number systems are used to describe the quantity of something or represent certain information. The digits are consecutive in a number system. The number of digits is equal to the size of the base. Zero is always the first digit. The base number is never a digit. When 1 is added to the largest digit, a sum of zero and a carry of one result. The numeric values determined by the implicit positional values of the digits. The number systems that are prevalent are Decimal (base 10), Binary (base 2), Octal (base 8) and Hexadecimal (base 16) systems.
- The conversion between various number systems are possible and vice versa. One can easily convert the decimal number to a binary or binary to octal or octal to hexadecimal or hexadecimal to decimal.
- The arithmetic operations are possible on binary numbers just as they can be done on decimal numbers. In fact the procedures are quite similar in both systems. The multiplication and division are not really difficult, but unfamiliarity with the binary numbers causes enough difficulty.
- The Boolean Algebra is a study of mathematical operations performed on binary variables. It provides a set of rules called Boolean logic that are indispensable in digital computer-circuit and switching-circuit design. The Boolean operation are carried out with algebraic operators called Boolean operators, the most basic of which are NOT, AND, and OR.
- The Logic Gates are the elemental blocks in a logic device and Boolean algebra can be performed using AND, OR and NOT gates.

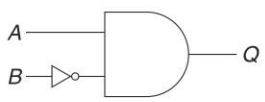
KEY TERMS

Address Bus
Analog Computer
Arithmetic and Logic Unit (ALU)
Binary Arithmetic
Binary Numbers
Boolean Algebra
Bus
Cache Memory
Central Processing Unit (CPU)
Communication Paths
Computer

Computer Hardware
Computer System
Control Bus
Control Unit
Data Bus
Decimal Numbers
Digital Computer
Dynamic RAM (DRAM)
EEPROM
EPROM
Extended Data-out RAM (EDO RAM)
Hardware
Hexadecimal Numbers
Hybrid Computer
Input Devices
Integrated Circuits
Logic Gates
Mainframe
Memory
Minicomputer
MIPS
Multiprocessing
Nonvolatile RAM (NVRAM)
Notebook
Number Systems
Octal Numbers
Output Devices
PDA
Primary Memory
PROM
Public Domain
RAM
Real-time Processing
Registers
ROM
Secondary Storage
Static RAM (SRAM)
Supercomputer
Synchronous DRAM (SDRAM)
Time Sharing
Truth Tables
Virtual Storage

SELF-STUDY QUESTIONS

1. A _____ is an electronic device that manipulates data. It has the ability to store, retrieve, and process data.
   (a) Secondary Devices (b) Memory
   (c) Computer (d) Software
2. The _____ computers are more intelligent and have 'thinking' power and capacity to take decisions. The grand scale integration (GSI) also happened.
   (a) Second Generation (b) Third Generation
   (c) Fourth Generation (d) Fifth Generation
3. A _____ computer is designed to operate and solve restricted class of problems.
   (a) Digital (b) Hybrid (c) Micro-computer (d) Special Purpose
4. Primary Memory, ALU, and Control units are main parts of _____
   (a) Bus (b) Secondary Memory (c) CPU (d) Registers
5. The _____ transports memory addresses, which the processor wants to access in order to read or write data.
   (a) Address Bus (b) Data Bus (c) Control Bus (d) Instruction Bus
6. In order to bridge the speed between the CPU and Main Memory, the modern computer has _____.
   (a) RAM (b) Cache Memory (c) ROM (d) DVD
7. Which of the following is NOT an input device?
   (a) Keyboard (b) DVD (c) Light Pen (d) TFT Screen
8. 0 + 1 = ?
9. 1 × 1 = ?
10. As per the logic gate shown alongside, what is the value of Q?



REVIEW QUESTIONS

1. Describe the major components of a computer system.
2. Describe the broader classification of computers.
3. List some of the commonly used input and output devices.
4. What is the role of registers and bus in computer system?
5. List different type of Registers.
6. Define Data, Address, and Control Buses.
7. List out the different types of RAM and ROM?
8. Why we need to study different number systems?
9. The Boolean algebra is an important concept for digital computers? Justify.
10. What is NAND and NOR gates?

QUESTIONS FOR DISCUSSION

1. What are the major trends in the hardware industry in India? Identify the major storage and processing devices commonly used.
2. A small manufacturer of leather hand bags wants to buy a computer system to manage its sales at the factory outlet. Suggest the best possible computer system configuration in terms of hardware and software needs.
3. With the convergence becoming a reality, will it affect the personal computer industry? Or it will become difficult for the PC vendor to sustain?
4. Today, PCs have a processing power, which is many times more than that of yesterdays mainframe computers. Does it mean that organisations may not need the mainframe servers in the future?
5. How important it is for the common user to have knowledge about the different types of RAM and ROM?

APPLICATION EXERCISES

1. ABC company is a leading food chain having 20 stores in the city. It manages all its raw material inventory on real-time space, keeps record of its sales, and manages, account on daily basis. The management wants to procure the computer system for its complete business. Identify the kind of hardware and software the company would require.
2. Do the Binary Arithmetic calculations for the following:

   (i) 1. 101 + 11 =
   2. 111 + 111 =
   3. 1010 + 1010 =
   4. 11101 + 1010 =
   5. 11111 + 11111 =

(ii) 6. 110 – 10 =
7. 101 –11 =
8. 1001 – 11 =
9. 1101 – 11 =
10. 10001 – 100 =

(iii) 11. 10 × 10 =
12. 100 × 11 =
13. 101 × 10 =
14. 1011 × 11 =
15. 11011 × 101 =

(iv) 16. 100/10 =
17. 111/11 =
18. 1010/100 =
19. 1101/11 =
20. 10111/10 =

3. Convert the decimal 68 to binary.
4. Convert the binary 101100 to decimal.
5. Convert the decimal 39 to hexadecimal.
6. Convert the hexadecimal 1AB to decimal.
7. Convert the decimal 25 to octal.
8. Convert the octal 42 to decimal.

GROUP PROJECTS

1. The sales department of a multinational decided to set up an online group communication system. Search the Internet or survey the market to identify the major players in this segment. Prepare the comparative analysis of various products and suggest the best option.
2. Search the Internet to identify the new developments happening in the field of processors and animation. Prepare a comprehensive report and make a presentation to your faculty.
3. Study the IT infrastructure of your own institution and compare it with similar institutes in India and abroad and prepare a comparative report for your IT head.

Caselets

1. Hindalco: Scaling for Growth

Hindalco has been in the news recently for its Novel's acquisition, but even otherwise, this flagship company of the Aditya Birla Group is the largest integrated aluminium manufacturer in the country. In fact, Hindalco was growing either through acquisitions or through major green field projects. These acquisitions bring with them the supplementary challenges of consolidation of infrastructure, applications and people.

Sanjeev Goel, senior VP, IT, Hindalco, elaborates: "The expansion strategy of the company entailed the availability of a reliable, scalable and robust IT infrastructure. The IT architecture had to envision the increase in the number of users from the current 2,000 to about 10,000 users in five years' time. There was a growing need for applications with expansion in business operations. The state-of-readiness of the infrastructure with no single point of failure and heightened level of business continuity were crucial strategic imperatives for the company."

Hindalco had already implemented an ERP solution based on centralised architecture using state-of-the-art IBM high-end RISC-based servers in September 2003. With an aim to be a premium metals major, global in size and reach, integration was clearly the key to streamlining operations across multiple locations and accordingly, a Branch Integration project was undertaken during October 2005. Further, two key modules viz. order management and financial management were successfully integrated with the existing ERP solution in February 2006 and now more than 2,000 users spanning all hierarchical levels were accessing a range of critical business applications across 52 locations.

Thus, Hindalco was looking for an end-to-end hardware architecture solution comprising of high-end servers and a reliable storage platform for its primary Data Centre at Renukoot and upgrading the DR solution at Renusagar.

Once Hindalco sketched out its roadmap for integration and consolidation, it became imperative to partner with a reliable, globally acknowledged vendor like IBM. In order to address the business growth and ambitious expansion plans of Hindalco over the next 5 years, IBM deployed its most contemporary enterprise server technology viz. 'POWER5 technology' and 'Enterprise Storage-DS8100'. There was a need to upgrade server and network architecture in order to accommodate additional locations of erstwhile Indal. Accordingly, existing IBM servers were upgraded from P-650 series to P-570 series servers and the storage was upgraded from FASt T500 to DS 8100.

Hindalco's Data Centre now comprises two p570 DB servers in cluster mode with Oracle 9i RAC configured with DS8100 storage with current capacity of 4.5 TB. High redundancy is built into each system, and total solution redundancy is ensured through clustering and DR implementation. In order to ensure point in time recovery in case of disaster, the production data of DS8100 is maintained in full sync with the DS 8100 at Renusagar through the synchronous PPRC.

One of the biggest benefits of opting for IBM technologies and solutions, according to Goel, is the fact that there is a clear roadmap for scaling up IT requirements.

The existing infrastructure is being retained in the solution to offer maximum investment protection and reduce the total cost of ownership. Also, the proposed solution is configured in such a fashion that in future additional investment would be required only on account of the incremental hardware capacities required at that point in time. So once Novelis integration becomes operational, Hindalco is not expected to lose too much sweat, thanks to IBM systems.

Questions for Discussion

1. As Hindalco grows through acquisitions, what systems helped it to counter the challenges of infrastructure consolidation?
2. What were the key challenges the company faced during these acquisitions?
3. What were the benefits they achieved?

Source: Dataquest, 28 Feb. 2007, Vol. XXV No. 04

2. SAN for SMBs

The storage area networks with improved entry level features and lowered costs are now proving to be a boon for SMBs

A storage area network (SAN) comprises the most powerful technology available for block level storage, and has been used by the enterprises for years. For many small to medium sized businesses (SMBs) though, SANs were long out of reach predominately due to their high cost. In addition, many SMBs simply did not have the need for large amounts of scalable storage space, and therefore able to function adequately using direct attached storage.

Two underlying factors have changed the storage landscape and made SANs more important and accessible to SMBs. The first is the recent explosion of digital data, and the second is the increasing availability of entry level, feature packed SANs that are specially priced and designed for SMBs.

MANAGING STORAGE

According to IDC, the research firm, the amount of digital information created, captured, or replicated in 2010 will amount to 1.2 ZB (1.2 tn GBs). By 2020, IDC estimates this will go upto 35 ZB or 35 tn GB. As a result of this massive growth in data, SMBs will face a number of challenges in the coming years as they try to deal with the increasing flow of information.

First, SMBs do not necessarily have standardised data storage, backup, recovery, or archiving methods. This is due to cost constraints and existing behavioral norms. While there is more digital content to handle now than ever, resources at SMBs have stayed at the same levels. With limited resources, many SMBs are forced to be very cost conscious, and might not even have staff dedicated to the IT backup. Additionally, IT staff at SMBs may not be able to keep pace with the increasing flow of data.

Given the limited resources, many SMBs may not have developed systematic ways to handle backups. The disk space is relatively cheap so many SMBs simply buy more disk space on an ad hoc basis. Those who had to recover data are exposed to the nightmare caused by haphazard backups and the existence of fragmented information located across multiple servers and storage elements.There are SMBs who have been able to recover data after spending an excruciating amount of time, while many others are confronted with the reality that their inadequate backups have caused them to permanently lose important business data.

Second, as the amount of data grows, data protection becomes crucial. Backups, as noted above, are vitally important but additional redundancy infrastructure is now a necessity, given the constant inflow of data. It is crucial to keep the amount of time it takes to recover data in case of a failure (a concept called recovery time objective or RTO) as short as possible, so that downtime is minimal. In addition, it is important to do backups frequently in order to minimise the amount of data that could be lost (commonly known as recovery point objective or RPO). If an SMB performs a backup at the end of a business day but its system fails in the middle of the next day, a half days worth of valuable data is lost.

Third, data does not necessarily equate to usable information unless it can be easily sorted and readily accessed. Without a means to catalog the growing amount of data, it merely becomes a steadily growing collection of bits and bytes that can suffocate SMBs which rely on manual methods to access it. In addition, many SMBs are scattered across multiple locales, trying to organise, and access data in multiple locations and jurisdictions, which could be a doubly impossible task without the right tools.

Fourth, SMBs need to utilise the resources efficiently to squeeze out the maximum out of their investments. This is a key point in the context of data storage. The preventive care is essential in order to minimize total cost of ownership. The failure to address storage and recovery issues with foresight could mean that an SMB is just away from enduring a devastating loss of valuable business information. The preventive care is not only prudent, but an effective use of resources will also maximise the return on investment.

ENTERPRISE LEVEL FEATURES

If we look around the market place today, we will see that a large number of vendors now offer middle range and entry level SANs that are priced and scaled for the SMBs. SANs have become commoditised and plum-

meted in price, while their feature sets have become better and better. It is beneficial for the SMBs that they learn as much as they can about the options available in the market.

The vendors now recognize SMBs as major players. This means that an SMB can attach multiple servers–mail servers, database servers, file servers, backup servers and provide hierarchical storage using either the FC or the iSCSI networking mode.

This type of next generation SAN aligns itself perfectly with the resources available as well as the needs of the SMBs. The future is now for enterprise level data protection that is cost-effective, secure, scalable, energy saving, economical, and easy-to-use, install, and maintain.

ENTRY LEVEL SAN SOLUTIONS FOR SMBs

The growth of data continues at an exponential rate. Certainly, in the near future there will be seismic shifts in the way SMBs approach data storage, management, and protection in order to deal with this reality. The SMBs will begin to explore virtualisation strategies, and try to control the tide of data growth using data deduplication. In addition, cloud computing will play a role in data storage, as online storage services will become more prevalent and affordable.

That said, it is vitally important that SMBs do not get too lost in the big picture or in hypothetical scenarios. The SMBs simply needs to look at their data storage, management, and protection situations, and ascertain what is necessary and viable to grow their businesses in an efficient manner. The answer lies not in some complex solution but instead, in an entry level, next generation SAN.

Questions for Descussion

1. List the main challenges being faced by SMBs with respect to data management.
2. What were the perceived benefits of the proposed solution?

Source: Dataquest, December 31, 2010

Answers to Exercises

Exercise 1

(a) 84	(b) 10	(c) 51	(d) 47
(e) 17	(f) 15	(g) 135	(h) 101
(i) 1001	(j) 10011	(k) 10110	(l) 11111
(m) 100000	(n) 101110		

Exercise 2

(a) 111	(b) 1001	(c) 10000	(d) 10100
(e) 11001	(f) 10000	(g) 101100	(h) 110011
(i) 110011			

Answers to Self-Study Questions

1. (c)	2. (d)	3. (d)	4. (c)
5. (a)	6. (b)	7. (d)	8. 1
9. 1	10. $Q = A$ AND NOT B		

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Chapter 4

Computer Software

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What is Software?
- What is the role of system software and operating system?
- What are the different types of programming languages?
- What are the steps required to select software?
- What are software trends and issues?

INTRODUCTION

In the last two decades, a great deal of developments happened in the computer hardware segment. While these developments have been truly astounding, without system and application software the computer revolution would have been stillborn. It is through software that computer hardware becomes useful to human beings and organisations. The computer hardware cannot perform any activity without a set of instruction. These sets of instructions are called computer programs or software. The major functions of software are to (i) manage the computer resources of the organisation; (ii) develop tools that human beings can utilise to take advantage of these resources; (iii) act as an intermediary between stored information and organisations; and (iv) enable the user to tailor a computer to provide specific business value.

The software is the set of instructions that the computer uses to get the job done. The computer software programs allow users to complete tasks. The process of writing the set of instructions is called programming. The modern software uses the stored-program concept, in which stored software programs are accessed and their instructions are executed in the computer's CPU. A computer program also includes documentation**,** which is a written description of the

functions of the program. The documentation helps the user operate the computer system and helps other programmers understand what the program does and how it accomplishes its purposes. The documentation is also vital to the business organisation for continuity and scalability.

A program can also be referred to as an application and the two words are used interchangeably. The examples of software programs or applications are operating systems (Windows, Unix, MacOS), wordprocessors (text processor), spreadsheets (analysis), databases, internet browsers, and email etc. There are many different types of software available for almost every conceivable need. The software is available commercially through stores and mail order and also available on the Internet. The software is also available through an Open Source license, which allows anyone to use the Open Source software free of charge as long as the license is maintained. Some of the Software developing organisations offer suites of software to meet variety of needs of their customers.

The different types of softwares that are available are commercial, shareware and open source software. Some software is also released into the public domain without a license called freeware.

COMPUTER SOFTWARE

The set of instructions used to control hardware and accomplish specific tasks are called software. The computer software provides the logic that drives computer hardware. The **software** is the set of instructions for controlling the hardware devices, instructing computers to transform data into information, and many other information processing tasks. The software can also be defined as written programs or procedures, or rules and associated documentation pertaining to the operation of a computer system and that are stored in a storage device. The different kinds of softwares typically run on an individual hardware device. It is through software that computer hardware becomes useful to human beings and organisations. The major functions of software are to:

- manage the computer resources of the organisation;
- develop tools that human beings can utilise to take advantage of these resources;
- act as an intermediary between stored information and organisations;
- enable the user to tailor a computer to provide specific business value.

Typically, computer software consists of two different layers—system software and application software. Earlier, user interface used to be treated as the third layer of software category, but over a period, it has been integrated into the application software layer. Each of these kinds of software specialises in a unique set of capabilities.

The computer software is set of instructions that are used to direct the operation of a computer.

The different kinds of softwares are illustrated in Figure 4.1. As shown in the figure, the system software (or Operating System) surrounds and controls access to the hardware. The application software must work through the system software. Lastly, the user interacts through the user interfaces of the application software.

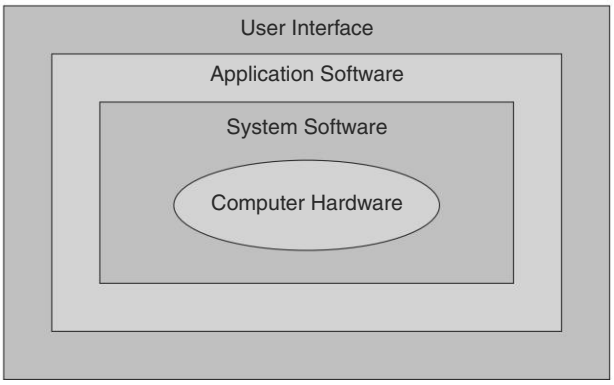


Figure 4.1 Relationship between Different Types of Softwares

System Software

The system software directly interacts with the hardware and comprises programs that manage the hardware components. It supervises the execution of all application software running on the computer system, converting high-level and 4GL programming codes into individual instructions that the hardware can execute. For example, system software controls the saving of data as well as data retrieval from secondary storage devices. The operating systems and language translator program are examples of system software. The system software helps an application programmer in abstracting away from hardware, memory, and other internal complexities of a computer.

Application Software

The program that help the user, the system software, and the hardware work together to solve end user problems are application software. For example, application software helps user to work on databases, writing a letter or creating a graph. The application software creates a communication bridge whereby the user can tell the system software how to direct the hardware to perform the desired functions. There are special software languages that are used to develop application software. They are composed of one or more individual computer program using one or more programming languages. A word processor is the most widely used example of applications software; it can be used to create a letter or memo or anything else you need to type. Other examples include games, spreadsheets, tax preparation program, managing accounts, etc. ***The applications software can be purchased in stores and is called packaged or commercial software.*** In other words, it is prewritten. However, there may be situations that require a specific type of software that is not available. It would then be necessary to design and write a program; this software is called custom software.

Packaged Software

The packaged software can be purchased, or in some cases, it is available free of cost called Freeware. The **freeware** is software package available in the public domain, and it may be used

or altered without fee or restriction. Another form of partially free software is shareware. In case of **Shareware,** the author of shareware assumes that the user will make a voluntary contribution for using the product. Another category of application packaged software is the word processing, spreadsheet, database management, graphics, and communications tools. Most often, these categories of software are bundled together into a single package. The most common example of this is Microsoft Office.

The most important applications of software categories included in office suites are described in the table below:

Software Category	*Function*
Word Processor	A tool for entering and revising text, adding graphical images, formatting, and printing documents. It is a text processing tool, very good for reporting.
Spreadsheets	A tool for working with numbers and allows creating, and editing electronic spreadsheets in managing and analysing information. A good tool for analytics.
Database Management	A tool for management of a collection of interrelated facts. The data can be stored, updated, manipulated, retrieved, and reported in a variety of ways. A tool where data repository is build.
Presentation	A tool for creating presentations using text, graphs, audio, and video based data.
Communication	A tool for online communication using email, appointments, and other important office management utilities.

SOFTWARE GENERATIONS

Corresponding to the five generations of hardware evolution are the five generations of software developments. The historical development that has happened in the Software industry is explained in the following paragraphs:

First Generation

During the 1950's the first computers were programmed by changing the wires and set tens of dials and switches. One for every bit sometimes these settings could be stored on paper tapes that looked like a ticker tape from the telegraph - a punch tape - or punched card. With these tapes and or cards the machine was told what, how and when to do something. The first generation of software was the **machine language**, which used the 0s and 1s of binary language and was the only way in which programmers could communicate with the computer. The machine language was the language of 1940's and programming in machine language is a slow and labour intensive process.

Second Generation

The second generation of software occurred in the early 1950's with the development of assembly language. By using assembly language the programmer was able to use mnemonic codes, names

(like add, sub, load), for the machine language operator and operand rather than the 0s and 1s. The translation of assembly code into machine code was accomplished by an assembler. The **assembler** is software tool that translate the assembly language mnemonics into machine language. But an assembler still works on a very low level with the machine. For each processor, a different assembler was written.

Third Generation

The development of third generation of computer software occurred from mid 1950's to 1970's. In this period, first high level languages emerged. The **high level languages** were more sophisticated extensions of assembly language and used more English like sentences. It permitted scientists and mathematicians to work with computers through the use of languages such as FORTRAN (FORmula TRANslation), which allowed the user to define variables and equations. The COBOL (Common Business Oriented Language) permitted the use of English statements for commercial applications. These languages are known as higher level languages because each statement of these languages can generate multiple statements at machine level. The program written in high level languages need to be compiled using the compiler. The **compiler** is the software that translates English like program codes into a specific series of machine codes. During the same period other languages that were developed were BASIC, ALGOL, PASCAL, C, and PL/1.

Fourth Generation

The fourth generation of software development began in the late 1970's. In this period, packaged software programs that perform limited functions were created. These programs reduced the need of writing and compiling small routine applications. This innovation leads to more demand from the end users. The 4GL allowed the end-user or non-programmer to build an application without using the complexity of third generation programming language. Therefore, knowledge of a programming language is not required. A few instructions in a 4GL will do the same as hundreds of instructions in a lower generation language like COBOL or BASIC. The main advantage of the 4GL was it is easier and faster to create an application. These are bit slow on processing.

As the high level languages became more human oriented they drifted further from the assembly language of the computer. The language C emerged as a small low level language solution for development work for the personal computer; it is portable, it is modular and it is appealing because of its powerful operators. The 'Object Oriented Programming' became popular in early 1980s and the language C++ emerged as a popular solution. As the World Wide Web (WWW) became an everyday buzz word the language Java, a pure object oriented language, was developed to do web programming. The Java is a small language, it provides for good graphical user interface (GUI) and multimedia facilities.

Fifth Generation

The fifth generation of software development began in early 1990's and is still in progress. In this period, integrated software, animations software, and multimedia technology is being introduced.

Still many individuals consider natural languages to be fifth generation languages. This natural languages are similar to query languages but eliminate the need for the user or programmer to learn a specific vocabulary, grammar, or syntax. A natural language closely resembles human speech. The Natural Language Programming (NLP) languages are known as fifth generation languages. In order to translate the NLPs to machine readable form requires a translator which requires lot of processing resources. Other development of this generation is Web Programming Languages like HTML, XML, Java, Javabeans, Active X, Active Server Pages etc., that helps in creating and managing web pages and websites. The software for the end user will be (may be) based on principles of knowbot-agents. An autonomous self changing piece of software that creates new agents based on the interaction of the end–user and interface.

SYSTEM SOFTWARE

The system software is a program that manages and supports the computer resources and operations of a computer system while it executes various tasks such as processing data and information, controlling hardware components, and allowing users to use application software. It acts as a bridge between computer system hardware and the application software. The system software is made up of many control programs, including the operating system, communications software and database manager. There are many kinds of computers these days. Some of them are easier to learn than others. Some of them perform better than others. These differences may come from different systems software.

The system software includes the management software for various computer resources, such as processing time, storage and memory, printers, terminals, communication links, and all of the peripheral equipment that surrounds a central processing unit. The systems software also facilitates the programming, testing, and debugging of computer programs. It is more general than applications software and is usually independent of any specific type of application. The special set of computer program that manages and controls these aspects of the central processing organisation and utility is called an **operating system**. Whenever users interact with a computer, the interaction is controlled by and takes place through an operating system.

The system software is a program that manages and supports the computer resources and operations of a computer system.

The system software has varied kinds of functionalities, which depend on the physical characteristics of the hardware. One may have single-tasking or multi-tasking operating systems. In single-tasking operating systems, only one program can be executed on a hardware device at any one point of time. The true multi-tasking operating systems are more complex and manage the concurrent execution of multiple program on various kinds of hardware devices. For example, one group of users are accessing a shared database, another group is sending and receiving emails and another group is browsing the Internet. A good multi-tasking operating system will manage all these tasks in a seamless manner without reducing the performance at the user end.

The systems software consists of three kinds of programs as explained below:

System Management Programs

These are programs that manage the application software, computer hardware, and data resources of the computer system. These programs include operating systems, operating environment programs, database management programs, and telecommunications monitor programs. Among these, the most important system management programs are operating systems. The operating systems are needed to be studied in more details. There are two reasons—first, users need to know their functions first, and second, there are many kinds of operating systems available. The telecommunications monitor programs are additions of the operating systems of microcomputers. These programs provide the extra logic for the computer system to control a class of communications devices.

System Support Programs

These are the programs that help the operations and management of a computer system. They provide a variety of support services to let the computer hardware and other system programs run efficiently. The major system support programs are system utility programs, system performance monitor programs, and system security monitor programs like virus scanners.

System Development Programs

These are programs that help users develop information system programs and prepare user programs for computer processing. These programs may analyze and design systems and program itself. The main system development programs are programming language translators, programming environment programs, computer-aided software engineering packages.

OPERATING SYSTEMS

An operating system is a system management program that is a collection of integrated computer programs that provide recurring services to other programs or to the user of a computer. These services consist of disk and file management, memory management, and device management. In other words, it manages CPU operations, input/output activities, storage resources, diverse support services, and controls various devices. The operating system is the most important program for computer system. Without an operating system, every computer program would have to contain instructions telling the hardware each step the hardware should take to do its job, such as storing a file on a disk. Because the operating system contains these instructions, any program can call on the operating system when a service is needed.

An operating system (OS) is a set of programs that manage computer hardware resources and provide common services for application software.

An operating system is a set of programs that controls and supervises a computer system's hardware and provides service to application software, programmers, and users of a computer system. The purpose of an operating system is to manage the hardware resources efficiently and to provide an interface between the hardware and an application program and end–user. An

operating system helps in increasing the efficiency of a CPU, it decides which resources will be used, which programs will run, and how the programs will be translated into machine language.

The portion of the operating system in use resides in primary storage, so the details of an operation are received and executed by the computer at computer speeds, thus eliminating the long delays that existed when humans had to intervene. An operating system can also execute another program immediately without human involvement.

There is however, not one universal operating system. Some operating systems are developed by computer manufacturers specifically to take advantage of an individual machine. Others are developed by software companies and are intended to be used across a wide range of computers. The majority of modern home computers use some form of Microsoft's operating systems. The original Microsoft operating system was called DOS (Disk Operating System) though most computers use Windows. The windows comes in various versions beginning with version 3.x then 95, 98, ME, XP, Vista and currently version 7. A few computers use IBM's O/S2. The Apple's Mac uses its own operating system called OS 10.x. The organisation with multi-user servers uses UNIX or Linux or Windows NT or one of the other network or server based operating systems.

Objectives of Operating Systems

The modern operating systems generally have following major objectives:

- Convenience. It makes the computer more convenient to use
- Efficiency. It allows computer system resources to be used in an efficient manner
- Ability to evolve. It permit effective development, testing, and introduction of new system functions without interfering with service.
- Hide details of hardware by creating abstraction. An abstraction is software that hides lower level details and provides a set of higher-level functions. An operating system transforms the physical world of devices, instructions, memory, and time into virtual world that is the result of abstractions, built by the operating system. There are several reasons for abstraction.
- First, the code needed to control peripheral devices is not standardised. The operating systems provide subroutines called device drivers that perform operations on behalf of programs for example, input/output operations.
- Second, the operating system introduces new functions as it abstracts the hardware. For instance, operating system introduces the file abstraction so that programs do not have to deal with disks.
- Third, the operating system transforms the computer hardware into multiple virtual computers, each belonging to a different program. Each program that is running is called a process. Each process views the hardware through the lens of abstraction.
- Fourth, the operating system can enforce security through abstraction.

Services Provided by Operating System

- Process Management—The creation and deletion of user and system processes, deadlock handling, etc.

- Main-Memory Management—It keeps, track of which parts of memory are being used;, also allocate/deallocate memory space as required, etc.
- Secondary-Storage Management—It provides free-space management, disk scheduling, storage allocation, etc.
- I/O System Management—It deals with hardware specific drivers for devices, keeps it all hidden from the rest of the system.
- File Management—It helps in creating/deleting files and directories, backup, etc.
- Protection System—It controls access to programs, processes, or users.
- Networking—The generalises the network access
- Command Interpreter System—It acts as an interface between the user and the OS
- Program development—It works as editors and debuggers
- Program execution
- Error detection and response
  - (i) It helps in the detection of internal and external hardware errors
    - Memory error
    - Device failure
  - (ii) Software errors
    - Arithmetic overflow
    - Access forbidden memory locations
  - (iii) Operating system cannot grant request of application
    - Accounting
      - (i) It also collect usage statistics.
      - (ii) It monitors performance.
      - (iii) It is used to anticipate future enhancements
      - (iv) It is also used for billing purposes

Operating System Functions

An operating system executes many functions to operate computer system efficiently. Among them, four essential functions are the followings.

- ***Resource Management.*** An operating system manages a collection of computer hardware resources by using a variety of programs. It manages computer system resources, including its CPU, primary memory, virtual memory, secondary storage devices, input/output peripherals, and other devices.
- ***Task Management.*** An operating system also controls the running of various tasks. For example it manages one program or many programs within a computer system simultaneously. That is, this function of operating system manages the completion of users' tasks. A task management program in an operating system provides each task and interrupts the CPU operations to manage tasks efficiently. A task management may also involve a **multitasking** capability.

The jobs that are being submitted for execution are prepared, scheduled, controlled, and monitored by task or job management control programs to ensure the most efficient processing. A job is a collection of one or more related job steps and their data. A Job Control Language (JCL) is used to tell the operating system what a job requires in terms of computer resources and operating system services. The JCL is the user's language for communication with the operating system, and each operating system has its own JCL. Some JCL's, such as those for mainframe operating systems, can be very complex and difficult to learn. Others, such as those found with many microcomputer operating systems, use simple one-line commands — for example, RUN to execute a program or ERASE to delete a file from a disk. Many operating systems keep a record of all the jobs processed. A job record, or log, can then be printed and reviewed by system administrator to determine the status of a job: has it been processed, and were there any errors?

- **File management:** This is a function that manages data files. An operating system contains file management programs that provide the ability to create, delete, enter, change, ask, and access of files of data. They also produce reports on a file.
- **User Interface:** It is a function of an operating system that allows users to interact with a computer. A user interface program may include a combination of menus, screen design, and keyboard commands. A well-designed user interface is essential for an operating system to be popular. Because of the function, users can load programs, access files, and accomplish other tasks.

Control and Processing Programs

The programs that make up an operating system are generally divided into two categories:

- ***Control programs.*** The control programs manage the computer hardware and resources. The major functions of these programs are: resource management; data/file management and job/task management. The main program in most operating systems is the supervisor program. The supervisor program is a control program that is known in some operating systems as the monitor, executive, or kernel; it is responsible for controlling all other operating system programs as well as other system and application programs. The supervisor program controls the activities of all the hardware components of the computer system.
- ***Processing Programs.*** The processing programs are programs in the operating system that provide a service to the user or the programmer of the computer system. The examples include language translator programs and utility programs. The language translator programs convert programmer authored programs into machine language instructions that can be executed by the computer. The utility programs perform routine but essential functions, such as loading, saving, or copying a program; keeping track of the files stored on a disk; and preparing a disk for use.

The operating system programs are stored on a system resident device—one that is always available. When the computer is turned on, essential portions of the supervisor program are loaded into primary storage from the system resident device and remain there throughout the computer's operation. The other portions of the supervisor program and the rest of the operating

system programs are loaded into primary storage as needed and are removed when they have completed their tasks.

Types of Operating Systems

There are several basic types of operating systems, including single user, multi-programming (concurrent), time sharing, multiprocessing, virtual storage, real time, and virtual machine operating systems. A particular operating system may exhibit characteristics from one or more of the various types.

- ***Single User Operating System.*** A single user operating system allows one program to be executed at a time, and that program must finish executing completely before the next can begin. This type of operating system is often found with old generation personal computers, for example, Microsoft's DOS (Disk Operating System) and also the older version of Windows. The goal of this type of operating system is to ensure maximum ease of use and minimum professional support.
- ***Multi-programming Operating System.*** This type of operating system permits multiple programs to share a computer system's resources at any given time through concurrent use of a CPU. It allows a computer to do several things at the same time. The multiprogramming creates logical parallelism. The concept of multi-programming is that the operating system keeps several jobs in memory simultaneously. The operating system selects a job from the job pool and starts executing a job, when that job needs to wait for any i/o operations the CPU is switched to another job. So the main idea here is that the CPU is never idle. The Unix operating system is an example of a multi-programming operating system.

  The multiprogramming is the technique of running several programs at a time using timesharing.

- ***Time-Sharing Operating System.*** A time sharing operating system allows multiple users to access a single computer system. The attention of the CPU is shifted among users on a timed basis, which is controlled by the operating system. As long as the computer system does not have more users than the operating system can handle, it appears as if each user has uninterrupted access to the CPU. However, if the number of users exceeds the operating system's capability, noticeable delays in processing result.

  A time-sharing operating system uses CPU scheduling using time-slice.

  The time sharing operating systems allocate specific periods of time, or time slices, for the execution of instructions of a particular program. These time slices are usually only a fraction of a second long and are controlled by the operating system through the use of time slice interrupts generated by a hardware clock. The time sharing concept enables each user's program to receive processor time at regular intervals, thus preventing anyone program from monopolising the CPU. When an event interrupt occurs (i.e., an input/output request), the operating system may switch to another program before a full time slice is used. This capability allows the CPU to be used more efficiently. Keeping track of the job next in line for processing is one of the responsibilities of the operating system.

- ***Multi-tasking Operating System.*** The multitasking is the logical extension of multi-programming. The concept of multi-tasking is quite similar to multi-programming but difference is that the switching between jobs occurs so frequently that the users can interact with each program while it is running. This concept is also known as time-sharing systems. A time-shared operating system uses CPU scheduling and multi-programming to provide each user with a small portion of time-shared system.

  The multi-tasking is simultaneous execution of multiple tasks or programs under the control of an interrupt-driven operating system.

- ***Multi-threading.*** The multi-threading is similar to multitasking, but enables the processing of multiple threads at one time, rather than multiple processes. Since threads are smaller, more basic instructions than processes, multi-threading may occur within processes. By incorporating multi-threading, programs can perform multiple operations at once. For example, a multi-threaded operating system may run several background tasks, such as logging file changes, indexing data, and managing windows at the same time. The web browsers that support multi-threading can have multiple windows open with JavaScript and Flash animations running simultaneously. If a program is fully multi-threaded, the different processes should not affect each other at all, as long as the CPU has enough power to handle them. Similar to multitasking, multithreading also improves the stability of programs. However, instead of keeping the computer from crashing, multithreading may prevent a program from crashing. Since each thread is handled separately, if one thread has an error, it should not affect the rest of the program.

  The multithreading is a programming and execution model that allows multiple threads to exist within the context of a single process.

- ***Multi-processing Operating System.*** A multi-processing operating system allows the simultaneous execution of programs by a computer that has two or more CPUs. Each CPU can be dedicated to one program, or each CPU can be dedicated to specific functions and then used by all programs. Many computer systems such as mainframes and supercomputers have more than one CPU. A more common form of multi-processing involves the use of a single large main CPU that is connected to multiple channels. Each channel is a processing unit that handles input and output from the main CPU and coordinates the work of slower input/output devices.

  The multi-processing is running of two or more programs simultaneously by a computer with more than one central processor.

- ***Virtual-storage Operating System.*** A virtual-storage operating system allows the use of a secondary storage device as an extension of primary storage. The virtual storage was developed after some limitation was faced in multiprogramming operating systems of insufficient primary storage to store an entire program. A virtual-storage operating system can resolve this problem by rapidly accessing the part of the program residing in secondary storage. The portions of a program can be swapped between a secondary storage device and primary storage as needed, giving the illusion of having the maximum amount of primary storage in the CPU available to each user. With a virtual storage operating system,

the user need not worry about how much primary storage is available since the program is segmented into pages. A page is a storage area of predetermined size that contains a certain number of instructions. The pages are kept on secondary storage devices and are swapped in and out of primary storage as needed.

- ***Virtual Machine (VM) Operating System.*** A virtual machine (VM) operating system is a very powerful programme that can run several different operating systems at one time. It allows several users of a computer system to operate as if each had the only terminal attached to the computer. Thus, users feel as if each is on a dedicated system and has sole use of the CPU and input and output devices.

  After a VM operating system is loaded, the user chooses the operating system that is compatible with the intended application. Other operating systems, such as the virtual-storage operating system, appear as just another application program to the VM operating system. Thus, the VM system gives users flexibility and allows them to choose an operating system that best suits the needs of a particular application.
- ***Mobile Operating Systems.*** An operating system for mobile devices, it is the software platform that helps in running a mobile application. It is meant for all kinds of mobile devices like handheld computers, set top boxes, mobile telephones, smart phones, PDAs, and factory floor equipment. The examples of mobile operating systems include embedded Linux, Microsoft's Windows CE, and Pocket PC, Windows Embedded NT 4.0, and Palm OS.

PROGRAMMING LANGUAGES

So for we have talked about operating systems softwares that seek to optimise the utilisation of the hardware and to meet the demands of users. The application softwares, by contrast, is primarily concerned with accomplishing the tasks of end users. Of the hundreds of different programming languages available, all fit into one of the four general categories: machine, assembly, high level, and fourth generation languages.

Machine Language

The machine language is made up of 1s and 0s and is the only programming language that the computer can understand. However, there is no single universal machine language. The arrangement of 1s and 0s to represent similar instructions, data, and memory locations differs among computers because of different hardware designs.

The machine language programs have the advantage of fast execution speeds and efficient use of primary memory. However, writing machine language is a very tedious, difficult, and time-consuming method of programming. As a low level language, it requires that the programmer has detailed knowledge of how the computer works since every detail of an operation must be specified. As you might imagine, it is easy to make an error but very difficult to remove it from (debug) a machine language program.

- Advantages:
  - Directly understandable by the computer.
  - It requires no translator to translate the code.
  - Processing and results are extremely fast.
- Disadvantages:
  - Being represented in Binary form, the codes are very difficult to learn and understand by humans.
  - All the data and instructions had to be manually transcribed into Machine. Language (Binary Form) and all results had to be decoded from Machine. Language to Human Readable form.
  - Coding and Decoding takes lot of time.
  - Length of the program used to be immense and subsequently resulted in errors.
  - All memory addresses have to be remembered.
  - It is hard to amend or find errors in a program written.
  - These languages are machine dependent, i.e. a particular machine language can be used on only one type of computer.

Assembly Language

The next higher level of programming language is assembly language. It is also classified as a low level language because detailed knowledge of hardware specifics is still required. An assembly language uses mnemonic in place of 1s and 0s to represent the instructions. A mnemonic is an alphabetical abbreviation used as a memory aid. For example, instead of using a combination of 1s and 0s to represent an addition operation, the mnemonic ADD might be used, SUB for subtraction, HLT for halting or stoping the program, etc. It also started the use of Octal or Hexadecimal codes as short hands for Binary codes.

The assembly languages simplified the programming process because the programmer does not need to know or remember the exact storage locations of instructions or data. The symbolic addressing is the expression of an address in terms of symbols chosen by the programmer rather than an absolute numerical location. Instead of assigning and remembering a number that identifies the address of a piece of data, a programmer can assign data to a symbolic name, such as TOTAL. The assembly language then automatically assigns an address when it encounters that symbolic name and remembers all addresses assigned.

Before it can be used by a computer, an assembly language must be translated into a machine language. This conversion is done by a language translator program called an **assembler**. The assembly languages provide an easier and more efficient way to program than machine languages do, while still maintaining control over the internal functions of a computer at the most basic level. In addition, assembly languages produce programs that are efficient, use less storage, and execute much faster than programs using high level languages. However, assembly languages are still machine oriented and require a thorough knowledge of computer hardware. And compared to high level languages, they are tedious and prone to errors.

- Advantages:
  - Simple–Easier code as compared to Machine Language.
  - Speed–The Assembly language programs are generally the fastest programs around.
  - Space–The Assembly language programs are often the smallest.
  - Capability–One can do things in assembly which are difficult or impossible in High Level Languages.
  - Knowledge–Our knowledge of assembly language will help you write better programs, even when using other types of programming languages.
- Disadvantages:
  - Assembly language is hard to learn.
  - Assembly language is hard to read and understand.
  - Assembly language is hard to debug.
  - Assembly language is hard to maintain.
  - Assembly language is hard to write.
  - The assembly language programming is time consuming.
  - Improved compiler technology has eliminated the need for assembly language.
  - Today, machines are so fast that we no longer need to use assembly.
  - Machines have so much memory, saving space using assembly is not important.
  - The assembly language is not portable.
  - Lack of uniformity: The abbreviations used by Assembly Language differed from machine to machine. Thus, each assembly language code was restricted to a particular machine and required a **Translator** to convert it to a machine usable form.

High Level Languages

A high level language is one whose instructions closely resemble human language and mathematical notation. The high level languages do not require that the programmer has detailed knowledge about the internal operations of a computer. Because of the close resemblance to human language, high level languages are much easier to learn and use than either machine or assembly languages. Typically, less time and effort are required for high level programming because errors are easier to avoid and correct.

Many high level languages are also designed to be machine independent; they can be transported from computer to computer and executed with few changes. As a result, high level languages are used more often than machine or assembly languages. The American National Standards Institute (ANSI) has developed standards to help make high level languages more machine-independent.

Sometimes, portions of a program may require more speed or efficiency that can be achieved with the high level programming language being used. Most high level languages allow assembly language programs to be used (called) to supply the needed boost in capabilities.

A high level language must also be translated into a machine language before it can be used by a computer. One of two language-translator programs is used to translate high level languages:

a compiler or an interpreter. Once converted, the program is stored in machine readable form, called the object code. The object code can be immediately executed anytime thereafter. The source code remains intact after the conversion and can be updated and changed as required and then recompiled into the object code.

Types of High Level Languages

Many languages have been developed for achieving different variety of tasks, some are fairly specialised others are quite general purpose. These are categorised according to their use:

(a) Algebraic Formula-Type Processing. These languages are oriented towards the computational procedures for solving mathematical and statistical problem. The examples include:

- BASIC (Beginners All Purpose Symbolic Instruction Code).
- FORTRAN (Formula Translation).
- PL/I (Programming Language, Version 1).
- ALGOL (Algorithmic Language).
- APL (A Programming Language).

(b) Business Data Processing. These languages emphasise their capabilities for maintaining data processing procedures and files handling problems. The examples include:

- COBOL (Common Business Oriented Language).
- RPG (Report Program Generator)

(c) String and List Processing. These are used for string manipulation including search for patterns, inserting and deleting characters. The examples include:

- LISP (List Processing).
- Prolog (Program in Logic).

(d) Object Oriented Programming Language. The object-oriented programming (OOP) is a programming language model organised around 'objects' rather than 'actions' and data rather than logic. Historically, a program has been viewed as a logical procedure that takes input data, processes it, and produces output data. In OOP, the computer program is divided into objects. The examples include:

- C++
- Java

(e) Visual Programming Language. These are designed for building Windows-based applications The examples include:

- Visual Basic
- Visual Java
- Visual C

Advantages

- Uniformity achieved: Overrides the deficiency of machine dependent code.
- Use of English with proper syntax made it easier to write programs.

- The programs written in High Level Languages are much shorter, versatile and faster to work with and debug.
- User-friendly
- They are easier to develop and maintain.
- Problem oriented rather than 'machine' based.
- The program written in a high-level language can be translated into many machine language and therefore can run on any computer for which there exists an appropriate translator.
- It is independent of the machine on which it is used i.e. programs developed in high level language can be run on any Computer.

Disadvantages

- A high-level language has to be translated into the machine language by a translator.
- The object code generated by a translator might be inefficient compared to an equivalent assembly language program.

Fourth Generation Language

The different categories of languages are sometimes labelled by generations—from lowest to highest. The machine languages are considered the first generation; assembly languages, the second generation; and high level languages, the third generation. A fourth generation language is one of a variety of programming languages that allows end users to spend much less effort creating programs than is required by high level languages. The objectives of a fourth generation language include:

- increasing the speed of developing programs;
- minimising end user effort to obtain information from a computer;
- decreasing the skill level required to end users so that they can concentrate;
- stressing on the application rather than the intricacies of coding and thus solve their own problems without the aid of a professional programmer.
- minimising maintenance by reducing errors and making programs easy to change.

The sophistication of fourth generation languages varies widely. These languages are usually used in conjunction with a database and its data dictionary and are often found as part of an MIS or DSS. The fourth generation languages include database query languages, report generators, and application generators. A database query language permits user formulation of queries that may relate to records from one or more files. The appropriate records can then be printed or displayed in a suitable format. The examples include SQL and Artificial Intelligence's INTELLECT.

A report generator allows data from a database to be extracted and formatted into reports. It also allows substantial arithmetic and logic operations to be performed on the data before they are displayed or printed.

An application generator allows data entry and permits the user to specify how the database will be updated, what calculations or logic operations will be performed, and what output will be created. This language allows a user to build an entire application.

- Advantages:
  - Simplified the programming process.
  - Use nonprocedural languages that encourage users and programmers to specify the results they want.
  - Use natural languages that impose no rigid grammatical rules.
- Disadvantages:
  - Less flexible that other languages.
  - The programs written in 4GLs are generally far less efficient during program execution that programs in high-level languages.

Object-Oriented

The number of 'rapid application development' (RAD) languages emerged in the 1990s, which usually came with an IDE, garbage collection, and were descendants of older languages. All such languages were object oriented. The more radical and innovative than the RAD languages were the new scripting languages. These did not directly descend from other languages and featured new syntaxes and more liberal incorporation of features. Many consider these scripting languages to be more productive than even the RAD languages, but often because of choices that make small programs simpler but large programs more difficult to write and maintain. Nevertheless, scripting languages became the most prominent ones used in connection with the Web.

The Object Oriented Programming (OOP) is a type of programming in which programmer uses objects and their interactions to design applications instead of simple data types and data structure.

An object includes both data and functions to define its state and behaviour. It became the most commonly used development technique of software application development after 1990. Most programming languages of today supports OOP. One of the major advantages of OOP technique is that it enables the programmers to create independent modules, which need not be changed when a new object is added. A programmer can create new objects (b) which can inherit number of characteristics from one of the existing objects. The OOP is easier to handle and modified. In order to perform object oriented programming, one needs an object oriented programming language (OOPL). The basic concept about OOP is as follows:

- ***Objects.*** The objects are the basic run-time entities in an object-oriented system. The programming problem is analysed in terms of objects and nature of communication between them. When a program is executed, objects interact with each other by sending messages. The different objects can also interact with each other without knowing the details of their data or code.
- ***Classes.*** A class is a collection of objects of similar type. Once a class is defined, any number of objects can be created which belong to that class.
- ***Data Abstraction and Encapsulation.*** The abstraction refers to the act of representing essential features without including the background details or explanations. The classes use the concept of abstraction and are defined as a list of abstract attributes. The storing data and functions in a single unit (class) is encapsulation. The data cannot be accessible to the outside world and only those functions, which are stored in the class can access it.

- ***Inheritance.*** The inheritance is the process by which objects can acquire the properties of objects of other class. In OOP, inheritance provides reusability, like, adding additional features to an existing class without modifying it. This is achieved by deriving a new class from the existing one. The new class will have combined features of both the classes.
- ***Polymorphism.*** The polymorphism means the ability to take more than one form. An operation may exhibit different behaviors in different instances. The behavior depends on the data types used in the operation. The polymorphism is extensively used in implementing Inheritance.

The Simula was the first object-oriented programming language. Java, Python, C++, Visual Basic. NET and Ruby are the most popular OOP languages today. The Java programming language is designed especially for use in distributed applications on corporate networks and the Internet. The Ruby is used in many Web applications. Curl, Smalltalk, Delphi and Eiffel are also examples of object-oriented programming languages.

Advantages

1. **Convenient:** The OOP applications are easier to maintain, have more reusable components, and are more scalable.
2. **Maintainable:** The OOP methods make code more maintainable. With this identifying the source of errors becomes easier because objects are self-contained.
3. **Reusable:** Because objects contain both data and functions that act on data, objects can be thought of as self-contained 'boxes'. This feature makes it easy to reuse code in new systems.
4. **Scalable:** The OO applications are more scalable then their structured programming roots. As an object's interface provides a roadmap for reusing the object in new software, it also provides with all the information that one need to replace the object without affecting other code.

Disadvantages

The challenges of OOP exists mainly in the conversion of legacy systems that are built in structured programming languages. The technical challenge is not as big as the actual design challenge. The goal when converting is to minimise the effects of the structural systems on the OO nature of the new design, and this can sometimes be difficult.

CHARACTERISTICS OF A GOOD PROGRAMMING LANGUAGE

There are number of computer languages that are popular and are being used by developers for various applications. There might be many reasons for the success of a language, some of the important reasons for making a programming language better are briefly discussed.

Ease of Learning

The easier the programming language is to learn, the quicker the programmers become productive. A good programming language must be simple and easy to learn and use. Thus, a

good programming language should provide a programmer with a clear, simple and unified set of concepts, which can be easily grasped. The Java is a lot easier to learn than C++; C is probably even easier.

Ease of Understanding

It is to note that most code is written once and read many times depending on the life of the program. Thus, it is important that the reader quickly understand the essence of code and its logic. The COBOL can usually be read easily; but, because it is verbose, one have to read many lines of code. In theory, object-oriented (OO) languages allows to write more compact code because of code reuse, and the structure of the objects can allow to mirror more closely the structure of the problem; thus, they should be easier to understand.

Help with Enforcement of Correct Code

The ideal programming language should turn logic errors into syntax errors. A powerful means to this end is type checking. The most standard languages, such as Java and COBOL, have good type checking.

Supported Platform Environments

The platform environment here does not refer only to the operating-system facilities, but also the middleware facilities, database facilities, and system-management facilities.

Portability

The most popular languages have been standardised by a nonvendor organisation. The aim is twofold: to reduce retraining needs and enhance portability.

Fit-for-Purpose

While Java is a good language and is highly portable, it is unsuitable for some purposes, such as some game programming and system programming. The game programming often requires fast access to the screen-display hardware. This can be done by using Direct X, which is available only in C++ or C.

Naturalness

A good language should be natural for the application area it has been designed. That is, it should provide appropriate operators, data structures, control structures, and a natural syntax in order to facilitate the users to code their problem easily and efficiently. The FORTRAN and COBOL are good examples of scientific and business languages respectively that posses high degree of naturalness.

Efficiency

The program written in good programming language are efficiently translated into machine code, are efficiently executed, and acquires as little space in the memory as possible. That is, a good

programming language is supported with a good language translator (a compiler or an interpreter) that gives due consideration to space and time efficiency.

Structured

The programming language should have necessary features to allow its users to write their programs based on the concepts of structured programming. This property of a language greatly affects the ease with which a program may be written, tested, and maintained. Moreover, it forces a programmer to look at a problem in a logical way so that fewer errors are created while writing a program for the problem.

Extensibility

A good programming language should allow extension through simple, natural, and elegant mechanisms. Almost all languages provide subprogram definition mechanisms for this purpose, but there are some languages that are rather weak in this aspect.

Suitability to its Environment

Depending upon the type of application for which a programming language has been designed, the language must also be made suitable to its environment. For example, a language designed for real time applications must be interactive in nature. On the other hand, languages used for data processing jobs like pay-roll, stores accounting, etc., may be designed to be operative in batch mode.

PROGRAMMING TRANSLATORS

The Programming Translators are programs that convert code written in assembly or high level language to machine language and reassemble the output back to assembly or high level language. The translators are of three types – Assemblers, Interpreters and Compilers. The assemblers are used to convert the instructions written in low-level languages like assembly language to machine language, whereas the compliers and interpreters are used to convert the instruction written in high-level languages into binary code.

Assembler

The Programming Translators converts the human-readable form of the program to executable machine language.

It translates programs written in assembly language to machine language and accordingly, the output back to assembly language. They convert mnemonics into binary instruction code and hexadecimal numbers into binary code before the data is processed. The assemblers create an object code by translating assembly instruction mnemonics into machine language. They also determine symbolic names for memory locations as well as for other entities. A prime characteristic of assemblers is the use of symbolic references, which saves time consuming manual calculations

and address updates after a program has been modified. The majority of assemblers also have macro facilities so that they can perform textual substitution, which means that they are able to create short sequences of instructions. It is easier to write an assembler for high level languages than it is to write a compiler, and in fact, they have been around since the 1950s.

The assembler translates Assembly language into machine language.

Compilers

It takes the entire user program as a *source program* and translates it into machine coded version called *object program*, which is an executable program. The translation and execution are separate processes. When executing the file, the compiler first parses or analyses all of the language statements syntactically in a sequential manner and then, in one or more successive passes, builds the output **code**, ensuring that statements that refer to other statements are referenced correctly in the final code. The code is linked to various libraries, which are common code sections found in many programs. The use of libraries helps keep redundant coding to a minimum. The compilation output is sometimes referred to as **object code** or an object module. The object code as used here refers to **machine code** that the processor executes one instruction at a time.

A compiler translates a whole program, called the source code, into machine language at once before the program is executed.

The high-level languages are usually compiled and are not limited to any particular **computer architecture**. The high-level languages are much easier to read than **assembly language**. The compiled languages are preferred by many developers because, once compiled, the program runs faster than if it were interpreted. Once a program has been compiled, it cannot easily be changed, so there's an element of security built in to compiled programs.

The Java programming language has taken code compilation one step further. Java, which is used in object-oriented programming, has introduced the idea of compiling output that can run on any computer system platform for which a Java bytecode interpreter (called a Java Virtual Machine) is provided to convert the bytecode into instructions that can be executed by the actual **hardware** processor. Using this virtual machine, the bytecode can be recompiled at the execution platform by a 'just-in-time' compiler. What all this means is that the bytecode is platform-independent code that can be sent to any platform (**Windows, MAC, Unix**) and run on that platform. This is one of the principal advantages of Java: write once, compile once.

Interpreters

It takes one instruction at a time, translates it and checks for errors and does not proceed to the next instruction unless the one with errors has been rectified. The translation and execution are interlaced processes. The execution of interpreted code is much more slower than compiled code. However, when a program is to be executed only once or twice, or when a program is frequently modified, it is easier and faster not to have to compile in order to run the program. The translation process for interpreters is simplified, since the code does not need to take into account different possible conditions; only actual conditions do matter. Some techniques are more easily to implement with interpreter than with a compiler, e.g self-modifying code. With

most interpreters the machine readable form is not stored in primary storage or on a secondary storage medium. Therefore, the program must be interpreted each time it is executed.

The interpreters do generate binary code, but that code is never compiled into one program entity. Instead, the binary code is interpreted each and every time the program executes. Some examples of interpreted programs are BASIC, QBASIC, and Visual Basic (version 5 and above of which has both a compiler and interpreter). Where compiled programs can run on any computer, interpreted programs can only run on computers that also have the interpreter.

An interpreter translates a program into machine languages one line at a time, executing each line of the program after it is translated.

The Practical Extraction and Reporting Language, or **Perl**, is a script-based programming language whose **syntax** parallels that of the C language but is an interpreted language; The Perl can optionally be compiled prior to execution into either C code or cross-platform bytecode. The Perl is easier to learn and faster to code in than the more structured (and compiled) C and C++ languages. When compiled, a Perl program can execute almost as fast as a fully precompiled C language program. The JavaScript is another example of an interpreted script-based programming language.

The interpreters offer programmers some advantages that compilers do not. The interpreted languages are easier to learn than compiled languages, which is great for beginning programmers. An interpreter lets the programmer know immediately when and where problems exist in the code; compiled programs make the programmer wait until the program is complete.

APPLICATION SOFTWARE

As described earlier, application software is any tool that helps in solving end user problems. Any data entry, data update, query, or report program that processes data for the end user needs is application software. It includes the generic productivity software like spreadsheets, word processors, database programs, email as well as custom and packaged programs for payroll, billing, inventory, and other accounting purposes.

The application software is a program or group of programs designed for end users.

Types of Application Software

There are different types of application software, which can be classified as per broader classifications:

Content Access Software. These softwares are primarily used by the users to access content with or without any modifications allowed. The prime application of these kinds of software is in all those areas where one needs to share the content among group of users like web browsing, media players, computer games, etc.

End-User Software. These kinds of application software address the individual end user needs like email management, document management, personal account management, scheduling tools, etc.

Enterprise Software. These kinds of application software address the needs of the organisations processes and data flows. The organisations that have integrated information system solutions would have enterprise software and will use these solutions for applications like supply chain management, customer relationship management, product life cycle management. Most of the ERP vendors provide enterprise application softwares like SAP, Oracle of etc.

Simulation Software. The software type that helps the user to test an idea or thought in simulated environment before putting it into reality. This will help in reducing the risk associated with the idea. The number of simulation based business solution exists in the market from flight simulator to crystal ball.

Application Suite. It has multiple applications bundled together. The related functions, features and user interfaces interact with each other.

Information Worker Software. It addresses individual needs required to manage and create information for individual projects within departments.

Examples of Application Software

Some well-known examples of application software are discussed below.

Word Processing Software

The writing is one of the most powerful learning experiences available ever. This weaving knowledge into written composition is often a more effective learning tool than listening or reading. One can facilitate the writing process by using the powerful, collaborative tools available in word processing software. The word processor is application software that helps in managing all text based documents; it is sometimes also referred as Text Processor. Today's word processors like Microsoft Word are not restricted only to processing of Text based data, but can process any kind of data from simple tables to graphics to multimedia.

The word processing software offers customisable and scalable features that accommodate the activities within the writing process. It can also facilitate collaboration through features that allow many individuals to participate constructively in the writing and review process. Tracking changes, adding comments, and saving documents as a Web page are all useful collaborative tools available in MS Word, the leading word processing software. The word itself collaborates nicely with other Microsoft software like Excel, Powerpoint. The word also offers thoughtful features that reflect the richly recursive and social/collaborative nature of the writing process.

Some of the other features that are available in a Word Processing Software are:

- Entering and Editing of data.
- Extensive range of formatting tools from character formatting to paragraph to page and document level formatting.
- An extensive set of automatic features like auto spell check, auto alignment, auto format, etc.
- The number of options that makes it faster and easier to work with tables, graphs, borders, and shading.

- The easy interface with Internet and World Wide Web.
- It provides number of file souring formats, like HTML, PDF, etc.
- It also integrates seamlessly with number of other application tools like spreadsheet, presentation, email, etc.

Spreadsheet Software

The spreadsheet software is a powerful tool that helps in managing, manipulating, and analysing large set of numeric data. These are very powerful analytical tools used to perform simple calculations to finding patterns hidden in a data set. The spreadsheet module provides competency in creating and modifying workbooks; manipulating worksheet data by applying mathematical formulae and functions; restructuring and formatting worksheets; manipulating the display of worksheets; creating and using multiple worksheets; printing worksheets and workbooks; and creating comments, graphics, diagrams and charts. It also provides tools for organising and analysing data; auditing worksheets to correct formula errors; performing what if analyses to determine input values in order to reach target goals; using templates; naming ranges; formatting graphics, and integration of tools with other software applications. The Microsoft Excel is one of the most popular spreadsheet software.

Some of the basic features that most of the spreadsheet have:

- Allows entering data in rows and columns, the worksheet format.
- One can handle large amount of data across number of worksheets and workbooks.
- Rich library of built-in formulae and functions to perform simple to advanced calculations in the areas of statistics, mathematics, finance, etc.
- One can represent the data in tabular or graphical format. Most of the spreadsheets have large number of options about creating two-or three-dimensional charts.
- Enhanced formatting and layout features help in presentation of data and outputs.
- Powerful interface with other application softwares and utilities.
- Powerful data summarisation tools like subtotals and pivots.

Presentation Software

It is very important to present ideas in clear and concise manner while sharing information with others. The presentation software enables visual organisation and communication of concepts. One can customise the presentations with sound, animation, charts, graphics, narration, and video. The online broadcast feature of this kind of software allows the delivery of a presentation over a network in real time. In other words, the presentation can be viewed over the network as it is being given. One can also save the presentation as a Web page to enable viewing in a browser. One can use this kind of software to create offline or on-line presentations. Some of the presentation tools also have time management option, which allow the user to plan the presentation as per the allocated time. The most common presentation software used is MS-Powerpoint.

Some of the common features of presentation software are:

- Built-in templates and layouts for easy creation of presentation.
- Online help for easy creation and integration.

- Helps in creating static and dynamic integration links with the data created using word processor or spreadsheet, etc.
- Powerful library of pictures, animation, sound and music to make the presentation livelier.
- Offers a rich set of tools to create and deliver 'virtual' presentations using Internet.

Database Software

The database software is a computer program for storing structured data in an easily retrievable form. It can store any type of data, but is primarily used to store text and numeric type of data. Most modern databases actually allow the storage of all types of data such as dates, currency, pictures and sounds. The basic objective of databases is management of large volume of data for faster retrieval. Most of the modern databases store the data in multiple tables and each table having a relationship defined with at least one other table in the database. Behind any powerful information system solution, there exists a powerful database application. The applications for which the databases are used include: payroll, library management, sales order system, accounting, and many more. Most common database software at the personal computer level of computers is MS-Access, whereas for high-end computers Oracle, SQL server, DB2, etc. are the leaders.

The database allows storing structure data, so it is important to plan its use in advance. This is more important if the database is to be used by number of other people. While creating database, one must consider the following:

- What information one needs to store?
- What output or queries one needs to run on the stored data?
- Who will be the users of the database?
- Whether to provide restricted access to database?
- Some of the important features of database software are:
- Easy to handle large volume of data.
- Databases are more versatile and flexible.
- Helps in managing integrated, consistent and non-redundant data.
- Security and data protection features are strong.
- User friendly query language support like Structured Query Language (SQL).
- Powerful user interface for data management and reporting.
- Easy integration with other softwares and Internet.

Communication Software

The communication software provides a world class messaging and collaboration platform to meet the different kinds of business needs. It integrates the most valuable messaging, collaborative and personal information management (PIM) resources—like e-mail, calendar, and to-do list—allowing users to access them while online or offline. It includes hundreds of enhancements to increase ease of use. It also provides industry leading calendar and scheduling functionality, which lets users collaborate and schedule meetings with colleagues across the world. Moreover it

helps reduce total cost of ownership with minimal training, end user productivity enhancements, and built-in management functionality. These are important desktop information management tools that help the user to organise and share variety of information across the organisation.

Some of the important features of a communication tool are:

- Manage personal and business information such as your e-mail messages, appointments, contacts, tasks, and files as well as track activities.
- Share information with a group of users by using group e-mails, group scheduling, public folders, etc.
- Allows sharing of information with other application tools like word processor, spreadsheet, etc.

Accounting and Financial Software

The number of standard software solutions exists in the market that helps in managing the accounts and finances of an organisation. These range of software helps from managing personal finance to entry level accounts to financial management of business. Every business organisation needs to manage their accounts and for creating statutory financial statements, this kind of softwares are very handy. It helps in managing daily accounting transactions, maintaining different ledgers, cash books, and generating profit and loss statement, balance sheets, etc. Some of the financial accounting software solutions also allow managing payroll of employees and the inventory. The tally is one of the leading accounting and financial software for small to large organisations.

Project Management

Every manager in an organisation needs to coordinate and manage various activities related to its job. Most of these activities need to be completed successfully within a specific timeframe as per allocated resources. Developing a software product, publishing a newsletter, implementing a training programme, starting a new business or even building a new home are some of the projects that number of managers do. The project management software helps to put together a plan of action, compile, and organise all the details that must be completed in order to achieve the set goal. Right from building a new project to preparing the project for publication, tracking progress, analysing costs, assessing the quality of the project and managing multiple projects are some of the important features of good project management software. MS-Project is one of the leading project management software for personal computer family.

Multimedia Software

The multimedia software allows users to create and play audio and video files. They are capable of playing media files. The audio converters, audio players, burners, video encoders and decoders are some forms of multimedia software. The examples of this type of software include Real Player and Media Player.

Enterprise Software

The enterprise software deals with the needs of organisation processes and data flow. The customer relationship management or the financial processes in an organisation are carried out with the help of enterprise software.

Education Software

The educational software has the capabilities of running tests and tracking progress. It also has the capabilities of collaborative software. It is often used in teaching and self-learning. The dictionaries like Britannica and Encarta, mathematical software like Matlab, statistical tools like SPSS, SAS, and others like Google Earth are some of the well-known names in this category.

Simulation Software

The simulation software is used to simulate physical or abstract systems, simulation software finds applications in both, research and entertainment. The flight simulators and scientific simulators are examples of simulation software. There are number simulation games related to different business scenarios.

Application Suites

The application suites is an application suite is an important type of application software. It consists of a group of applications combined to perform related functions. The OpenOffice.org and Microsoft Office are the best examples of this type of application software. These application suites, as you know, come as bundles of applications like word processors, spreadsheets, presentation software, etc. The applications in the suite can work together or operate on each other's files.

BUILDING COMPUTER PROGRAMMES

The programming can be defined as the development of a solution to an identified problem, and the setting up of a related series of instructions which, when directed through the computer hardware, will produce the desired results. The formal creation process of programming is known as the Programming Development Life Cycle (PDLC). There are seven steps to this: define, outline, develop, test, code, run, and document and maintain.

Define

It involves to decide and define the problem that is to be solved.

Outline

It involves breaking a large problem up into smaller ones. A tool that is available to help the programmer during this step is a **Flowchart,** which is a visual diagram of the flow of the program.

The flowchart is a schematic representation of a sequence of operations, as in a manufacturing process or computer program. It is a graphical representation of the sequence of operations in an information system or program. The information system flowcharts show how data flows from source documents through the computer to final distribution to users. The program flowcharts show the sequence of instructions in a single program or subroutine. The different symbols that are used to draw each type of flowchart are shown in Figure 4.2.

The Flowchart is a diagrammatic representation of an algorithm using standard symbols and checks the flow of logic running through it.

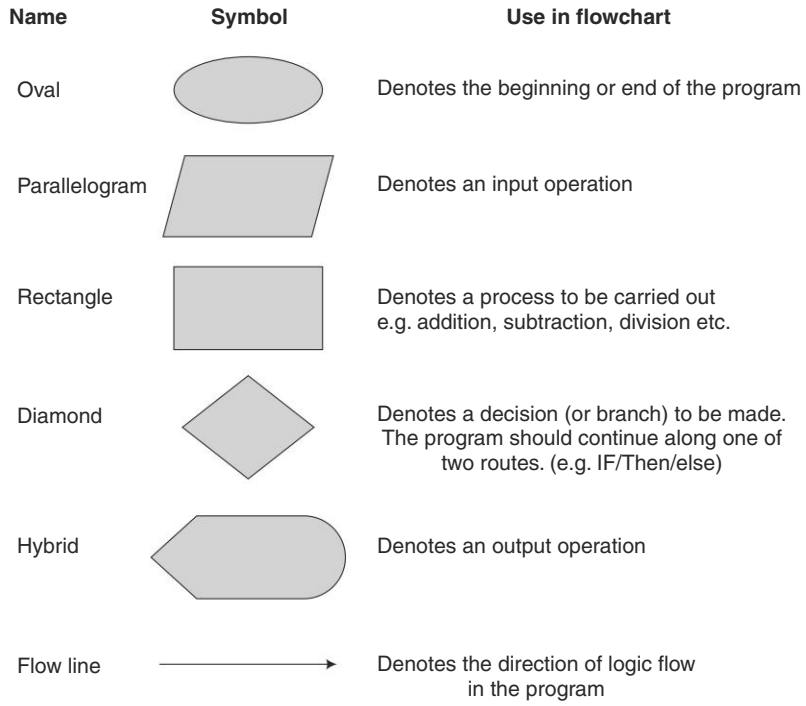


Figure 4.2 Flowchart Symbols

Develop the Algorithm

An **algorithm** consists of the steps that a programmer will write that will become a program. It is written in a form of structured language called **Pseudocode.**

The Pseudocode is an artificial and informal language that helps programmers develops algorithms. The Pseudocode is very similar to everyday English.

The pseudocode is language independent and could be used by any programmer. The each step of the algorithm will be directly translated into a line of code using the programming language. The algorithms are written in sequential order of action and are also language independent. If an algorithm is written correctly, any programmer using any language could directly translate each line of the algorithm into a line of code. It is possible to desk check the algorithm; it saves a programmer a lot of time to use an algorithm and trace it to make sure that the program will be correct rather than just sitting down at a computer and writing out the program using the program language. The pseudocode should not use any **reserve word**. A reserve word, also known as a key word, is a word that is reserved or used by a specific programming language to accomplish something. For example, in C++, cout is the reserve word to show something on the computer screen and writing in Pascal and println in Java.

In order to help write the algorithm, many programmers use **flowcharts**. This is a pictorial image of the steps of a program. The majority of programmers use both – the flowchart first and then the algorithm. Although flowcharting is not a requirement to creating an algorithm, it is a very helpful tool.

An Algorithm is a sequential and logical list of instructions to solve a problem covering all possible alternatives.

Test

In order to make sure that the algorithm of the program does what it should. An error in a program is also known as a **bug** and the process of finding bugs is known as **debugging.** The **desk checking** is looking at the lines of code one by one to see if they have been written correctly and the logic is correct. The desk checking is also called **tracing**. The **walkthrough** is just when a group of people do a desk check.

Code

The writing code is actually using any specific programming language to write lines of a program. These lines of code are also called the **listing**, and are also known as the **source code**. The executable program is called the **object code**. One needs the translators to convert the code into the object code.

Run (Execute)

In order to execute the program in a bug free mode. The high-level language codes are compiled or interpreted. This translates the code into machine language. When executed, there are two main types of errors (if any) - **syntax** and **logic errors**. The **syntax errors** are problems with grammar, spelling, or punctuation. **The logic errors** are errors that make a program's results incorrect because of wrong logic being used. These are much more difficult to find. There is another type of error called a **run time error.** Add to that, one type of run time error is called a **linking error,** if the program is unable to find the library that is being linked. Another type of run time error would be a program that tires to divide some number by zero.

Documentation and Maintenance

The **Documentation** is to put together all of the materials that have been generated throughout the PDLC process. All of the flowcharts, messages, algorithms, lines of code, and the user manuals are part of this documentation. These documentations are very useful for maintenance of the programs and also for user training. On the other hand, the **Maintenance** is to make sure that the program keeps running as it should and also take care of future updations and problem solving. The maintenance is the longest phase of the PDLC. With the use of the programs, user keep giving the feedback for improvements, which is handled at the maintenance level.

Example 1 Write a pseudocode, algorithm, and flowchart to determine a student's final grade and indicate whether it is passing or failing. The final grade is calculated as the average of four marks.

Pseudocode

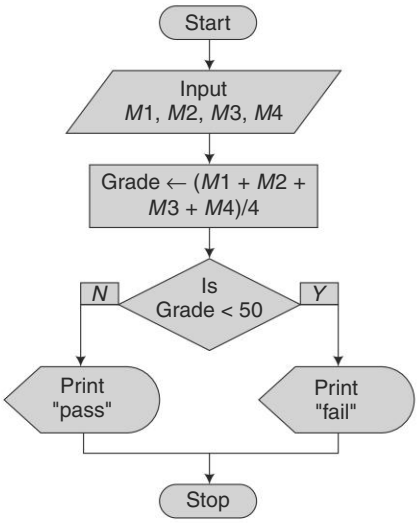
- *INPUT A SET OF 4 MARKS*
- *CALCULATE THEIR AVERAGE BY SUMMING AND DIVIDING BY 4*
- *IF AVERAGE IS BELOW 50*

  PRINT "FAIL"

  ELSE

  PRINT "PASS"

Flowchart



Detailed Algorithm

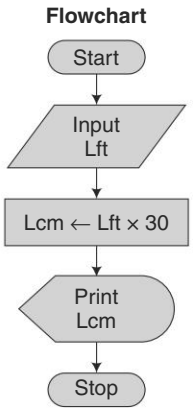
STEP 1: INPUT M1,M2,M3,M4
STEP 2: GRADE ← (M1+M2+M3+M4)/4
STEP 3: IF (GRADE < 50) THEN
PRINT "FAIL"
ELSE
PRINT "PASS"
ENDIF

Example 2 Write an algorithm and draw a flowchart to convert the length in feet to centimeter.

Pseudocode

- Input the length in feet (Lft)
- Calculate the length in cm (Lcm) by multiplying LFT with 30
- Print length in cm (LCM)

Flowchart



Detailed Algorithm

- **Step 1:** Input Lft
- **Step 2:** Lcm ← Lft × 30
- **Step 3:** Print Lcm

SELECTING AND ACQUIRING SOFTWARE

Determining the best kind of software system for the organisation is always a complex task, as it involves both organisational and technical issues. The organisational issues include

1. the degree of data integration required and level of communication needed within the organisation;
2. business strategies for communicating and sharing information among various people, departments, and locations within the organisation;
3. the extent to which organisation wants to have linkages with its customers, suppliers, and other business partners.

4. Moreover, with the fast changing hardware and software technologies, organisations need to focus on information technology architecture, describing the complete requirements in terms of organisational goals and objectives that are linked to the operational strategies of the organisation.
5. The technical issues that need to be addressed include—the speed of processing, the amount and type of storage required, data access and retrieval systems, and the ability to link to the internal and external communication channels.

Keeping the above factors in mind, one needs to choose the right kind of software from a wide range of software applications. There are number of ways the organisation may acquire a software —

1. one may develop the software in-house, using their own manpower;
2. one can buy off-the-shelf software and implement it;
3. one may buy the commercial software, but get it customised to fit in their specific needs.

The different options that are available to the organisation while procuring the off-the-shelf or readymade software are as follows:

Licensed

A majority of software applications are licensed and not sold. In this case, a user purchases a software license and not the software itself. The vendor allows for the installation of this software on a specific number of machines. Sometimes, the license is limited to a certain number of users. Most software licenses allow one to run the application on only one machine, although one is allowed to copy the software on other machines for backup purposes. The licenses disallow the resale of software.

Sold

As opposed to licensed software, these software are sold to users. One needs to purchase this type of software from the vendor in which case, one owns a legitimate copy of the software. This allows one to resale the software.

Public Domain

Usually these types of software are not under copyright, meaning anyone may access and duplicate the software. The software may be developed by government or donated by its developer or by a not-for-profit organisation for the benefit of the society at large. The public domain is defined by works that are not categorised as copyright infractions. In public domain, no compensation is expected and the source code is available free.

Open Source

The Open source software can be downloaded free of cost from Internet space. It allows the developers to change the source code with suggested modifications. The term Open Source

Software is part of 'Open Source Software Initiative' or OSI, which was designed to prevent people from attempting to make profit by modifying the free software. The software like Linux and Firefox are examples of open source. The developer of the software may release the open source of the software to get feedback, ideas, and may also generate interest in the mind of users before the final product is launched.

Freeware

The application software that can be downloaded, used, and copied without any restrictions is known as freeware. The freeware is also a copyrighted software application available for an unlimited usage and is usually distributed free of cost. The freeware software includes public domain and proprietary software. The original developer of the software usually maintains the complete control over future developments and also takes credit about the creation.

Shareware

The shareware are ready to use software developed by third-party vendors. These are copyrighted software with free of charge use for a limited period, usually 30 day free trial. The idea behind shareware is to share the software application and test it to explore the application for user needs, before taking a purchase decision. One can also share the software across number of users.

Needs to be Installed

This is true with many application software; for example spreadsheet software, word processors, data management software, etc. They need to be installed on our computer hard drive for use.

Runs Online

An antivirus software runs online. Similarly, the Internet games that you can play online and which don't need to be downloaded fall under this category.

Componentware

It is a term used to describe a component-based software development approach. The software components are the "building blocks" of applications. They provide the operations that can be used by the application repeatedly. Any given application may contain any number of components, each providing specific business logic or user-interface functionality. For example, a shopping cart application in e-commerce.

Services-oriented Architecture (SOA)

The SOA is a framework for constructing and interlinking a organisation's back-end systems in order to make the computing systems more flexible and cost-effective. The SOA communications, enabled by Web Services, are different from existing middleware. Under SOA and Web Services, applications automatically link to one another as needed, which is the concept of 'loose coupling.'

TYPES OF INFORMATION PROCESSING

There are broadly four types of information processing: batch processing, real-time processing, distributed processing, and parallel processing.

Batch Processing

The batch processing occurs when data is collected and stored in files for a while before processing. The batch processing is more common with data backup.

Real-time Processing

In real-time processing, the transactions are processed to update a file or to make any changes in a data immediately or instantly as transaction occurs in the real life. All Internet based transaction models are real time processing models. The railway or airline ticket booking and online banking transactions are examples of real-time processing.

Distributed Processing

The distributed computing is one where computers are located at different sites/locations and are interconnected with each other using telecommunication infrastructure. The objective of distributed computing is to process information where it is most effective to satisfy operational, economic and geographic conditions. The terms distributed processing, distributed systems, and distributed networks are almost synonymous. The three major ingredients of a distributed system are distribution, local management, and central management.

A local computer in a distributed system has the characteristics of a small stand-alone system. The computer is under the operational control of local management and is expected to do the processing of a given set of applications for its host facilitator. The control and processing of the applications in a distributed system are distributed to the remote location, hence, the terminology of distributed system and distributed computing.

The essence of a distributed system is to perform some data processing tasks at the points of user activity, while permitting other tasks to be transmitted to a centralised computer for processing. The concept also means the transferring between adjacent systems of information resources, which may take the form of database structures or computed results. The programs may also be transferred between locations in a distributed system. The source data is entered at the local site and is received at one of the dispersed computers either through a hardwired network connection or through local telecommunication facilities. Normally, processing is performed locally and summary information is communicated from the dispersed computer to the central computer for review and for incorporation into central files or into the centralised database. If the source data is to be processed at the central computer, the dispersed computer would be used to verify and store the data locally and then transmit it via telecommunication facilities to the central computing facility for processing. The computed results would then be transmitted from the central computer facility to the local computer system for printing and also for local storage. In a database environment, a local database is maintained at the distributed computer site as

though it were a stand alone, self contained system. Then on a periodic basis, data is transferred via telecommunication facilities between the centralised database and the dispersed data base to maintain them.

Parallel Processing

The purpose of scheduling activity of an operating system is to provide a steady flow of work to the computer. The scheduling can be divided into two types. They are:

Sequence scheduling. A sequence scheduling program selects the next program to be run on the basis of priority of the programs in the job stack and availability of input data. Only one program is scheduled into memory at a time.

Concurrent scheduling. The concurrent scheduling program not only schedules the sequencing of programs but also directs the concurrent processing of two or more programs. This technique of computer handling in which several programs are executed concurrently is known as 'parallel processing'. The programs are placed in different sections (partitions) of memory and the operating system switches control from one to another. For example, a program to read data in magnetic tape and print their contents may be run concurrently with a programme to update a file. The control routine in the operating system first gives control to the read/print program. This initiates the magnetic tape read instruction. The control is then shifted to the file update program. When the data for the first program is read, the second program is interrupted and control is passed back to the first program and so on. Since the read/print routine can proceed no faster than the printer and magnetic tape can operate, the central processing unit would be idle much of the time if parallel processing were not used.

CESC: Calls on Linux

By embracing Open Source, this power utility major reached out effectively to its customers and improved its overall service levels.

CESC, a part of the RPG Group is a power utility major that is into generation and distribution of electricity. The company has been selling electricity to consumers in Kolkata and Howrah. CESC today operates over 567 sq. km. of area serving 2.1 mn consumers. It distributes 1,300 MW of electricity, and generates on its own around 1,000 MW from its four generating stations. With a huge customer base, the company cannot afford any downtime in its service.

One of the key challenges the company was facing came from its regional reporting centres spread across the 567 sq.km. of business area. The business process integration and application management were turning out to be the problem areas. The total system of call capturing, feedback for calls generated, manual intervention in restoration details in a distributed setup were making it difficult for the consumers to track their complaints through a single window. So the key challenge was related to the centralisation of the contact management system in order to provide efficient service.

The system at CESC works like in the following manner. Whenever a consumer faces any power supply related problems, they need to call up a 4-digit telephone number. The call lands at a central customer call handling centre. This facility is manned by 60 agents and runs round the clock. Depending upon the nature and location of the problem, the calls are docketed with suitable classifications and allocated priority. The

software intelligently routes the calls to the relevant district depots where the field service personnel take the call and sends technicians to attend to the problem. This called for a secure, reliable, and cost effective interconnecting platform. According to Subrato Das, CIO, CESC, "The consumer database had to provide CESC with very fast responses and hold the past 36 months consumption and payment details of 2.1 mn customers. Hence, the non-stop availability of all the services was of paramount importance."

The company constituted a core team to study the anomalies in the existing systems and to migrate to a system that was robust enough for its mission critical applications. The core team decided on Red Hat Linux. Says Das, "Once the team decided to adopt Linux and Open Source, they reviewed industry standard implementation methods and the procedures for an equivalent scenario. We had to consider factors like manageability, scalability, interoperability, reliability, usability, functionality, support services, and cost-effectiveness".

The implemented solution consisted of deployment of the application over a fully configured two node active clustered environment deployed on RHEL 3.0 as the primary infrastructure. For instance, one node hosted the MySQL database server and the other node hosted the FTP server and the application developed in PHP was deployed over an Apache web server. In case of failure of a cluster member node, the configured services would be restarted on the live cluster member node seamlessly. The off site data backup was implemented through MySQL replication on another server at a different location.

The Red Hat deployment has ushered in a wide range of benefits. On a macro level, it has created a robust 24/7 availability of IT—the company is now running a system that has facilitated a single interface with the consumer. The solution is also scalable in terms of increase in call load and data load. As Das opines, "To measure customer satisfaction and operational efficiency, we have developed our own metrics, called Return on Value (ROV) metrics. After the implementation of the IT initiative, we have recorded increase in revenue, improvement in quality of service, reduction in various lead times, and improvement in productivity, and enhanced customer intimacy, leading to customer loyalty."

At a Glance

Challenges

- Need for a secure, reliable, and cost-effective platform to run mission critical enterprise applications
- To improve customer service levels

Solution

- Red Hat Enterprise Linux

Benefits

- Improvement in productivity
- Enhanced customer intimacy leading to greater customer loyalty
- Prompt resolution of problems

Source: *Dataquest*, 28 Feb, 2007, Vol. XXV No. 04

SOFTWARE TRENDS AND ISSUES

There are number of interesting business software trends on the horizon. Some of these that will significantly impact IT organisations and are seeking to align IT operations with business objectives are listed below.

Mobile Applications

The mobile applications are quite volatile as mobile manufacturers continue to introduce new devices and approaches, picking a stable platform remain a difficult decision. Despite the fact that consumer phones are exciting, one needs to wait for validation of new platforms before basing the business IT strategy on them.

Integration of In-house and Outsourced Services Strategy

Business software continues to benefit from a foundation of enterprise software services known as service-oriented architecture (SOA). The IT managers pursuing an SOA strategy should pay special attention to the mix between in-house and outsourced services. As more and more applications and infrastructure are moved to the cloud, the barriers to external Web services may well be decreasing. Nevertheless, one has to pay special attention to the service level agreements (SLAs) offered by Web services vendors. One can also note that SOA is not a technology; it's a model, a method and a strategy.

Cloud Based Enterprise Solutions

The more and more organisation would explore cloud based solutions. The cloud application platforms that allows the options of on-demand or on-premise deployment. The private cloud will dominate this trend for a few years, especially, with the larger companies who are risk averse and want to move into the cloud in smaller steps.

Software Lifecycle Management

Both developers and application managers need to pay attention to software lifecycle management for different reasons. Many organisations will be able to leverage the capabilities of integration to further extend software life and reduce the need for additional development. A formal approach to software lifecycle management may well be in order.

Legacy Modernisation Delivers much-sought ROEI

An attention should be paid to legacy modernisation approaches that allows to do more than simply reface application interfaces. Also, one has to look for incremental enhancements to existing applications that leverage the possibilities for better user experiences without sacrificing operational integrity and without tossing away our past investments. So that one can get the full return on existing investments (ROEI).

Service Level Agreement (SLA)

With all of the growth in cloud computing and third-party services, IT departments need to develop an understanding that SLAs are more than just fine print. A good SLA outlines the way that your enterprise interacts with IT vendors and service providers.

Graphical user Interfaces get Richer

There will be a year when some enterprise software developers may indeed go too far in the direction of impressive graphics at the expense of real transactional and business functionality.

Better Performance Comes to Rich Business Applications

On another level, we will see continued improvement in rich business applications that not only look better and are browser-free, but also perform better. The trend towards social media on the Web is a good parallel. The real paradigm shift was not about multimedia; multimedia has been available for years. The real paradigm shift in social media was in the way people interacted with the Web, which was a shift from media consumption to media sharing with peers and the world. Today's rich business applications will continue to emerge that provide unparalleled levels of information transaction and sharing.

SUMMARY

- A program, or software, is the series of instructions that directs the hardware to perform various tasks. The system software and application software are the two major categories of the software. Each of these serves a different purpose. The software has evolved along with hardware.
- The system software helps in managing the hardware resource, while the application software acts as an interface between the user and the system software and is used to manage a business application. The general trend in software is towards user-friendly solutions.
- The application software is a program that help the user, the system software, and the hardware work together to solve end user problems are application software.
- Like Computer Hardware Generations, software has also evolved over five generations. Starting from Machine Language to Assembly Language to High-level language to fourth generation languages to Natural Language Processing.
- The set of programs that controls a computer system's hardware and provides services to users of the system is called an operating system. It is composed of two types of programs: control and processing programs. The control programs manage the computer hardware and resources. The processing programs provide a service to the user or programmer of a computer system.
- There are several types of operating systems, including single user, multiprogramming (concurrent), time sharing, multiprocessing, virtual storage, real time, and virtual machine operating systems.
- In order to instruct a computer to perform specific tasks, a set of written codes is called a programming language. Each programming language has a set of rules, or syntax, governing the use of its symbols. There are many programming languages, but each includes the following basic instructions: input/output, arithmetic, logic, control, data movement, and specifications. The different types of programming languages that exists can be categorised as: machine, assembly, high level, fourth generation languages and object oriented languages.
- Some of the key characteristics of a good programming language are ease of learning, ease of understanding, enforcement of correct code, supported platforms, portability, fit-for-purpose, naturalness, efficiency, structured, extensibility, and suitability to its environment.
- The programming translators are programs that convert code written in assembly or high level language to machine language and reassemble the output back to assembly or high level language. The translators are of three types – Assemblers, Interpreters, and Compilers.

- Many tasks that people perform manually can be done faster and more efficiently with a computer. An application package is a program that interacts with the system software to direct the computer hardware to complete a task for the user. The commonly used application software are word processor, spreadsheet, database, presentation tools, communication software, accounting and financial software, and project management.
- The formal creation process of programming is known as the Programming Development Life Cycle (PDLC). There are seven steps to this: define, outline, develop, test, code, run, and document, and maintain.
- The flowcharts, Pseudo codes and algorithms are three problem solving tools that are used in building computer programs.
- Software programs can be developed in-house or can be procured from the software vendor. While procuring the software, different options that are available include shareware, freeware, open source and public domain. One needs to be clear about these options and use them appropriately. One also needs to be clear about the need of the user and the organisations objectives while procuring the software.

KEY TERMS

Accounting & Financial software
Algorithms
Application Software
Assembler
Assembly Language
Batch Processing
Bug
Communication Tools
Compiler
Computer Language
Computer Software
Databases
Debugging
Distributed Processing
Education Software
File Management
Flowcharts
Freeware
High-level Language
Interpreter
Licensed Software
Logic Error
Machine Language
Mobile OS
Multimedia Software
Multi-processing
Multi-programming
Multi-tasking
Multi-threading
Object Code
Object Oriented Programming (OOP)
Open Source
Operating System
Packaged Software
Parallel Processing
Presentation Software
Programming Language
Project Management
Pseudo code
Public Domain
Real-time Processing
Resource Management
Shareware
Simulation Software
Software
Source Code
Spreadsheet
Syntax Error
System Software
Task Management
Time-sharing
Translators
User Interface
Virtual Machine
Word-processing

SELF-STUDY QUESTIONS

1. _____ is software package available in the public domain, and it may be used or altered without fee or restriction.
   (a) Freeware (b) Shareware (c) Open Source (d) Sold

2. Which of the following is NOT a part of system software?
   (a) System Management Programs (b) System Support Programs
   (c) System Development Programs (d) Resource Management Programs
3. _____ is a low-level language and use mnemonics to represent instructions.
   (a) Machine Language (b) High-Level Language
   (c) Assembly Language (d) Object Oriented Language
4. COBOL, LISP, ALGOL, C++ are some of the examples of
   (a) High-level language (b) Business Data Processing Language
   (c) Object-oriented Language (d) Fourth Generation Language
5. _____ is the process by which objects can acquire the properties of objects of other class.
   (a) Encapsulation (b) Polymorphism (c) Inheritance (d) Sharing
6. _____ converts the human-readable form of the program to executable machine language.
7. Which of the following is a sequential and logical list of instructions to solve a problem covering all possible alternatives.
   (a) Flowchart (b) Pseudo code (c) Algorithm (d) Program
8. _____ are problems with grammar, spelling, or punctuation within a program.
9. _____is a framework for constructing and interlinking an organisation's back-end systems in order to make the computing systems more flexible and cost-effective.
10. _____ and _____ are the two scheduling techniques of parallel processing.

REVIEW QUESTIONS

1. List the ways in which system software is different from application software.
2. The operating system is an important component of computer system. What are the main characteristics of a good operating system?
3. What is Object Oriented Programming? List the common OOP languages.
4. In how many different ways one can process information? Describe each of the methods.
5. List general purpose application software and business purpose application software.
6. List some of the good characteristics of a programming language.
7. List some of the key difference between an assembler, interpreter, and compiler.
8. How open source softwares are different from freeware and shareware?
9. What is the difference between multi-tasking, multi-programming and multi-processing systems?
10. What are the major factors that one needs to consider while procuring the software?

QUESTIONS FOR DISCUSSION

1. Is it necessary for all end users to learn operating system to work on computer systems effectively? Comment.

2. When application softwares are there to manage business functions, why one needs to write program. Justify.
3. Identify the application software that your organisation must procure to manage its cash flow and basic inventory. Justify your answer.
4. What are key reasons for buying off-the-self software as compared to getting it developed in-house?
5. What are the key benefits of writing a pseudo code and algorithms, while developing a program? How important is to maintain the documentation related to each program. Justify.

APPLICATION EXERCISES

1. Application software suites are becoming popular for small businesses. Identify the key applications that fit in the need of these businesses of today.
2. Identify the list of accounting software for mid segment companies. Compare these in terms of features and cost. Prepare a cost comparative sheet.
3. Write an algorithm and draw a flowchart that will read the two sides of a rectangle and calculate its area.
4. Write an algorithm that reads three numbers and prints the value of the largest number.

GROUP PROJECTS

1. The sales department of a multinational decided to set up an online group communication system. Search the Internet or survey the market to identify the major players in this segment. Prepare the comparative analysis of various products and suggest the best option.
2. Search the Internet to identify the new developments happening in the field of processors and animation. Prepare a comprehensive report and make a presentation to your faculty.
3. Study the IT infrastructure of your own institution and compare it with similar institutes in India and abroad and prepare a comparative report for your IT head.
4. Microsoft recently launched Windows Vista and the beta version on Windows 7 is also available. Do a comparative analysis between the two from the end user perspective?

Caselets

1. IFFCO: Farming its Resources

The Indian Farmers Fertilizer Cooperative (IFFCO) is the world's largest fertilizer cooperative, and the largest producer of chemical fertilizers in India. Established in 1967 as a collective initiative of the farmers of the country, IFFCO today boasts of annual sales of over Rs. 9,700 crore, and markets its products through more than 37,300 Cooperative Societies and 165 Farmers' Service Centres across India.

Over the years, as IFFCO emerged as the largest producer of fertilizers in the country, the scale and spread of its operations demanded best of breed interconnectivity between plants and offices for efficient sharing of data. In 2001, IFFCO initiated a complete network upgrade to meet several strategic objectives and engaged Cisco for the purpose. As SC Mittal, senior general manager, IFFCO, informs "Spurred by the rapid increase in business volume, IFFCO was keen to revamp its IT infrastructure and put in place a unified network that would facilitate information sharing among various cooperative members."

Another objective was to build a foundation for future IP services and to prepare for the convergence of data and voice over a common network backbone. A third objective was to accommodate growth, enabling IFFCO to connect a growing base of cooperative offices across India, while assuring high application performance for a wide range of application traffic.

The WAN architecture deployed by Cisco encompassed 80 locations, including IFFCO's Kandla plant and some regional and area offices. The network runs on point-to-point leased links and MPLS VPN links, and is powered by the Integrated Service Routers (ISR) and the Catalyst range of multi-layer switches—6500 Series, 4500 Series, and 2950 Series. The Cisco Catalyst LAN switches at the access layer extend control from the network core to the edge, with intelligent network services, including advanced Quality of Services (QoS), scalable performance, comprehensive security, and manageability.

As part of the end-to-end IP architecture, Cisco installed 200 hard phones and the VT Advantage communication solution at some locations for providing the video telephony functionality to Unified IP phones. In addition, Cisco deployed wireless access points, the PIX series of dedicated firewall appliances and the Intrusion Prevention System (IPS) for securing the network. With this interconnectivity, IFFCO offices and plants can now efficiently exchange production information and report results online. The network also supports ERP-like applications and mail messaging that enhances the organisation's productivity.

The network has facilitated the deployment of centralised applications, the consolidation of data and resources, assets monitoring, virus management, version control, standardisation of business processes, production and sales performance monitoring, and faster policy communication, etc. The eighty locations of IFFCO are now interconnected over WAN.

Questions for Discussion

1. List the main challenges being faced by IFFCO.
2. One of the key problem areas identified by IFFCO IT team was integration of information resources. How did they overcome this problem?
3. Why IFFCO needs to run a web based application to provide new bouquet of services to its members?
4. What were the perceived benefits of the proposed solution?

Source: *Dataquest*, 28 Feb., 2007, Vol. XXV No. 04

2. Buying vs. Developing Software

Most companies recognize the many advantages of buying software applications off-the-shelf rather than developing them in-house. By purchasing packaged applications (such as those from Microsoft, Oracle,

SAP, and other vendors) or by using applications that vendors create, host, and make available over the Web (for example, those from SalesForce.com), companies can acquire effective business solutions with the benefits of standardisation. In this way, they can keep up with of the innovations created by focused specialists.

In spite of those advantages, custom-built applications are still very much a part of the IT landscape. The companies in many sectors spend well over half their applications budgets on custom software, used largely to enhance, support, and operate customised systems. For large companies in competitive, fast-moving industries such as telecommunications, financial services, high-tech, pharmaceuticals, and media, those outlays can run into hundreds of millions of dollars. The banks, for instance, frequently build custom applications to support new financial products or to manage risk. The pharmaceutical companies regularly build custom applications to support R&D and marketing activities.

Even when a company uses off-the-shelf applications, it frequently customises them, typically by adding modules that provide a distinctive capability. A high-tech company, for example, installed a suite of packaged enterprise-resource-planning applications but also built a customized cash-management application to supplement the ERP product's plain-vanilla finance functionality. Unfortunately, even a little customisation here and there quickly adds up. It is worse, when companies must revise systems to meet new business needs, changing interconnected, customised applications can be difficult and costly, and upgrades to customised applications usually cost more than those to packaged software.

Nevertheless, some pioneering companies have found a way to capture the benefits of packaged software in a customised-applications environment. They have adopted the approach of software vendors, which package and sell applications aimed at the common needs of many customers rather than of individuals, by writing an application once and then selling it many times. In this way, pioneering banks and media and pharmaceutical companies have reduced the complexity and cost of managing applications and speeded up the deployment of new or updated ones.

An approach some companies have used to turn elements of custom-applications support into packaged activities involves standardising the maintenance, support, and software-management activities that groups of applications share. The applications that support field service work, for instance, may undertake similar functions (such as call planning) or incorporate similar types of tools (such as calculators, diagnostics, or checklists for customers). A company can define the management of common elements among applications as standardized 'products' designed to provide for the needs of many applications rather than one. Similarly, it can assemble new, custom-built applications from common, internally built modules of functionality and then reuse services developed by its teams to undertake common tasks such as authenticating users or accessing attributes of customers or products. Like software vendors, such a company writes the code once but uses it frequently—a tactic made possible by creating application interfaces that incorporate broadly accepted standards such as those from the Web Services Interoperability Organisation.

The upside of this approach is now quite clear. One company that adopted these support and maintenance principles reduced spending on applications maintenance by 30 percent—amounting to 60 percent of the entire applications budget—and speeded up the deployment of new applications, thereby completing in two to three weeks what once took two to three months.

Focusing in-house applications management on such products can be challenging and clearly isn't right for all companies. The payback will be greatest in fast-moving sectors. The companies prepared to try will be tempted to seek solutions for the problems of today's applications portfolios rather than those of tomorrow's—problems that are inevitably harder to pinpoint and understand. But treating support services as products is all about building for the future. The companies will need to change how they organise support resources, perhaps even overhauling IT governance structures to ensure the appropriate funding, oversight, and accountability of a very different applications environment.

TURNING APPLICATIONS MANAGEMENT INTO A PRODUCT

The companies that adopted the strategy of standardising applications-management activities as products have found the following benefits:

- Reduced work for application 'owners' (such as business units) and developers in sorting through management issues
- Reduced costs and enhanced cost transparency derived from per-seat, per-application prices
- Standardised, fine-tuned processes for applications of the same archetype
- Dramatically higher resource utilisation
- Increased manageability of service levels
- Concentration of skills around fewer technologies, leading to better training and development
- Full value for companies that consolidate applications in shared services

TURNING BUSINESS FUNCTIONALITY INTO PRODUCTS

There arae several leading companies who are at the stage of defining archetypes to reduce spending on applications management. Some of these companies have begun to experiment with applying the lessons of packaged software—write once, sell to many—to the *development* of customised applications as well. In essence, such companies have taken the writing of reusable code, an idea as old as computing, into a new era. The task is to create software that performs a particular function—calculating an interest rate or targeting a customer, say—and then to reuse it in any new application that might need this functionality. In the past, locating such code and deciding how best to use it were difficult because this knowledge could be shared effectively only within a tightly knit team.

Today companies bring some order and standardisation to the process by using Internet-based service-oriented-architecture (SOA) standards. These IT advances help companies to codify business functionality in ready-to-use software building blocks much more easily and quickly, to scale up the kinds of functionality suitable for reuse in applications, and to ensure that such building blocks are employed more effectively across project teams and organisations—and maintained in a more standard fashion after an application has been deployed.

In a company with reusable components of business functionality, such changes are a lot easier. A major bank created a library of reusable modules—essentially off-the-shelf products—that codified business functions for analytic modeling. The bank uses these products repeatedly in applications that support the trading of a wide range of financial instruments, such as equities, bonds, derivatives, and foreign exchange.

It is still early to make definitive predictions. But internal, off-the-shelf components of business functionality might allow IT to deliver its true promise: promoting business innovations instead of being the boat anchor holding them back.

LESSONS FROM EARLY ADOPTERS

As we noted earlier, this approach isn't suitable for all companies. Those that must roll out new applications quickly and constantly—banks and media companies, for instance—will benefit from it. But those in slow-moving sectors may have little need. If applications don't have to change much, writing them once is good enough—it's not worth all the work required to standardize custom activities. For businesses that can benefit from product-oriented approaches, we offer the following lessons from early adopters:

- Build the products 'prospectively,' mindful not just of the existing base of applications but also of future needs.
- Organise groups to deliver products effectively against business needs and not just technology outcomes.
- Pay attention to organisational factors that will ensure proper governance and realise the business benefits.

Finally, those financing new applications must favour standardised business functionality products (on the development side) and management products (on the support side). People should be held accountable for moving toward these new, common approaches. The costs for developing functionality and management products are ascribed to a single applications project, but subsequent applications can reuse them, and this possibility has implications for the way projects are measured and their performance is graded. The companies may find it necessary to finance standardisation efforts separately from other development projects and to establish pricing mechanisms

for recouping the investment from business users of the applications. The funding must take into account both efficiency and relevance, and pricing should balance recovering the investment with encouraging greater use.

The companies that live or die by how quickly they can roll out new, innovative business capabilities to their customers can benefit from making their customised applications more like products.

Questions for Discussion

1. List the main challenges being faced by the organisation that are developing software's in-house
2. What are some of the benefits and challenges of buying the software off-the self?
3. Explore some of the Indian organisations that have gone for a hybrid approach.

Source: Adapted from McKinsey Quarterly, "The next – generation of in-house software development", February, 2006

Answers to Self-Study Questions

1. (a)	2. (b)	3. (c)	4. (a)
5. (d)	6. Translator	7. (c)	8. Syntax Errors
6. SOA	10. Sequence and Concurrent		

The McGraw·Hill Companies

Chapter 5

Networks and Telecommunication Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What are networks and why one needs them for business applications?
- What are the different kinds of data communications channels that exist and are there any defined standards for these channels?
- How many types of networks exist and what are the different topologies that these networks may follow?
- What are the different components of networks and how one can select a network?
- What are the roles Internet, Intranet, and Extranet play for success of the business?
- What is Virtualisation and what are its benefits?
- What is Cloud Computing and Businesses are taking benefit from this?

INTRODUCTION

The businesses across the globe have integrated and become interconnected. The emergence of global networks and digital economy has forced organisations to remain connect across boundaries. In order to provide seamless connectivity across boundaries and across organisations, it is important to have good network and telecommunication systems. The objective of this chapter is to provide a basic understanding of the management and technical aspects of business data networks and telecommunications systems.

In today's competitive business environment, data networks and telecommunication technologies are as important as the computer technologies that support them. No organisations,

be it a school, or grocery shop, or a bank, or stock trading company can exist in this competitive environment without integration of networking and communication technologies into their businesses. Today's managers use data communications to communicate with a wide variety of individuals within the same organisation as well as across the organisations like suppliers, distributors, retailers, banks, customers, government officials, advertisers, and many more. Thus the communications can take place locally, nationally, or internationally.

The managers need to send and receive data and information in a timely fashion in order to identify and solve problems and make effective decisions. Often, in today's fast paced electronic environment, even the slightest delay can mean a missed opportunity. However, getting data to a desired destination in a timely manner is not a manager's only concern. The communication systems must transmit the data accurately and in a form that can be understood and used by the receiving system.

The managers are faced with numerous decisions concerning networks and data communication. They must decide the type of network, the right topologies, the type of communications hardware and software options that are right for their organisations. This crucial decision must take into account a number of factors, including cost, and performance. In addition, the managers must be aware of current or emerging networking and data communication standards. In this chapter, we will examine some of the ways in which network and data communication is used in an information system.

NETWORKS

A network is a technology solution that helps organisation to interconnect its hardware, software, databases and various media to achieve interconnectivity between its employees and stakeholders.

If organisations need to be connected across the globe and need to serve its customers, suppliers on real-time basis, it becomes important for these organisations to interconnect their resources and share them among its stakeholders. ***A network is interconnection of resources that organisation owns.*** Network helps organisation to create effective communications, real time sharing of data and other resources, and also helps in creating virtual access. Each computer in a network can have its own processing capabilities and can also share hardware, data files, and programs. Network also allows organisations to provide e-mail communication, data communication, audio communication and video communication among group of users—internal, or external to the organisation.

One of the most effective uses of networks is e-mail communication. The e-mail is one of the most innovative applications that became a reality in early 1990s. It allowed users to communicate effectively on real-time basis at minimum possible cost. The e-mail is the cheapest and most effective mode of communication. The data communication is another effective use of networks. ***The data communication or data conferencing allows two or more users to share the common data resource either on the common computer server or their networked computers.*** This is very useful specially when the users are located in geographically spread locations and wants to work on the same data at the same time, for example, team members of the same project. Other

usages of network technologies are the audio conferencing and videoconferencing. All the modes of conferencing allowed users to communicate effectively over geographic boundaries in a cost-effective manner. The latest mode of communication is IP-telephony, which uses the concept of Voice over Internet Protocol (VoIP). The VoIP allows the users to have telephonic communication over the organisation's Internet networks. The VoIP based communication bypass the traditional telephone network.

The Data Communications concerns with the transmission of digital messages over a network.

Types of Networks

Broadly, there are only two types of networks that exists—Local Area Network (LAN) and Wide Area Network (WAN). All other forms of networks that people keep discussing about are sub-forms of either LAN or WAN.

Local Area Networks (LAN)

A local area network (LAN) interconnects two or more computers, or devices within a relatively small, well-defined area, such as a room, building, or cluster of buildings using physical wires, infrared links, or wireless systems. A LAN may include only microcomputers or any combination of microcomputers and large systems. A LAN always uses a proprietary communication channel to interconnect devices. It is not dependent on any third party telecommunication service provider services.

A LAN connects networking devices within short spam of area using proprietary communication channels.

Local area networks are usually privately owned with limited coverage, this means that the underlying network technologies and network services may be freely selected. The growing demand for local area networks is due to technical, economic, and organisational factors:

- Cost reductions through sharing of information and databases, resources, and network services.
- Increased information exchange between different departments in an organisation, or between individuals.
- The trend to automate communication and manufacturing process.
- Improve the community security.
- Increasing number and variety of intelligent data terminals, PCs and workstations.

A LAN can be wired and wireless. A **wireless local area network** (**WLAN**) links two or more devices using some wireless distribution method like Wi-Fi. A LANs also vary in the type and number of computers that can be connected, the speed at which data can be transferred, and the type of software used to control the network. The number of computers in a LAN varies widely, from smaller LANs that typically connect two to 25 computers to larger LANs that can connect as many as 10,000 computers. A single organisation may have one LAN or may have any number of LANs; it all depends on IT policy of the organisation. In case the organisation has more than one LAN, they can interconnect all of them to share resources across LANs. A LAN characteristics are determined by:

- Topologies
- Medium Access Control (MAC)
- Transmission media
- Size of coverage

The CSMA is a protocol in which a node verifies the absence of other traffic before transmitting on a shared transmission medium.

The LANs that use a **bus topology** can use the **carrier sense multiple access (CSMA**) method. With this method a device listens to the channel to sense whether it is in use. If the channel is not being used, the device can send its message. If the channel is in use, the device waits for a specified period of time and then checks again to see whether the channel is available. It is possible with this method for two or more devices to send messages at the same time, creating the possibility that messages may collide and become lost or incorrectly transmitted. In order to avoid this situation, the CSMA method is also available with collision detection capabilities. When these methods are combined, the access method is referred to as **carrier sense multiple access/collision detection (CSMA/CD).** In CSMA/CD

The CSMA/CD is used to improve CSMA performance by terminating transmission as soon as a collision is detected.

- **The multiple access** refers to the fact that in bus systems, each station has access to the common cable.
- **The carrier sense** refers to the fact that each station senses to see if no other station is transmitting before sending data.
- **The collision detection** refers to the principle of sensing to see if other stations are transmitting whilst it is transmitting.

The LANs that use a **ring topology** often use a token passing access method. A token is a string of bits that is passed around the network. When a device wants to transmit a message, it must wait for a token. When a token appears, the device holds the token and then transmits its message. When the device is finished transmitting, it returns the token to the network. With only one token, message collisions do not occur. This method is most effective if the volume of network traffic is high; it ensures that use of the network will be balanced among all the devices. However, if traffic is low, devices on the network must still wait for a token before they can transmit, even if the network is available.

The LANs can be connected to WANs through the use of gateways. A gateway is an interface that converts the data codes, formats, addresses, and transmission rates of one network into a form usable by another network.

Wide Area Networks (WAN)

A wide area network (WAN) interconnects two or more computers that are geographically dispersed. These computers are interconnected using the telecommunication facility provided by third party telecom service provider like MTNL, Airtel, etc. This telecommunication facility can either be wire-based or microwave based or satellite based. This type of network is often

used by large organisations and government agencies to transmit data between geographically dispersed locations. The satellites are often used to transmit data across large distances divided by geographic barriers, such as oceans, or mountains. The Internet is the best example of Wide Area Network, where physical boundaries have no meanings. The organisations that want to share internet connections with its LAN users will need to connect their LAN to a public communication service provider called Internet Service Provider (ISP). This interconnection of LAN with ISP qualifies to be WAN.

A wide area network (WAN) is a geographically dispersed network using third party telecom services for interconnectivity.

The Wide Area Networks are made either using dedicated point-to-point leased lines or 'cloud' services. In case the dedicated lines are not shared; as the name implies, and they are dedicated to one customer. The cloud services are owned and operated by a service provider and are shared by many customers. Dedicated lines have the advantage of being private, but they are expensive, especially when many sites are to be connected. Cloud services provide a meshed network that readily allows connection from many different sites, at lower cost.

Switching Techniques

(a) Circuit switching: The circuit switching is the method used to connect telephone lines. It opens up a complete predetermined transmission route from sender to receiver before a message is transmitted. An entire message is then transmitted at once. This method guarantees exclusive use of the transmission route and an uninterrupted message transmission. If all possible transmission routes to the receiver are being used, the sender must wait for a link to become free. The data transmission with circuit switching is an all-or-nothing process. It is faster and more efficient for data to be transmitted with packet switching.

(b) Message switching: It also involves sending an entire message at one time over a predetermined transmission route. However, in this case the transmission route is not dedicated to just one message. It is possible that somewhere along the transmission route the message will encounter a portion of the route that is not available. When this happens, the message is temporarily stored. When that part of the route becomes available, the message is removed from storage and transmission continues.

(c) Packet switching: The packet switching is the most complex of the data movement methods discussed here. Its advantage is that it can increase the utilisation of the network, thus decreasing the cost of using the network. In packet switching there is no temporary storage of messages in secondary storage devices. Instead, messages are divided into packets, or blocks, of standard size; a single message may be made up of one or more packets. Each packet is sent along a transmission route that is determined in one of the two ways. It may be predetermined at the time of transmission, or it may be dynamically determined at transmission time and at each node, depending on the amount of traffic and the availability of portions of transmission routes. Most of the Internet communication uses the packet switching. The packets contain the data as well as header information such

as source and destination addresses. The packets are sent individually and they rely on network protocols to find a route to their destination, where they are rearranged into their original configuration. If a packet is lost or corrupted during transport, another is sent until all packets are arrived and reassembled. The packet switched networks are fast, efficient, and economical compared to circuit switched networks.

WAN Protocols

The major WAN protocols in use today are X.25, frame relay, ISDN, ATM, and PPP.

(a) X.25: The X.25 protocols are packet switching technologies. The X.25 was designed for operation over unreliable analog telephone lines, and incorporates built-in error correction, flow control and retransmission of lost packets. While it is reliable, it is not as fast as the newer protocol, frame relay.

(b) Frame Relay: The frame relay is a very popular WAN protocol and is a packet switching approach, but it assumes the error checking will be handled in the hardware and does not perform its own error checking or accounting. Consequently, it is capable of faster operation. The frame relay establishes a path between end points called a Permanent Virtual Circuit (PVC) which is fixed, similar to the idea of a dedicated line, but with the advantages of a cloud service. The frame relay is available in speeds of 56 Kbps to 1.544 Mbps. The frame relay puts data in a variable-size unit called a frame and leaves any necessary error correction (retransmission of data) up to the end points, which speeds up overall data transmission. It requires a dedicated connection during the transmission period. When adding a frame relay connection to your network, it is important to verify the guaranteed minimum data transmission rate called the **Committed Information Rate** (CIR). Since frame relay operates over shared lines, actual speed will vary depending on how much the network is being used.

(c) ISDN: In contrast to frame relay, ISDN is a circuit switched protocol that offers integrated voice and data service. A dedicated connection is set up at the start of communication, then closed at the end. The cost of using ISDN includes both basic service charges and per-minute usage charges. This can end up being more expensive than frame relay if the network utilisation is high.

(d) Asynchronous Transfer Mode (ATM): The ATM is also a packet switching protocol capable of very high speeds. It uses fixed length 53-byte 'cells' at typical speeds of 155 Mbps and 622 Mbps. Like frame relay, it sets up a Permanent Virtual Circuit (PVC) between points in the network for a communication session. The ATM is used with various types of media including twisted pair cable, optical fiber, T3 lines, and Optical Carrier (OC) lines. The ATM is commonly used in carrier clouds.

(e) Point-to-Point Protocol (PPP): It is a standard for transmitting multiple protocols, like IP, over a leased line, or dial-up connection. When combined with Synchronous Optical Network (SONET), very high data rates are possible.

Other Type of Networks

As described earlier, LAN and WAN are the only two types of networks that exists, but people have coined number of other sub-classifications like:

- **Metropolitan Area Network (MAN)** is the most popular classification. A MAN is a computer network that usually spans a city or a large campus. The MAN is subset of WAN which allows the high-speed connectivity between LANs spread across metropolitans. The telecommunication connectivity is provided by the telecom service provider and these networks are geographically spread, so it qualifies to be a WAN.
- **Campus Area Network (CAN)** is an extended Local Area Network of an Institution Campus or Organisation Campus. The CAN allows interconnecting of different campuses of the same institution spread either in the same or different geographical locations.
- **Home Area Network (HAN)** helps the user to interconnect all digital devices on a common network. This helps the user to share the photographs clicked using digital camera, listen to the music on his computer recorded on his iPod, and many more resource sharing activities.
- **Virtual Private Network (VPN)** is a network that uses a public telecommunication infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organisation's network. A virtual private network can be contrasted with an expensive system of owned or leased lines that can only be used by one organisation. The goal of a VPN is to provide the organisation with the same capabilities, but at a much lower cost.
- **Storage area network (SAN)** is a kind of LAN designed to handle large data transfers. A SAN typically supports data storage, retrieval, and replication on business networks using high-end servers, multiple disk arrays, and interconnection technology. The term SAN can sometimes refer to **system area networks** instead of a storage area network. The system area networks are clusters of high performance computers used for distributed processing applications requiring fast local network performance. The storage area networks, on the other hand, are designed specifically for data management.

Sumul: Milking Wirelessly

The concern faced with the challenge of laying cable and providing connectivity to new buildings that were coming up, Sumul went for the wireless route.

Surat District Cooperative Milk Producers Union (Sumul), a leading dairy cooperative, used to have its plant and sales building connected using single mode fibre.

As time progressed, many small buildings came up in the campus which needed to be connected to the main building as connectivity to the administrative building. After having fibre connectivity to sales and plant building, Sumul had gone with hard rock roads in the campus due to continuous movements of heavy loaded milk tankers making it difficult to lay fibre. The need was to provide connectivity for internal buildings that were coming up and needed to be connected to the central application and mail servers.

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(To read the complete case example visit www.mhhe.com/behl2e)

NETWORK TOPOLOGY

The topology is the process and method of connecting different nodes in a network.

Each computer or device in a network is called a node. How these nodes are connected is the network's topology. This topology describes the method used to do the physical wiring of the network. The topology to be followed in a network is decided by the network administrator on the basis of cost, type of the computers to be interconnected, wire-based or wireless, distance between devices, layout of the network, and building and the criticality of the data transfer speed. A network can be arranged as per one of the five different topologies.

Star Topology

A star network consists of several devices connected to one centralised computer (refer Figure 5.1). All communications go first through the centralised computer called Hub, allowing it to control the operation, workload, and resource allocation of the other computers in the network. For example, a bank with several branch offices would typically use a star network to control and coordinate its branches. The advantage is its simplicity, but the single point vulnerability of the network may be a problem. If the central computer breaks down, none of the other computers can communicate with each other. But, if the node stops working nothing happens to the rest of the network. The star topology is one of the most common methods of connecting and setting the network. In star topology, data packets are sent via the central computer.

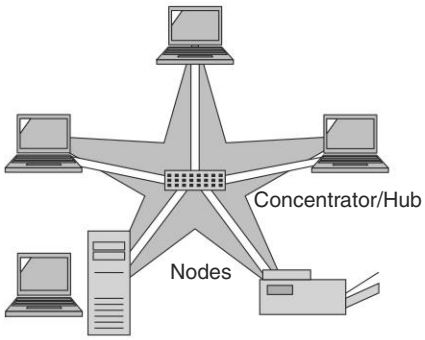

Figure 5.1 Star Topology Network

Ring Topology

A ring topology network consists of several devices connected to each other in a closed loop by a single communication channel (refer Figure 5.2). There is no central or predominant computer in this network. The data must travel around the ring to each station until it reaches at the desired station. A unidirectional ring moves data in one direction only; a bidirectional ring can move data in both directions, but in only one direction at a time. When one node malfunctions in a bidirectional ring a message from an adjacent node can usually be sent in the opposite direction, still allowing communication among all the active nodes in the network. In a unidirectional ring, if one of the nodes stop working the complete network will get affected.

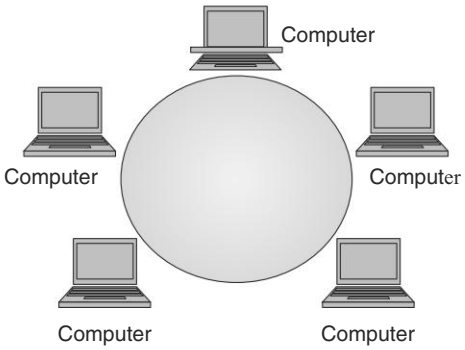

Figure 5.2 Ring Topology Network

Bus Topology

In a bus topology network, each computer is connected to a single communication cable via an interface; thus, every computer can communicate directly with every other computer or device in the network (refer Figure 5.3). A special device called the terminator is connected at the end of the communication cable. In case, the terminator is not connected, the network will start malfunctioning. Each node is given an address, and a user simply needs to know the address to access a particular node. This topology is frequently used with local area networks. If any one of the nodes stops working, it will not affect the network, but if there is a broken link that will lead to failure of the network.

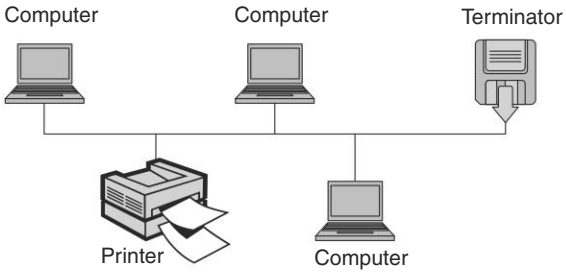

Figure 5.3 Bus Topology Network

Tree Topology

A tree topology network links computers in a hierarchical fashion and requires data to flow through the branches (refer Figure 5.4). The tree topology is hybrid topology of star and bus. The number of cables (tree branches) like the star topology is drawn out of the hub computer and each branch will have number of nodes connected to it like a bus topology. One advantage of a tree structure is that functional groupings can be created. For example, one branch could contain all the general ledger terminals, another branch may have all the accounts receivable terminals, and so on. Also, if one branch stops functioning, the other branches in a tree network are not affected. However, data movement through this network can be slow.

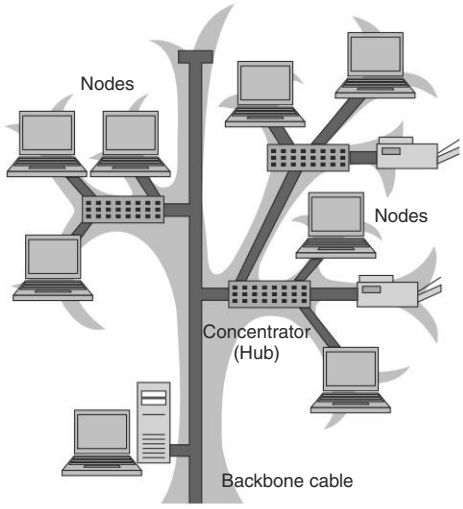

Figure 5.4 Tree Topology Network

Mesh Topology

The mesh topology networks are difficult to create and quite similar to the spider web (refer Figure 5.5). In mesh topology each single computer is directly connected to each other computer in the network. The Internet is the best example that follows the mesh like topology. This kind of network is most rugged and reliable as each computer is connected to each other

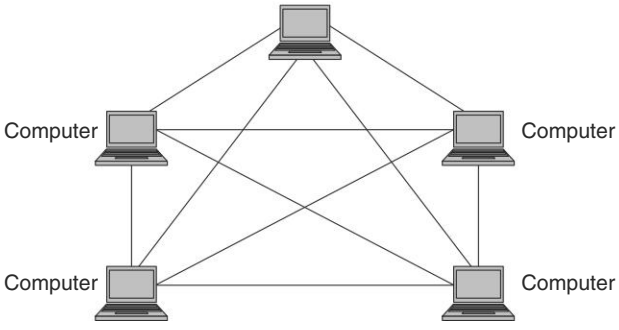

Figure 5.5 Mesh Topology Network

computer available on the network, so if one computer fails, all other connections are always active.

Build Intelligent Network to be Integrated

The IIN is an evolutionary approach rather than a revolutionary approach to the evolving role of the network.

Despite enormous IT investments, many organisations find that vital networked resources and information assets remain largely unlinked. In fact, it is not uncommon for organisations to have hundreds of 'siloed' applications and databases that cannot communicate with each other. The result is an inability to share information efficiently across the organisation. The customer records, for example, cannot be accessed easily by sales, customer service, or purchasing departments without creating different overlay networks that join applications and information. This lack of transparency exists because most IT infrastructures have grown without systematic planning. Many organisations have found that this unplanned expansion has left them with multiple systems and distributed resources that are uncoordinated and underused. These disparate systems are also difficult and costly to manage.

An Evolutionary Approach to Networks

Having a long term view of the network can help global IT organisations correct these problems and address new challenges such as the deployment of service-oriented architectures, Web services, and virtualisation. The vision of an Intelligent Information Network (IIN) facilitates this integration of the hardware and software that makes it possible for organisations to better align IT resources with business priorities. The IIN is an evolutionary approach rather than a revolutionary approach to the evolving role of the network. By building intelligence into an existing network infrastructure, IIN will help organisations realise the benefits such as reduced infrastructure complexity and cost. The IIN will also give organisations the enhanced functionality they need to develop enterprise wide visibility and organisational agility so they can respond rapidly to changing business and market conditions.

Why Build Intelligence into the Network?

In order to eliminate the technology islands that are found in today's IT environment, the infrastructure needs be more closely linked to, aware of, and responsive to the needs of the applications, resources, and devices connected to it. And therefore, a need to build an ecosystem with applications vendors, hardware, and software giants, such that organisations can integrate business processes tightly with IT and allow computing resources to be dynamically allocated to users as needed.

However, enterprises need to realise that these greater functions can't be realised without rethinking the network, the foundation on which an IT infrastructure is built. This is because the network is the one element of the infrastructure that touches all others, from the applications and middleware to the servers and users. Therefore, it is in a unique position to not only monitor the transfer of information but also to enforce policies coherently and cost-effectively.

An integrated system, active participation, and enforcing policy with the network are the three distinguishing attributes of an intelligent network. By adding intelligence to the network, the network can actively participate in the delivery of applications and services. The active participation in service delivery makes it possible for the network to effectively manage, monitor, and optimise application and service delivery across the entire IT environment. The network wide intelligence also allows infrastructure wide policies. And the enforcing policy with the network lets organisations link business objectives and processes to network rules so they can closely align the IT environment with business goals and more

effectively use IT resources to improve business operations. It also gives organisations the ability to adapt quickly to the IT environment to respond to changing business requirements.

How to Build an Intelligent Network

The Intelligent Information Network (IIN) transforms an existing infrastructure with all its interconnected 'components' into a single integrated system. This systems approach extends intelligence across multiple products and infrastructure layers and more closely links the network to the rest of the IT infrastructure.

This vision offers an evolutionary approach that consists of three phases in which functionality can be added to the infrastructure as required.

Phase 1 Integrated Transport

Everything—data, voice, and video—consolidates onto an IP network for secure network convergence. By integrating data, voice, and video transport onto a single, standards-based, modular network, organisations can simplify network management and generate enterprise wide efficiencies. The network convergence also lays the foundation for a new class of IP-enabled applications. The early adopters of IP Communications have realised substantial savings in toll charges, maintenance, and support costs. But recent studies reveal that the principal reason for adopting IP Communications isn't just cost savings; it's the potential for deploying new applications that transform communications and build competitive advantage.

(**Source:** Sage Research, IPC Productivity Report, March 2005)

Phase 2 Integrated Services

Once the network infrastructure has been converged, IT resources can be pooled and shared or 'virtualised' to flexibly address the changing needs of the organisation. The integrated services help to unify common elements such as storage and data center server capacity. By extending virtualisation capabilities to encompass server, storage, and network elements, an organisation can transparently use all of its resources more efficiently. The business continuity is also enhanced because shared resources across the Intelligent Information Network provide services in the event of a local systems failure.

Phase 3 Integrated Applications

With Application-Oriented Networking (AON) technology, Cisco has entered Phase 3 of building the Intelligent Information Network. This phase focuses on making the network "application aware" so that it can optimise application performance and more efficiently deliver networked applications to users.

In addition to capabilities such as content caching, load balancing, and application-level security, Cisco AON makes it possible for the network to simplify the application infrastructure by integrating intelligent application message handling, optimisation, and security into the existing network. This integration delivers the information transparency and organisational agility needed to succeed in today's fast-paced business environment.

Benefits of Intelligent Information Network

The role of the network is evolving. The intelligent network of tomorrow will offer much more than basic connectivity, bandwidth for users and access to applications. The intelligent network will offer the kind of

end-to-end functionality and centralised, unified control that will promote true business transparency and agility. The active intelligence within the network is currently providing organisations with benefits such as network wide security system, faster deployment of services and applications, efficient use of computing resources, reduced complexity, and lower total cost of ownership.

With the integration of business processes, applications, and the network, organisations will be able to collect and share data anytime and anywhere, whether it is external information from partners and customers or internal data across business functions, product groups, or geographies. The Intelligent Information Network will make it possible for IT organisations to act quickly and efficiently on that information by adding, removing, or changing business processes to adapt to new market conditions.

Source: http://www.ciol.com/content/special/ITAssets/feature5.asp

NETWORK COMPONENTS

There are two basic components to the backbone of a network: (a) the network connectivity (cable or wireless) and (b) the hardware devices that connect networks to the network backbone. The cable is essentially the same that used in LANs, except that it is usually of a higher quality to provide higher data rates. The commonly used cable types are twisted pair, coaxial cables, and fiber optic cables. The wireless networks use either infrared or radio signals to transmit data between different devices. Most of the laptops are equipped with Wi-Fi cards to provide connectivity on the move, provided the organisation network supports it. The hardware devices can be computers or special purpose devices that are used to transfer messages/data from one network to another. These include hubs, bridges, routers, brouters, gateways, and switches.

Network Connectivity

Twisted Pair Cables

The twisted pair cables are the thick copper cables (Figure 5.6) normally used in traditional telegraph and telephone networks. The older type of twisted pair cables were less reliable as they used to handle low-bandwidth, but the newer cables support higher bandwidth and are more reliable. It consist of a pair of wires, each wrapped in a protective coating and twisted around each other. The upgraded cables can transmit the data at 1 Gbps. The Category 5, popularly known as Cat 5 cable is a four pair twisted pair that can carry data upto 100 metres without any data loss at a speed of 100 Mbps. The Cat 6 is a new standard that support more reliable data transmission at higher speed. The twisted pair cabling comes in two varieties: shielded and unshielded. The standard connector for unshielded twisted pair cabling is an RJ-45 connector. This is a plastic connector that looks like a large telephone-style connector (Figure 5.7).

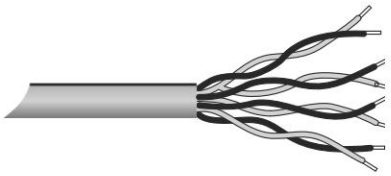

Figure 5.6 Unshielded Twisted Pair (UTP)

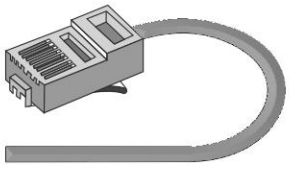

Figure 5.7 RJ-45 Connector

Coaxial Cables

The coaxial cables are the ones that are normally used by cable TV operators to transmit TV signals. This coaxial cable has a single copper conductor at its center. A plastic layer provides insulation between the center conductor and a braided metal shield (Figure 5.8). The metal shield helps to block any outside interference from fluorescent lights, motors, and other computers. The coaxial cables are more reliable as compared to twisted pair and it can handle more amounts of data and can also transmit the data at 10 Mbps. There are two basic categories of coaxial cables: base band and broadband. The base band coaxial cables carry a single digital signal at a rate between 1 Mbps to 50 Mbps. The broadband coaxial cables can carry multiple data signals together (voice, data, and video) at speeds between 20 Mbps and 50 Mbps. The broadband is the more expensive of the two categories.

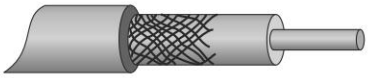

Figure 5.8 Coaxial Cable

As it is easier and cheaper to use the extensive wire cable networks that already exist, wire cable channels are the most popular. Another reason for their popularity is that the technology used to transmit data along wire cables is standardised, thus reducing compatibility problems. One disadvantage of wire cables is that data must be transmitted in analog form. The conversion of digital data not only requires special hardware but also slows down the transmission of the data. Another disadvantage is that wire cable is subject to electrical interference, making it less reliable than other types of communication channels. In addition, it is difficult to create the necessary physical links where users are separated by long distances or by natural barriers, such as mountains or large bodies of water. The most common type of connector used with coaxial cables is the Bayone-Neill-Concelman (BNC) connector (Figure 5.9). There are different types of adapters available for BNC connectors, including a T-connector, barrel connector, and terminator. The connectors on the cable are the weakest points in any network.

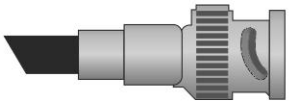

Figure 5.9 BNC Connector

Fiber Optic Cables

The Fiber Optic Cables (Figure 5.10) are the one that are made out of glass that can transmit data using laser beams. It uses light impulses that travel through clear flexible tubing, which is thinner than a human hair. Hundreds of these tubes can fit in the same amount of space required for one wire cable. The fiber optics are reliable communication channels; data can be transmitted at high speeds with few or no errors. And unlike wire cables, fiber optic cables are not subject to electrical interference. They do, however, require repeaters to read and boost the signal strength because light pulses lose signal strength over long distances. This kind of cables can carry large volume of data at much higher transmitting speed of 100 Gbps. It is a slightly expensive mode of data transmission, but more reliable.

Figure 5.10 Fiber Optic Cable

There are two common types of fiber cables—single mode and multimode. The multimode cable has a larger diameter; however, both cables provide high bandwidth at high speeds. The single mode can provide more distance, but it is more expensive.

Microwave Transmission

Another type of communication channel is microwave. The microwave signals are transmitted through the atmosphere rather than through wire cables, in the same way radio and television signals are transmitted. However, microwave signals must be transmitted in a straight line because they cannot bend around corners or follow the curvature of the earth. The microwave transmitters have to be strategically located about every 50–60 kms to accommodate the curvature of the earth. The transmitter stations redirect and boost the signals.

Sakthi PURA Project: Facilitating Rural Connectivity

The microsense overcomes challenges posed by uneven, hilly terrain to bring benefits of connectivity to rural community.

The Sakthi PURA project in Pollachi, which is aimed at providing tele-education, health care and other information/content services to outlying villages, as part of the PURA (Provision of Urban Amenities in Rural Areas) is an initiative championed by the President of India. Nachimuthu Polytechnic College (NPTC) and Mahalingam College of Engineering and Technology (MCET), are the implementing agencies for Sakthi PURA Pollachi.

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Challenges

- Hilly terrain posed a hurdle in connecting rural community of Pollachi, TV
- Line of sight visibility difficult at distances beyond 10 km

Benefits

- Stable and reliable wireless links of required capacity, supporting data, voice, and video services, have been established
- Microsense provides last-mile RF connectivity links to a variety of other customer segments also.

Source: *Dataquest*, 28 Feb, 2007, Vol. XXV No. 04

(To read the complete case example visit www.mhhe.com/behl2e)

Satellite Transmission

The problem of line-sight and repeaters are overcome by using satellites, which are the most widely used data transmission media in modern days. The satellites are also used to direct microwaves over large, geographically dispersed areas. A communication satellite is an electronic device that receives, amplifies, and then transmits signals from space to earth. The microwave signals are sent from a transmitter station to an earth station and are then beamed to an orbiting satellite. From there they are beamed directly back to another earth station if a direct line of sight is possible. If direct transmission is not possible, the signal is transmitted first to another satellite that does have a direct line of sight and then back to an earth station. Only three satellites are required to send a signal anywhere on earth.

Compared to wire cable, microwave has a much lower error rate, making it more reliable. Also, because there are no physical connections between the sending and receiving systems,

communication links can span large distances and rough terrains. One disadvantage, however, is the high cost of transmitter stations, earth stations, and satellites to support a microwave network. The main advantage of satellite communication is that it is a single microwave relay station visible from any point of a very large area. In microwave the data transmission rate is 16 giga bits per second.

Infrared (IR) Light

The infrared is just below the visible range of light between 100Ghz and 1000Thz. The infrared light lies between the visible and microwave portions of the electromagnetic spectrum. The infrared light has a range of wavelengths, just like visible light has wavelengths that range from red light to violet. A light emitting diode (LED) or laser is used to transmit the signal. The signal cannot travel through objects. light may interfere with the signal. 'The near infrared' light is closest in wavelength to visible light and 'far infrared' is closer to the microwave region of the electromagnetic spectrum. The longer, far infrared wavelengths are about the size of a pin head and the shorter, near infrared ones are the size of cells, or are microscopic. The IR light is not visible to human eyes and requires line-of-sight transmission. Many computers and devices use infrared to transmit data between them. Most popular example of infrared is remote device used by many appliances like TV, VCD, DVD, etc.

Bluetooth

The Bluetooth is a method for data communication that uses short range radio links between mobile PCs, mobile phones, and other portable devices. The software controls and identity coding built into each microchip ensure that only those units preset by their owners can communicate. It supports both point-to-point and point-to-multipoint connections and provides up to 720 Kbps data transfer within a range of 10 metres (up to 100 metres with a power boost). It is a wireless technology that allows all computing devices equipped with Bluetooth to communicate with each other. The Bluetooth is non line-of-sight technology which allows the transmissions of data across corners, walls, and through briefcases. The Bluetooth networks, also feature a dynamic topology called a piconet or PAN. The piconets contain a minimum of two and a maximum of eight Bluetooth peer devices. These devices communicate using protocols that are part of the Bluetooth Specification.

Wireless Networks

The older networks were more cable based but the latest trend is towards providing connectivity anywhere to everywhere, so the networks are becoming wireless. Laying cables and proving data access points anywhere to everywhere within an organisation, outside an organisation, on road, tracks, and while on the move is just impossible. The organisations are creating wireless networks for their employees and are also providing them with wireless cards to remain connected wherever they are.

Wireless Fidelity (Wi-Fi): The wireless fidelity has emerged as a standard wireless communication that is also known as 802.11. The Wi-Fi or 802.11b standard allows the wireless speed of up to 11 Mbps, which is much faster than a DSL connection. The 802.11g standard is for LAN, which can provide connection speed of 20 Mbps.

In order to set up the wireless LAN, the network administrator needs to install the wireless access points as per the number of nodes and the spread of the network. One wireless access point helps in connecting one or more computers, provided each computer is equipped with the Wi-Fi card. The effectiveness of the Wi-Fi network is dependent on power of the access point and its location. Some access points are low range access points and support very few computers at one point of time and the signal can also travel small distance as it depends on the power of the antenna.

Advantages of Wireless Networks

- Mobility—With a laptop computer or mobile device, access can be available throughout a school, at the mall, on an airplane, etc. More and more businesses are also offering free WiFi access ('Hot spots').
- Fast setup—If one's computer has a wireless adapter, locating a wireless network can be as simple.
- Cost—Setting up a wireless network can be much more cost effective than buying and installing cables.
- Expandability—Adding new computers to a wireless network is as easy.

Disadvantages of Wireless Networks

- Security—Protect one's sensitive data with backups, isolated private networks, strong encryption and passwords, and monitor network access traffic to and from your wireless network.
- Interference—Because wireless networks use radio signals and similar techniques for transmission, they are susceptible to interference from lights and electronic devices.
- Inconsistent connections—Because of the interference caused by electrical devices and/or items blocking the path of transmission, wireless connections are not nearly as stable as those through a dedicated cable.
- Speed—The transmission speed of wireless networks is improving; however, faster options are available via cables.

Global Positioning Systems (GPS)

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit.

The Global Positioning System (GPS) is a wireless system based on satellite communication used to provide reliable positioning, navigation, and timing services to its users on a continuous basis worldwide. One needs a GPS receiver and a service connectivity from a service provider. The system will provide location and time for unlimited number of users in all weather, any time and in any part of the world. The GPS is made of three components—satellite orbiting the earth, control and monitoring system on earth; and the GPS receiver owned by the user. The satellite broadcast signals from space that are picked and identified by GPS receiver and each receiver then provide three-dimensional location comprising of latitude, longitude and altitude and time.

The GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. The GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map. With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude, and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more. The GPS has become a popular technological innovation in the transportation industry to track their consignments while they are on the move. The industries, where GPS systems are widely used include maritime, aviation, banking, mobile communication, power, railways, and disaster management. The GPSs are now also available on handheld devices like PDAs and Blackberries.

Cellular Networks

The cellular networks are divided into cells, each cell being serviced by one or more radio transceivers (transmitter/receiver). The communication in a cellular network is full duplex, where communication is attained by sending and receiving messages on two different frequencies—frequency division duplexing (FDD). The reason for the cellular topology of the network is to enable frequency reuse. The cells, a certain distance apart, can reuse the same frequencies, which ensure the efficient usage of limited radio resources. The cellular telephone infrastructure has primarily been used for voice transmission, but recent development of a transmission standard called cellular digital packet data (CDPD) has made it possible for the infrastructure to support two-way digital transmission. The access technologies of cellular networks are:

- ***FDMA.*** The Frequency Division Multiple Access (FDMA) is the most common analog system. It is a technique whereby spectrum is divided up into frequencies and then assigned to users. With FDMA, only one subscriber at any given time is assigned to a channel. The channel therefore is closed to other conversations until the initial call is finished, or until it is handed-off to a different channel. A 'full-duplex' FDMA transmission requires two channels, one for transmitting and the other for receiving. The FDMA has been used for first generation analog systems.
- ***TDMA.*** The Time Division Multiple Access (TDMA) improves spectrum capacity by splitting each frequency into time slots. The TDMA allows each user to access the entire radio frequency channel for the short period of a call. Other users share this same frequency channel at different time slots. The base station continually switches from user to user on the channel. The TDMA is the dominant technology for the second generation mobile cellular networks.
- ***CDMA.*** The Code Division Multiple Access is based on 'spread' spectrum technology. Since it is suitable for encrypted transmissions, it has long been used for military purposes. The CDMA increases spectrum capacity by allowing all users to occupy all channels at

the same time. The transmissions are spread over the whole radio band, and each voice or data call are assigned a unique code to differentiate from the other calls carried over the same spectrum. CDMA allows for a 'soft hand-off', which means that terminals can communicate with several base stations at the same time. The dominant radio interface for third-generation mobile is a wideband version of CDMA with three modes.

The evolution of cellular transmission from analog to digital is described below:

- ***First Generation (1G).*** The first generation services were analogue services for cell phones. These were for voice only and the technology did not provide for SMS or other data services. The 1G is circuit switched, which means that when you place a call, a connection is established for you, and is maintained until you hang up.
- ***Second Generation (2G).*** The 2G services were digital. The transition to 2G provided the ability to store, copy, encrypt and compress data, and allowed data transmission without loss and with error correction. It also allowed wireless data services such as internet access, though at slower speed. The voice quality was much better as compared to 1G. There are two kinds of 2G services—Global System for Mobility (GSM) and Code Division Multiple Access (CDMA). The GSM is based on a time-sharing process in which a slice of spectrum is shared between multiple users, by dividing and creating small time slices and allocating a slice to each user in turn. The CDMA is more complicated as compared to GSM.
- ***2.5/3G.*** The moving from 2G to 2.5G/3G introduced another revolutionary change, the introduction of packet switching for data rather than circuit switching. For the consumer, packet switching provides two benefits. First, the commodity being sold is packets, not network time connected, so the pricing model becomes more data oriented. Another benefit to consumers is the speed.
- ***'True' 3G.*** The third generation networks offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. The services include wide area wireless voice telephony, video calls, and broadband wireless data, all in a mobile environment. The 3G is the network expansion which allowed direct internet connections, Wideband data access, simultaneous voice, data, music, and telephone, plus network based apps all rolled into one.
- ***4G.*** Promises to deliver data up to 10 times faster than 3G speeds. A 4G system is expected to provide a comprehensive and secure all-IP based mobile broadband solution to laptop computer, wireless modems, smartphone, and other mobile devices. Facilities such as ultra-broadband Internet access, IP telephony, gaming services, and streamed multimedia may be provided to users. The data speeds of as much as 1 Gbytes/sec will be possible when using a mobile phone utilizing 4G.

Hardware Devices

Ethernet

The most of the cable based network communication happen using the Ethernet. The Ethernet ensures the collision free reliable data transmission over the network. Early Ethernet, which were

10 Base-T supported a speed of maximum 10 Mbps, which were replaced by faster Ethernets called 100 Base-T, which again supported maximum speed of 100 Mbps. The latest are the Gigabit Ethernet, which support data transfer rate 1 Gbps, but the technology is also available that supports data transfer of 5 Gbps.

The Ethernet is a physical and data link layer technology for local area networks (LANs).

- The Ethernet is the dominant cabling and low level data delivery technology used in local area networks (LANs).
- The Ethernet supports networks built with twisted-pair, thin and thick coaxial, and fiber-optic cabling.
- The data is transmitted over the network in discrete packets (frames), which are between 64 and 1518 bytes in length.
- Each device on an Ethernet network operates independently and equally, precluding the need for a central controlling device.
- The Ethernet also supports a wide array of protocols, the most common is TCP/IP.
- In order to prevent the loss of data, when two or more devices attempt to send packets at the same time, The Ethernet detects collisions. All devices immediately stop transmitting and wait a randomly determined period of time before they attempt to transmit again.

Hubs

The hubs are very simple devices that pass all traffic in both directions between the LAN sections (refer Figure 5.11). They are the connection components for different devices on the network. They link and operate at the physical layer of OSI model (explained later in the chapter). The main function of the hub is to repeat and amplify signals before transmitting them to other parts of the network. The hubs forward every message they receive to the other sections of the LAN, even those that do not need to go there. The hubs are used within one LAN. They are of three types—passive, intelligent, and switching hubs.

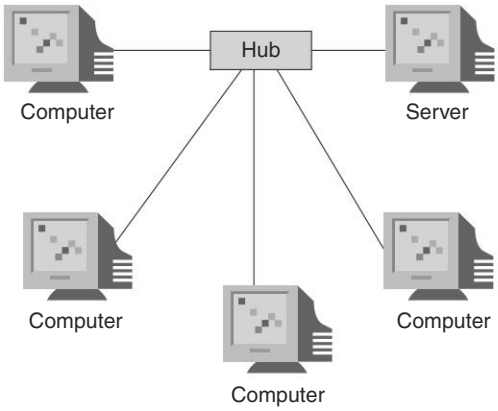

Figure 5.11 Hub Connecting to LAN

- A *passive hub* serves simply as a conduit for the data, enabling it to go from one device (or segment) to another.
- An *intelligent hub* includes additional features that enables an administrator to monitor the traffic passing through the hub and to configure each port in the hub. Intelligent hubs are also called *manageable hubs.*
- A *switching hub*, actually reads the destination address of each packet and then forwards the packet to the correct port.

A hub is used in a wired network to connect Ethernet cables from a number of devices together.

Bridges

A bridge device filters data traffic at a network boundary and connects two LANs or two segments of the same LAN. They connect two LANs that use the same data link and network protocol, and operate at the data link layer of OSI model (refer Figure 5.12). The bridges reduce the amount of traffic on a LAN by dividing it into two segments. Since similar networks use same protocols, bridges usually do not perform protocol conversion. They are very useful devices for large networks and are more sophisticated than hubs because they forward only those messages that need to go to other network segments. The bridges are a combination of both hardware and software. A typical bridge is a 'black box' that sits between the two networks and has its own processor, memory, and software; its operations are transparent to the network user. A bridge also can be a regular computer with two or more Network Interface Cards and special bridging software.

The bridge helps connecting two parts of a network and filtering data.

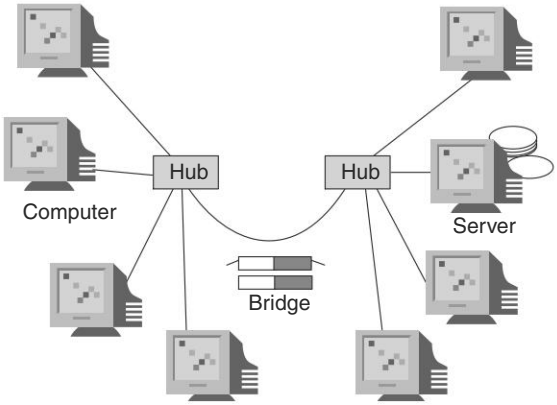

Figure 5.12 Bridge Connecting LANs

Switches

The switches connect two or more LAN segments that use the same data link and network protocol (refer Figure 5.13). Similar to bridges, switches work and operate at the data link layer of OSI model. They may connect using the same or different types of cables. The switches typically provide ports in a multiple of four like 4, 8, 16 or 32, and allow all ports to be in operation at the same time. The switches also connect several low speed LAN segments into a faster backbone network. They are the most popular networking device.

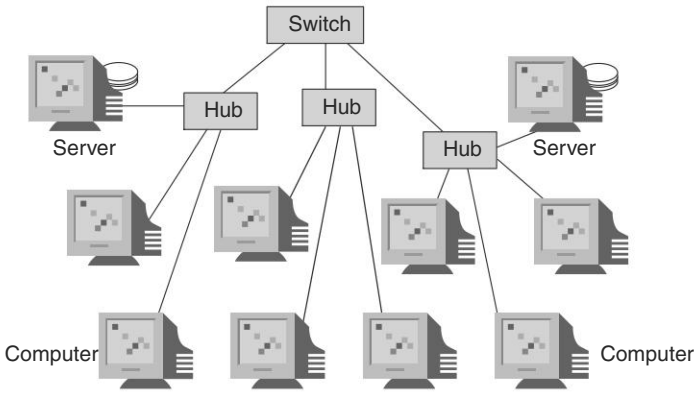

Figure 5.13 Switch Based LAN

- The switches are sometimes called "multi-port bridges" for this reason.
- A switch is a combination of a hub and a bridge.
- It can interconnect two or more workstations, but like a bridge, it observes traffic flow and learns.

A switch or switching hub is a computer networking device that connects network segments.

- When a frame arrives at a switch, the switch examines the destination address and forwards the frame out the one necessary connection.
  - Workstations that connect to a hub are on a *shared segment*.
  - Workstations that connect to a switch are on a *switched segment*.
- The backplane of a switch is fast enough to support multiple data transfers at one time.
- A switch that employs a *cut-through architecture* is one that passes on the frame before the entire frame has arrived at the switch.
- The multiple workstations connected to a switch use dedicated segments. This is a very efficient way to isolate heavy users from the network.
- A switch can allow simultaneous access to multiple servers, or multiple simultaneous connections to a single server.
- The switches are easy to install and have components that are hot-swappable.

Routers

The routers connect two or more LANs that use the same or different data link protocols, but the same network protocol. A router operates at the network layer of OSI model and forwards only those messages that need to go to other networks (refer Figure 5.14). One of the major features of a router is its capability of selecting the optimal network path to transmit the packets. In order to accomplish this task, a router uses a routing table. The routers also has a software based intelligence to identify the best routes. The routers allow the logical separation of an internet work into many networks by using an addressing scheme that distinguishes between device addresses at the data link layer and internet work addresses at the network layer. The routing systems use the internet work address specified in the network protocol packet and their routing tables for routing decisions. Another difference between a router and a bridge is that a router processes only those message that are specifically addressed to it. The routers also come with built-in hubs and switches and also provide a basic level of security from intruders or hackers. The routers also act as a firewall if implemented properly.

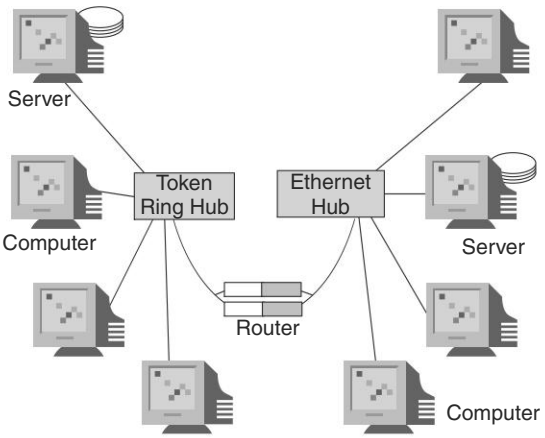

Figure 5.14 Router Based Network

The routers are physical devices that join multiple networks together.

- The device that connects a LAN to a WAN or a WAN to a WAN.
- A router accepts an outgoing packet, removes any LAN headers and trailers, and encapsulates the necessary WAN headers and trailers.
- Because a router has to make wide area network routing decisions, the router has to dig down into the network layer of the packet to retrieve the network destination address.

- Thus, routers are often called "layer 3 devices". They operate at the third layer, or OSI network layer, of the packet.
- The routers often incorporate firewall functions.
- It reads the information in each packet to tell where it is going.
- If it is destined for an immediate network it has access to, it will strip the outer packet, readdress the packet to the proper Ethernet address, and transmit it on that network.
- If it is destined for another network and must be sent to another router, it will re-package the outer packet to be received by the next router and send it to the next router.
- The routing occurs at the network layer of the OSI model.
- They can connect networks with different architectures such as Token Ring and Ethernet.
- Although they can transform information at the data link level, routers cannot transform information from one data format such as TCP/IP to another such as IPX/SPX.
- Routers do not send broadcast packets or corrupted packets. If the routing table does not indicate the proper address of a packet, the packet is discarded.
- There are two types of routers:
  - Static routers—They are configured manually and route data packets based on information in a router table.
  - Dynamic routers—They use dynamic routing algorithms. There are two types of algorithms: 'Distance vector' and 'Link state'

Brouters

A Brouter or Bridge Router is a network device that works as a bridge and as a router.

The brouters (Figure 5.15) combine the function of routers and bridges and work at the data link and network layers of the OSI model. They can connect similar or dissimilar data link layers. A bridge is a device that connects one local area network (LAN) to another local area network that uses the same protocol. If a data unit on one LAN is intended for a destination on an interconnected LAN, the bridge forwards the data unit to that LAN; otherwise, it passes it along on the same LAN. A bridge usually offers only one path to a given interconnected LAN. A router connects a network to one or more other networks that are usually part of a wide area network (WAN) and may offer a number of paths out to destinations on those networks. A router therefore, needs to have more information than a bridge about the interconnected networks. It consults a routing table for this information. Since a given outgoing data unit, or packet from a computer may be intended for an address on the local network, on an interconnected LAN, or the wide area network, it makes sense to have a single unit that examines all data units and forwards them appropriately. The advantage of brouter is that they are not only as fast as bridge for same data link type network, but can also connect different data link type networks.

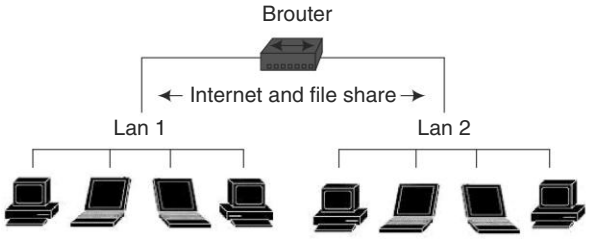

Figure 5.15 Brouter Based Network

Gateways

The gateways are more complex than bridges or routers because they are an interface between two or more dissimilar networks. For example, a gateway can connect three networks—one using TCP/IP, another using Ethernet and third using System Network Architecture (SNA). The function performed by a gateway may require a combination of hardware and software. It may connect the same or different types of cables. The gateways operate at the network layer, and sometimes at the application layer as well. They forward only those messages that need to go to other networks (refer Figure 5.16). The gateways translate one network protocol into another, translate data formats, and open sessions between application programs, thus overcoming both hardware and software incompatibilities. The gateways are classified into three types, network-to-network, system-to-network, and system-to system.

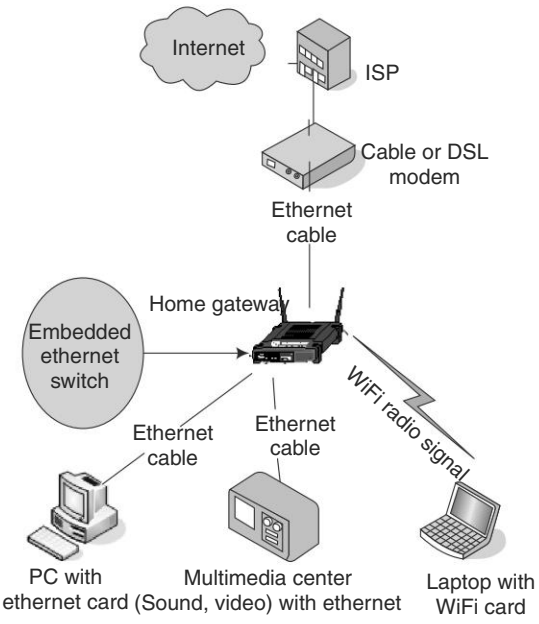

Figure 5.16 Gateway Based Network

A gateway is a routing device that passes traffic between different subnets and networks.

DATA COMMUNICATION

The data communication is the process of sending data electronically from one point to another. The linking of one computer to another computer or device permits the power and resources of both computers to be tapped. It also makes possible the sharing and updating of data in different locations, may be across geographical boundaries.

The data communication is electronic transmission of information that has been encoded digitally.

The computers that are physically close to each other, either in the same room or building, can communicate data through a direct cable link or through Bluetooth technology or through Wi-Fi. The computers that are located in far distant locations, use a special form of data communication called telecommunication. ***The telecommunication, or teleprocessing, is the process of using communication facilities, such as the telephone system, microwave relays, and satellite to send data between computers.*** The data transmission broadly is of two types—Analog and Digital.

Analog Data Transmissions: ***The Analog data transmission is the transmission of data in a continuous waveform*** (refer Figure 5.17). The telephone system is an example of a system designed for analog data transmission. But today's computer system is a digital machine and the data these machines transmit is also in digital manner.

The Analog Data transmission takes continuous values.

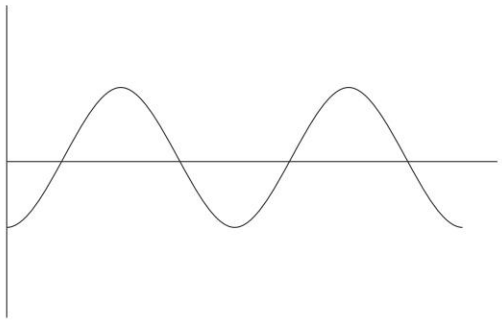

Figure 5.17 Analog Data Transmission

- Analog Transmission
  - Takes on continuous values. Ex. Voice or video
  - Not used with digital signal
  - Transmits analog signals irrespective of whether it represents digital or analog data
  - Uses amplifiers which also boosts noise
  - Good for voice
  - Can distort digital data
- Why use Analog
  - Already in place
  - Significantly less expensive
  - Lower attenuation rates
  - Fully sufficient for transmission of voice signals

The Digital Data Transmission takes discrete values.

Digital Data Transmission: ***Digital data transmission is the transmission of data using distinct on and off electrical states*** (refer Figure 5.18). Remember that data in digital form are represented as a sequence of 1s and 0s. Since the digital computer understands and works in digital form and also digital data communication is faster and more efficient than analog, most of the current day communication between computers is shifting to digital form. A completely digital system is possible, but the traditional telephone systems are still analog systems, and are used for a great percentage of data communication because it is the largest and most widely used communication system already in place. Though Internet has become the cheapest and the widest communication network of the world, but the majority of average users connect its computer to the Internet using the old traditional telephone line (which in some cases is still analog). The most of these digital computers are connected to the analog telephone line using the device called Modem. ***The modem is a modulation-demodulation device which converts the digital signal to analog and vice versa.***

- Digital Transmission
  - Takes discrete values. For example, text and integers
  - Concerned with the content of the signal

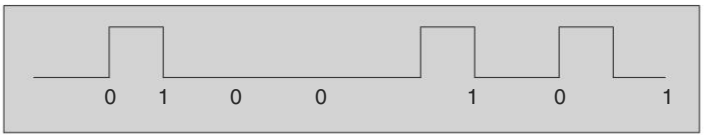

Figure 5.18 Digital Data Transmission

- Uses repeaters which recover the pattern of 0's and 1's and retransmits
- Can be used with analog signals if it carries digital data
  - Again it recovers the digital data from the analog signal and generates a new clean analog signal
- Is becoming more standard

- Advantages of Digital
  - The signal is exact
  - The signals can be checked for errors
  - The noise/interference are easily filtered out
  - A variety of services can be offered over one line
  - The higher bandwidth is possible with data compression

The basic components of data communication are:

- **Data:** A collection of facts in raw forms that become information after processing.
- **Signals:** The electric or electromagnetic encoding of data.
- **Signaling:** The propagation of signals across a communication medium.
- **Transmission:** The communication of data achieved by the propagation and processing of signals.

Data Perspective

- **Analog data:** The continuous values on some interval.
  - Example: audio, video, temperature and pressure sensors.
- **Digital data:** It discrete values.
  - For example, text, integers.
  - It helps in encoding using binary patterns. For example, ASCII.

Signal Perspective

- **Analog signal:** It is a continuously varying electromagnetic wave that may be propagated over a variety of media, depending on bandwidth.
- **Digital signal:** It is a sequence of voltage pulses that may be transmitted over a wire medium.
- **The analog** data can also be represented by **digital** signals and **digital** data can be represented by **analog** signals.
- The digital data can be represented by analog signals: **modem**.
- The analog data can be represented by digital signals: **codec**.

Transmission Perspective

- **Analog transmission:** It is the transmission of analog signals irrespective of content.
  - For long distances, amplifiers are used.
  - Amplifiers boost noise, and are 'imperfect'.
  - The analog voice is tolerant of the distortion, but for digital data errors will be introduced.
- **Digital transmission:** It is the transmission of digital data (using either analog or digital signals).
  - For long distances, repeaters are used.
  - If spaced properly, the errors are eliminated.
  - Preferred because of: Digital technology, data integrity (error coding), capacity utilisation, security, and integration of voice, data etc.

Modulation, Demodulation, and Modems

The Modem is a device that transfers digital information over an analog network by modulation and demodulation.

The data in a computer are stored and formatted as digital signals. Because telephone lines were designed to transmit the human voice, they format data as analog signals. Thus, for communication between computers to take place via a telephone line, the digital signal must be converted to an analog signal before it is transmitted. At the end of the data transmission over the telephone line, the analog signal must then be reconverted to a digital signal so that it can be used by the receiving computer. ***The process of converting a digital signal to an analog signal is called modulation. The demodulation is the process of reconverting the analog signal back to a digital signal. The device that accomplishes both of these processes is called modem, short for* mo*dulator*-dem*odulator*** (Figure 5.19).

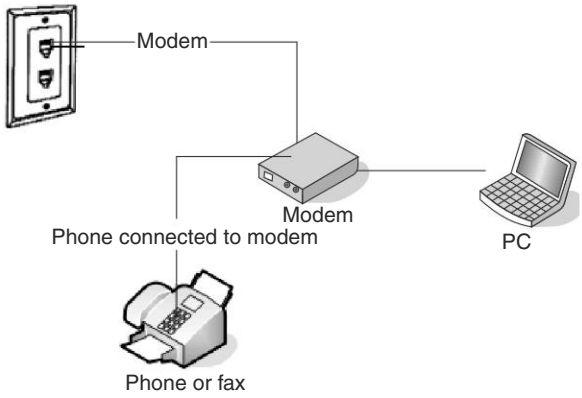

Figure 5.19 Modem

There are two types of modems which are popular in the market—external and the internal modems. An external modem is external to the computer and connects directly to the telephone line with a modular phone jack. The direct connection greatly reduces the signal's distortion and permits faster data transfer rates. The most external direct connect modem have a variety of capabilities:

- Checking the operating status using status lights and speakers
- Changing the speed at which data are transmitted
- Dialling and answering the phone automatically
- Responding to commands from a communications program
- Self testing their own ability to correctly transmit data.

As the specialised circuitry in these modems allowed them to perform such functions, they are often called smart or intelligent devices. For an external modem to work, the computer must be equipped with a communications adapter or other serial interface, which provides a standard method for serial transmission of data. A modem cable to connect the modem to the serial interface is also needed. For example, the RS-232C serial interface is used on most microcomputers. It has 25 pins, called a male connector, to which a modem cable is connected; the modem has 25 receptacles, called a female connector, to which the other end of the modem cable is connected. Nowadays, the modern computer systems are equipped with Universal Serial Bus (USB) port which by definition allows the user to connect multiple types of devices.

An internal direct connect modem has all the needed communications circuitry on a plug-in board that fits into one of the expansion slots (empty spaces) inside a computer. Some of the latest laptops are now equipped with the modem on the motherboard itself. The internal direct-connect modems also link directly to a telephone link, with a modular phone jack. These modems have many of the same special features that the external direct-connect modems have. In addition, they take up no desk space and are ideal for use in portable computers. These type of modems either internal or external are also called dial-up modems.

Types of Analog Modulations

- Amplitude Modulation (AM)
  - The amplitude modulation is the process of ***varying the amplitude of a carrier wave in proportion to the amplitude of a baseband signal.*** The frequency of the carrier remains constant.
  - The AM requires a simple circuit, and is very easy to generate.
  - It is simple to tune, and is used in almost all short wave broadcasting.
  - The area of coverage of AM is greater than FM.
  - However, it is quite inefficient, and is susceptible to static and other forms of electrical noise.
- Frequency Modulation (FM)
  - The frequency modulation is the process of ***varying the frequency of a carrier wave in proportion to the amplitude of a baseband signal.*** The amplitude of the carrier remains constant.
  - The main advantage of FM is its audio quality and immunity to noise. The most forms of static and electrical noises are naturally AM, and an FM receiver will not respond to AM signals.
  - The audio quality of an FM signal increases as the frequency deviation increases (deviation from the center frequency), which is why FM broadcast stations use such large deviation.
  - The main disadvantage of FM is the larger bandwidth it requires.

Types of Digital Modulations

The digital communication systems also employ modulation techniques, some of which include:

- Amplitude Shift Keying (ASK)
  - The most basic (binary) form of ASK involves the process of switching the carrier either on or off, in correspondence to a sequence of digital pulses that constitute the information signal. One binary digit is represented by the presence of a carrier; the other binary digit is represented by the absence of a carrier. The frequency remains fixed.
- Frequency Shift Keying (FSK)
  - The most basic (binary) form of FSK involves the process of varying the frequency of a carrier wave by choosing one of two frequencies (binary FSK) in correspondence to a sequence of digital pulses that constitute the information signal. This two binary digits are represented by two frequencies around the carrier frequency. The amplitude remains fixed.

Although digital telephone lines are becoming a reality nationwide. The role of modem is still important to connect the computer with the telephone line. The telephone companies now have started giving broadband communication lines, which allow the user to communicate faster any kind of data using these lines. The users need to use broadband modems or digital modems to connect their computers to transmit data at higher speed as compared to dial up modems. In India, one can get digital modem which can transmit the data at the maximum speed of 512 Kbps as compared to maximum 56 Kbps for dial up modems. A modem's transmission speed is measured in bits per second (bps).

COMMUNICATION CHANNELS

A communication channel is the medium or pathway, along which data are transmitted between devices. The communication channels fall into two basic types: wire/cable based and wireless. The wire/cable includes telegraph lines, telephone lines, coaxial cables, and fibre optics; it is the most common type of data communication channel in use today. On the otherhand the wireless communication includes microwave, satellite, radio, and WiFi. We have already discussed these in the section on Network Components.

Channel Configurations

The two principal configurations of communication channels are point-to-point and multipoint.

1. **Point-to-point channel:** In this configuration, a device (e.g., a node or a computer) is connected directly to another device by a dedicated communication channel, giving those devices sole use of that channel. The point-to-point can be an inefficient and costly configuration if a terminal is not active enough to keep the channel busy. The large computers that communicate with each other continuously often use point-to-point channel configurations (refer Figure 5.20).

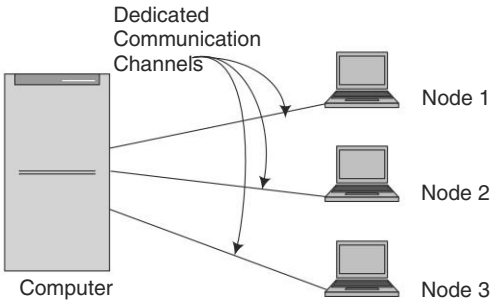

Figure 5.20 Point-to-point Channel Configuration

2. **Multipoint channel:** In this configuration (refer Figure 5.21), two or more devices are connected to the same line. The multipoint configuration uses a 1:1 communication channel more efficiently and reduces the amount of inter-cabling needed, thus lowering costs. There are two methods, which are used to determine which device gets access to a channel:

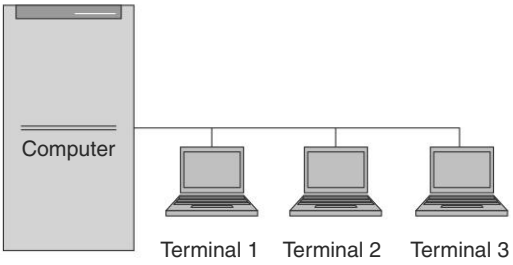

Figure 5.21 Multipoint Channel Configuration

   (a) Polling: In polling, the computer checks with each device, one at a time, to see whether the device has a message to send. If the device has a message ready, transmission begins; if not, the computer moves on to poll the next device. After all, devices have been individually polled, the process begins again. A disadvantage to polling is that the computer's processor will be idle, wasting expensive processor time, if there are no messages to be sent by the device being polled.

   (b) Contention: In contention it puts the devices in control; that is, each device monitors the communication channel to see whether the channel is available. If so, the device sends its message. If the communication channel is being used, the device waits for a predetermined amount of time and tries again, repeating this process until the channel is available. One problem with this approach is that a single device can tie up the communication channel for long periods of time.

Channel Sharing

The two methods that are used to regulate the flow of data from communication channels into a computer are multiplexing and concentration. Their purpose is to increase the efficiency of channel use.

1. Multiplexing

The multiplexing is the process of combining the transmissions from several devices into a single data stream that can be sent over a single high speed communication channel. A multiplexer is the hardware device that provides multiplexing. It is also used on the sending end to collect data from several devices and send them over one channel; it is used on the receiving end to separate the transmissions back into their original order for processing (refer Figure 5.22). The rationale behind this process is that most communication channels can transmit much more data at one time than a single device can send. Thus, a multiplexer allows a communication channel to be used more efficiently, thereby reducing the cost of using the channel.

The multiplexing is sending multiple signals on a carrier at the same time in the form of a single, complex signal, and then recovering the separate signals at the receiving end.

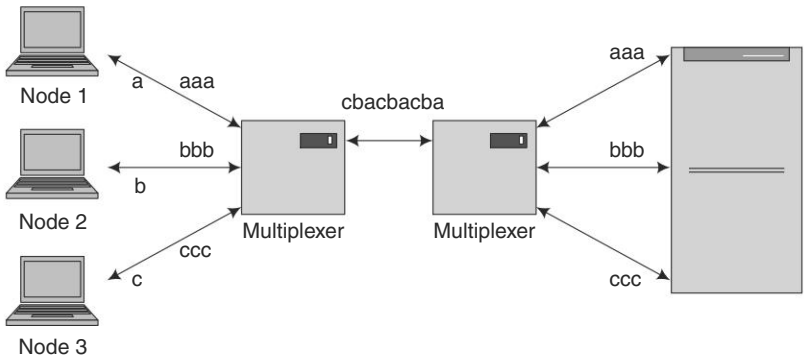

Figure 5.22 A Multiplexer Allows Several Nodes to Share One Communication Channel

There are multiple techniques in which multiplexing is accomplished:

A. ***Frequency Division Multiplexing (FDM).*** In frequency division multiplexing, a high speed channel is divided into multiple slow speed channels of different frequencies. Each attached device is assigned a different frequency so that it can transmit data whenever it has traffic. Each frequency assigned for traffic is surrounded by guard bands of unassigned frequencies to prevent adjacent signals from overlapping or interfering with each other.
   - Assignment of non-overlapping frequency ranges to each 'user' or signal on a medium. Thus, all signals are transmitted at the same time, each using different frequencies.
   - A multiplexor accepts inputs and assigns frequencies to each device.
   - The multiplexor is attached to a high-speed communications line.
   - A corresponding multiplexor, or demultiplexor, is on the end of the high-speed line and separates the multiplexed signals.
   - The broadcast radio and television, and the AMPS cellular phone systems use frequency division multiplexing.
   - This technique is the oldest multiplexing technique, since it involves analog signaling; it is more susceptible to noise.

B. ***Time Division Multiplexing (TDM).*** In time division multiplexing each device sharing a channel is assigned an equal time period, or slot, to transmit data. The multiplexer delays all incoming transmissions until their assigned time slots. With this method the assignment of time slots is static. That is, when a device has no data to send, the portion of the channel capacity assigned to that device is wasted. The time division multiplexing comes in two basic forms:

   (a) Synchronous Time Division Multiplexing
      - The original time division multiplexing.
      - The multiplexor accepts input from attached devices in a round-robin fashion and transmits the data in a never ending pattern.

- The T-1 and ISDN telephone lines are common examples of synchronous time division multiplexing.
- If one device generates data at a faster rate than other devices, then the multiplexor must either sample the incoming data stream from that device more often than it samples the other devices, or buffer the faster incoming stream.
- If a device has nothing to transmit, the multiplexor must still insert a piece of data from that device into the multiplexed stream.

(b) Statistical Time Division Multiplexing (STDM)

- Statistical time division multiplexing dynamically reassigns unused time slots to devices with data waiting to be sent.
- A statistical multiplexor accepts the incoming data streams and creates a frame containing only the data to be transmitted.
- A statistical multiplexor does not require a line over as high a speed line as synchronous time division multiplexing since STDM does not assume all sources will transmit all of the time!
- A statistical multiplexor transmits only the data from active workstations.
- If a workstation is not active, no space is wasted on the multiplexed stream.
- It is Good for low bandwidth lines (used for LANs).

C. Wavelength Division Multiplexing (WDM)

- It gives each message a different wavelength (frequency).
- It is easy to do with fiber optics and optical sources

D. Dense Wavelength Division Multiplexing (DWDM)

- The dense wavelength division multiplexing is often called just wavelength division multiplexing.
- The dense wavelength division multiplexing multiplexes multiple data streams onto a single fiber optic line.
- The different wavelength lasers (called lambdas) transmit the multiple signals.
- The each signal carried on the fiber can be transmitted at a different rate from the other signals.

E. Code Division Multiplexing (CDM)

- Also known as code division multiple access (CDMA).
- An advanced technique that allows multiple devices to transmit on the *same* frequencies at the *same* time using different codes.
- Used for mobile communications.
- Each mobile device is assigned a unique 64-bit code (chip spreading code).
- To send a binary 1, mobile device transmits the unique code.
- To send a binary 0, mobile device transmits the inverse of code.
- Receiver gets summed signal, multiplies it by receiver code, adds up the resulting values.

Concentration

Frequently, it is necessary to connect more devices to a computer than a communication channel can handle at one time. The ***concentration is the process of connecting and serving these devices; a concentrator, often a computer, provides the concentration***. When the number of transmitting devices exceeds the capacity of a communication channel, then data are stored in a buffer for later transmission. There are many multiplexers, which also provide concentration. It is simple form of data multiplexer that concentrates traffic from multiple low speed asynchronous devices onto a single high speed synchronous circuit, usually by time division multiplexing (TDM). In a simple concentrator, the total speed of the low speed incoming channels is equal to or less than the speed of the high speed outgoing circuit, so the maximum incoming load placed on the concentrator never exceeds the capacity of the outgoing circuit. In a more sophisticated concentrator, the incoming traffic load may exceed the capacity of the outgoing circuit, with buffers serving to store the excess data traffic for short periods of time until capacity is available on the outgoing circuit. At this more sophisticated level, a concentrator is a relatively unsophisticated statistical time division multiplexer (STDM).

The cocentrator is a type of multiplexor that combines multiple channels onto a single transmission medium in such a way that all the individual channels can be simultaneously active.

DATA TRANSMISSION

As people are becoming accustomed to the speeds at which computers can transfer data, they seem to demand faster methods of transmission. The information that once took days to receive now seems slow if it has taken a few seconds by computer. The rate at which data are transferred is the **baud rate**; it is the number of times per second that the signal being transmitted changes (modulates or demodulates). The baud is often equated with **bits per second** (bps); however, that comparison is not entirely accurate because a signal does not always carry one bit. Although higher speeds are possible, typical data transmission speeds that larger computer systems use for business communications is much higher. The two factors that determine the rate at which data can be transmitted are the bandwidth of the communication channel and the method of data transmission—asynchronous, or synchronous.

Communication Channel Bandwidths

The bandwidth of a communication channel determines the rate, or speed, at which data can be transmitted over that channel. Usually, it is measured in baud, which is bits-per-second (bps). The term bandwidth is often referred as band. This can also be described as the data handling capacity of a communication system (medium). The bandwidth is a range of frequencies offered by a medium that are available for the transmission of data.

The bandwidth refers to the data rate supported by a network connection.

Depending on their transmission speeds and communication channels (path) are grouped into three basic categories.

(a) Narrow Band Channels: The narrow bands channels are used for handling low data volumes and adequate for low speed data transfer. They transmit data at rates between 40 and 100 bps. They are used mainly for telegraph lines and low speed terminal.

(b) Voice Band Channels: The voice band channels handle moderate data volumes and can transmit data at speed up to 56,000 baud. This major application is for ordinary telephone voice communication. More over, most remote terminals also connected to computers through voice band channels.

(c) Broad Band Channels/Wide Band Channels: The broad band channels, or wide band channels are used when large volume of data is to be transmitted at high speed (128,000 baud for integrated services digital network- ISDN). The advancement in technology will soon allow data to be transmitted on some types of broad band channel at speeds of more than a billion bps. The fibre optics, microwaves, and satellite based communications are broadband channels.

The broadband connectivity is becoming a reality and some of the common broadband examples include integrated services digital network (ISDN), T1 link, T3 link, Digital Subscriber Line (DSL), and many more. Some of these are defined as:

- **T1 Link:** It is the most widely used connection line, the basic unit of the T-carrier system. A T1 consists of 24 channels of 64 Kbps with a total capability of 1.544 Mbps. Each of the channels may be used as a separate data or voice channel, or channels may be combined for higher transmission rates.
- **Integrated Services Digital Network (ISDN):** The ISDN combines two data channels of 64 Kbps and one error-correction channel of 19 Kbps. In some of the developed countries ISDN offer a bandwidth of 1.544 Mbps as the service provider offers 24 data channels of 64 Kbps each, which is quite similar to the T1 link.
- **T3 Link:** The T3 link offers a bandwidth of 44.736 Mbps by offering 672 data channels of 64 Kbps each. The T3 lines are equivalent to 28 T1 lines or 44.736 Mbps.
- **Digital Subscriber Line (DSL):** It is quite similar to ISDN connection, but is more powerful and reliable. The DSL allows simultaneous data, voice, and video transmission on the same lines. The various version of DSL technology exists and offer data transmission in the range of 128 Kbps to 30 Mbps.
- **Asymmetric Digital Subscriber Line (ASDL):** The commonly used DSL is Asymmetric Digital Subscriber Line (ADSL). It is a method for moving data over regular phone lines. An ADSL circuit is much faster than a regular phone connection, and the wires coming into the subscriber's premises are the same (copper) wires used for regular phone service. An ADSL circuit must be configured to connect two specific locations, similar to a leased line. A commonly discussed configuration of ADSL would allow a subscriber to receive data (download) at speeds of up to 1.544 Mbps, and to send (upload) data at speeds of 128 Kbps; thus the 'Asymmetric' part of the acronym. Another commonly discussed configuration would be symmetrical: 384 Kbps in both directions. In theory ADSL allows download speeds of up to 9 Mbps and upload speeds of up to 640 Kbps. An ADSL is often

discussed as an alternative to ISDN, allowing higher speeds in cases where the connection is always to the same place.

- **Synchronous Optical Network (SONET):** For higher bandwidth applications, optical carriers are used. The Synchronous Optical Network (SONET) was developed to connect long-distance carriers and to unify different standards. The data rates are defined in terms of Optical Carrier or OC levels. The first level is OC-1 with a rate of 51.84 Mbps, and the most widely used is OC-3 with a rate of 155.52 Mbps.

Data Transmission Methods

There are different network protocols and different protocols can be available even on a single layer. Specially, with lower-layer protocols, the types of transmission that are facilitated are different, whether they provide connection-oriented, or connection-less services. The different methods of data transmissions are:

1. **Asynchronous transmission:** ***This is a method that sends one character at a time.*** The transfer of data is controlled by start bits and stop bits; thus, each character is surrounded by bits that signal the beginning and the end of the character. These characters allow the receiving terminal to synchronies itself with the transmitting terminal on a character by character basis. The asynchronous transmission, the less expensive of the two methods, is often used in low speed transmission of data in conjunction with narrow band and some slower voice band channels for which the transmitting device operates manually or intermittently.
2. **Synchronous transmission:** ***In this, blocks of characters are transmitted in timed sequences.*** Rather than using start and stop bits around each character, each block of characters is marked with synchronisation characters. The receiving device accepts data until it detects a special ending character, or a predetermined number of characters, at which time the device knows the message has come to an end.

The synchronous transmission is much faster than asynchronous transmission. It commonly uses the faster voice band and broadband channels and is usually used when data transfer requirements exceed several thousand bps. The synchronous transmission is used in the direct computer to computer communications of large computer networks because of the high data transfer speeds required.

The equipment required for synchronous transmission of data is more sophisticated than that needed with asynchronous devices. The special character used by asynchronous and synchronous transmissions to alert a modem that data is being sent or that transmissions are complete is called message characters. Before data are transmitted, however, a set of traffic rules and procedures called protocol must be established. The purpose of protocol is to perform such tasks as getting the attention of another device, identifying all the devices involved in the communication, checking to see whether a message has been sent correctly, and initiating any necessary retransmission and/or error recovery. This protocol may vary depending on the devices being used, but the same protocol must be followed by all devices participating in a communication session. The prearranged signals defining the protocol are sent between computers in an exchange called handshaking.

Modes of Data Transmission

The transfer of data over communication channels occurs in three modes: simplex, half duplex, and full duplex.

1. **Simplex Mode:** ***In the simplex mode, data can be transmitted in only one direction*** (refer Figure 5.23). A device using the simplex mode of transmission can either send or receive data, but it cannot do both. This mode might be used in a radio or television transmission or burglar alarm system, because it always transmits the signals in one direction. The simplex mode has no means of feedback to ensure correct interpretation of the received signal.
2. **Half Duplex:** ***The half duplex mode allows a device to send and receive data but not at the same time.*** In other words, the transmission of data can occur in only one direction at a time (refer Figure 5.24). An example of half duplex transmission is a walky talky communication, or computer printer communication. In walky talky example, the user can talk or listen but cannot do both at the same time.
3. **Full Duplex:** The most sophisticated of these transmission modes is the ***full duplex mode, which allows a device to receive and send data simultaneously*** (refer Figure 5.25). It really consists of two simplex channels, a forward channel and a reverse channel, linking the same points. The transmission rate of the reverse channel may be slower if it is used only for flow control of the forward channel. For example, telephone systems use a full-duplex mode, which allows the user to talk and listen at the same time. The telephone systems use either the half duplex or full duplex mode.

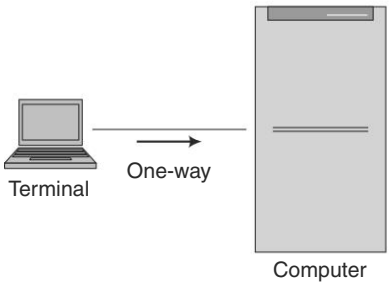

Figure 5.23 Simplex Mode

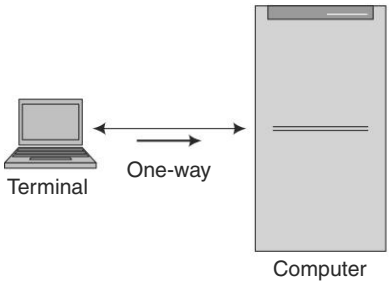

Figure 5.24 Half-duplex Mode

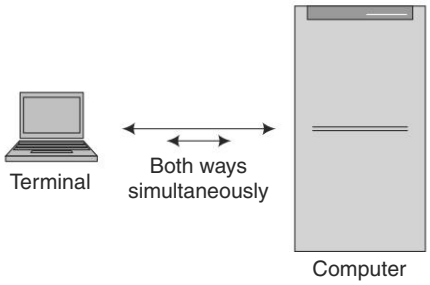

Figure 5.25 Full-duplex Mode

Data Communication Standards

With the growth in importance of data communications, number of products and solutions were introduced in the market by different vendors. Many of these products had different ways of interconnecting and used different protocols. It was becoming nearly impossible to interconnect disparate systems; even individual vendors had numerous data communication products that were incompatible with each other. In an effort to bring some standardisation in the area of data communication world, many organisations and vendors got together and began to consider standard models for connecting devices.

The basic objective of standardisation was to create easy user interface and allow the software to fulfill the technical requirements of transmitting the data effectively at the back end. The standardisation process made the communication process easy and simple, which can be handled in a plug and play manner. For example, an organisation could change its data communication hardware without changing its programs or retrain the users and the user might not even realise that there had been a change. The ability to insulate the user from the hardware changes has become increasingly important as the pace of technological improvements has continued to increase. The businesses must be able to implement the new technologies needed to stay competitive and gain a strategic edge without the associated costs of changing programs and retaining users.

Two of the first data communications models were IBM's System Network Architecture (SNA) and DEC's Network Architecture (DNA). These and other models were designed primarily to link a vendor's own hardware. In response to the numerous vendor models, the International Standards Organisation (ISO) developed the seven layered Open System Interconnect (OSI) model, hoping to standardise the entire communication industry.

OSI Model

The Protocol is a formal set of rules, conventions, and data structure that governs how computers and other network devices exchange information.

The seven layers of the OSI model describe what happens when a computer communicates with another computer. The model provides a set of standards that define a common language with which two computers can talk to each other over a network. This protocol describe how the data are to be transferred between different parts of model. The ***protocol is a communication language that computer networks use to communicate with each others.*** A brief explanation about each of the seven layers is given below. The complete seven layer OSI model is described in Figure 5.26.

1. The first layer, i.e., the **physical layer** enables the electrical connections and signaling to take place. This layer is made up of cables, such as twisted pair cables, coaxial cable, RS-232 cable, and fibre optics. All communication signals from higher levels travel through the physical layer. It is the lowest layer in the hierarchy, which helps in physical connectivity.
2. The second layer, i.e. **data link layer**, is responsible for controlling the data stream between the sending and receiving nodes. Its job is to string characters together into messages, check them for errors, and start their transmission. It also checks to see whether the message arrives at its destination, and initiates any necessary re-transmission. Many different protocols are used in this layer including High Level Data-link Control (HLDLC), bisynchronous, and Advanced Data Communications Control Procedures (ADCCP). The data-link functions for PC based communications are usually performed by special integrated circuits that reside on an interface card. In large systems these functions are performed by separate software.
3. The third layer, i.e. **network layer**, determines the physical pathway the data will take when they are communicated. This decision is based on network conditions, priorities of service, and other factors.

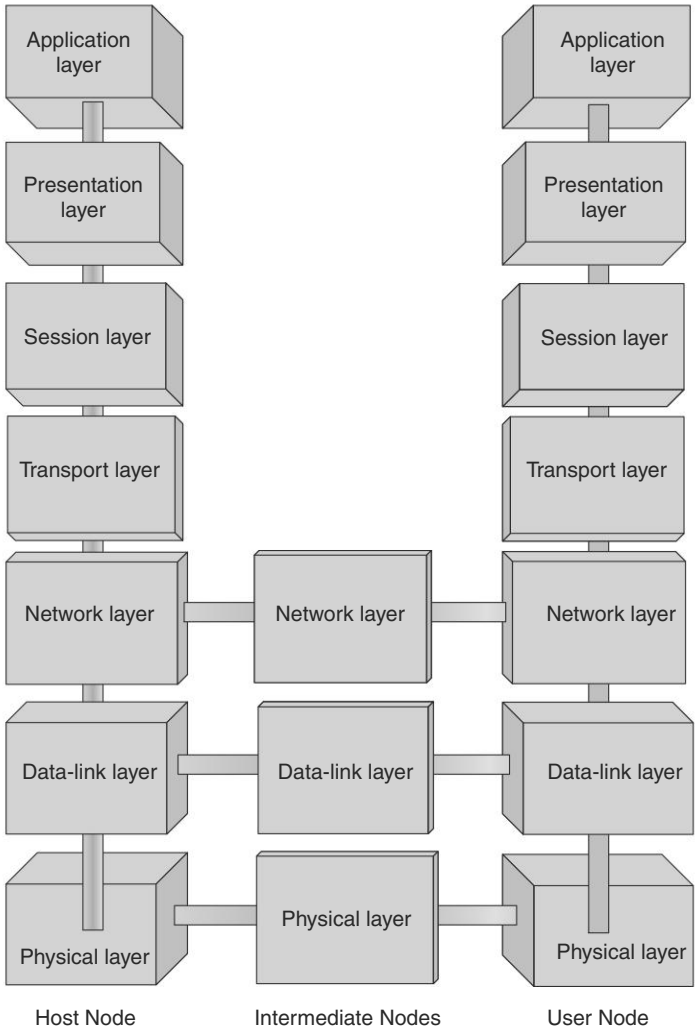

Figure 5.26 Seven-layered OSI Model for Network Communications

4. The fourth layer, i.e., **transport layer**, is used to look for alternate routes, or saving transmitted data in the event the network fails. It is also responsible for quality control of data received; data are hacked for proper order and format. A popular protocol used in the transport layer by many PC based networks is the Transmission Control Protocol (TCP).
5. The fifth layer, i.e., **session layer**, initiates, maintains, and terminates each session. It allows two applications or two pieces of the same application to communicate across the network and is responsible for such functions as logging, administration, name recognition, and security. The NetBIOS and Advance Programs-to-Programs Communication (APPC) are two commonly used session-layer software products; programs such as these reside in every network station and pass calls between application programs in the network.

6. The sixth layer is a **presentation layer**, and its function is to format data so that they can be used by the application program or communication devices. This layer controls such screen features as blinking characters, reverse video, special data entry formats, and graphics. It may also control encryption and other special file formatting. All control codes, special graphics, and character sets reside in this layer. The operation of printers, plotters, and other peripherals is also controlled by the software in this layer.
7. The seventh and the final layer is the **application layer.** The network operating system and application programs reside in this layer and are directly controlled by the user.

Each layer in this model performs a service for the layer above it and these are summarised in Figure 5.27. The bottom three layers are connected only with data transmission from one computer to the next, i.e., moving the message from one end of the network (sender) to the other end (receiver). The layers 4 through 7 allow the host computer and user computer to 'talk' to each other.

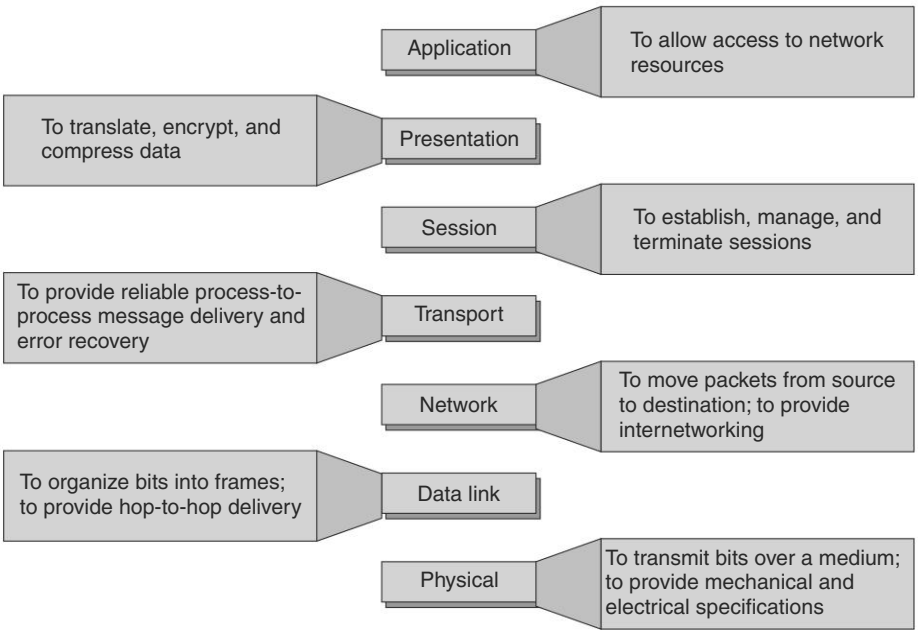

Figure 5.27 Summary of Seven-layered OSI Model

The standards were motivated by the proliferation of data communication products and by user demands to interconnect different types and brands of computer equipment and systems. The advent of standards has begun a movement in the right direction. However, the number of emerging standards can still leave a user confused.

TCP/IP Protocol

The Transmission Control Protocol/Internet Protocol (TCP/IP) is the internet protocol and is required on any computer that wants to access and communicate data on the Internet. The TCP/IP

is the default networking protocol available on all versions of Microsoft Windows operating system. The TCP/IP was created by DARPA in 1970s to solve internetworking problems. It is a five-layer model as compared to seven layers of OSI model. The first three layers in TCP/IP is same as the OSI model with physical layer, data link layer, and network layer. The fourth layer is transport layer, which is responsible for establishing end-to-end connections, translates domain names into numeric addresses and segments messages. The fifth layer is the application layer meant for managing the applications. The comparative table is given below in Figure 5.28.

<table>
<tr><th>OSI Model</th><th>Internet Model</th><th>Groups of Layers</th></tr>
<tr><td>7. Application Layer</td><td rowspan="3">5. Application Layer</td><td rowspan="3">Application Layer</td></tr>
<tr><td>6. Presentation Layer</td></tr>
<tr><td>5. Session Layer</td></tr>
<tr><td>4. Transport Layer</td><td>4. Transport Layer</td><td rowspan="2">Internetwork Layer</td></tr>
<tr><td>3. Network Layer</td><td>3. Network Layer</td></tr>
<tr><td>2. Data-link Layer</td><td>2. Data-link Layer</td><td rowspan="2">Hardware Layer</td></tr>
<tr><td>1. Physical Layer</td><td>1. Physical Layer</td></tr>
</table>

Figure 5.28 Comparative Charts Between OSI and TCP/IP Model

The **Telnet** and **FTP** (File Transfer Protocol), the two basic client application programs, are an essential part of the TCP/IP protocol suite and should be found in all implementations in some form. These programs contact server programs on remote computers to initiate remote login sessions or file transfers, respectively.

Figure 5.29 clearly explains how the user over the Internet communicates using the TCP/IP model.

NETWORK ARCHITECTURES

Broadly, there are two types of network architecture that are being implemented by most of the organisations. They are centralised and distributed.

Centralised Architecture

The ***centralised network architecture is a type of network where all users connect to a central server, through which all communications take place.*** This server would store both the communications and the user account information, data to be shared and the software programs to be shared among users. This is also called centralised server structure. This type of architecture

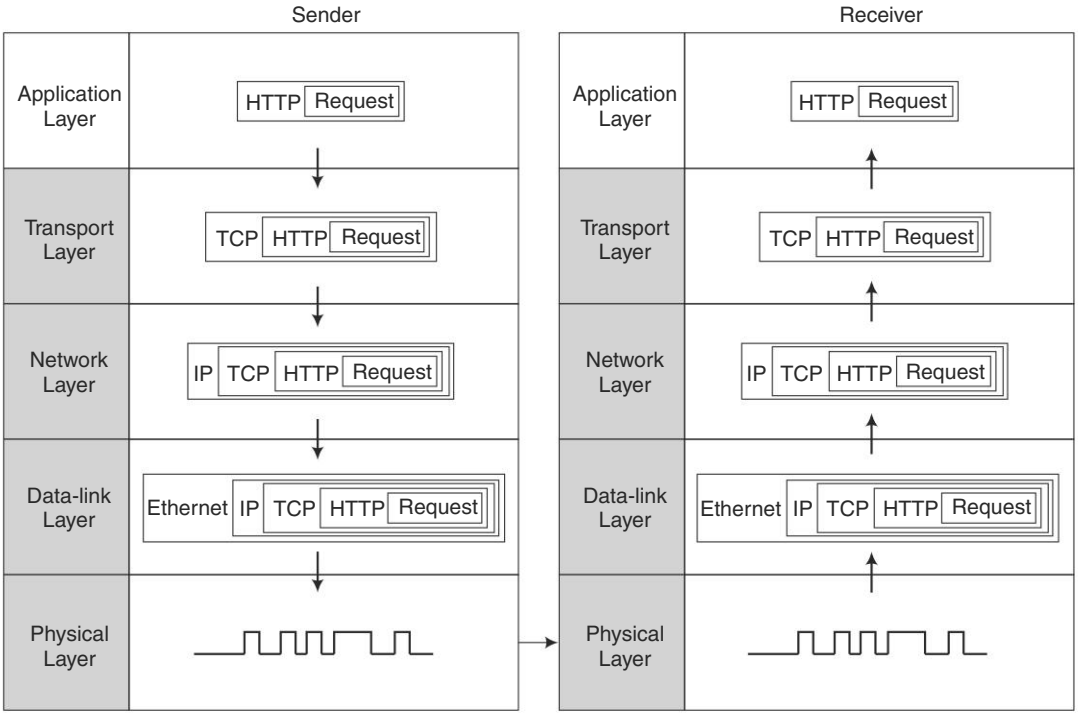

Figure 5.29 TCP/IP Message Transmission Example

is more popular in mainframes based networks. The centralised computing can include all sizes of computer processors, including a mix of computers acting in parallel. Some of the advantages include more secured networks, best fits with hierarchical type of organisations. Some of the disadvantages include high dependence on the central server, reliability of the network low, high communication cost, and data quality issues.

Distributed Architecture

The ***distributed network architecture allows the users to implement distributed data processing (DDP).*** The DDP is a concept of dispersing into areas where the computers, devices, software, and data are connected by communication channels. The computers are distributed by function and geographical boundaries and work together as a cohesive system to support user requirements. The DDP contrasts with a centralised system, where all data processing resources are in one location and may be in one computer. Typically, a centralised system has one large general purpose computer with many terminals attached to it. Even though the centralised computer can do many tasks, it may not do many of them in the most efficient or cost-effective way. A DDP system allows many smaller, more specialised computers to be tailored to complete a particular task(s) efficiently and cost effectively.

A distributed system is a collection of independent computers that appear to the users of the system as a single coherent system.

Goal of Distributed Systems

- Transparency
- Openness
- Reliability
- Performance
- Scalability

Advantages of using Distributed Systems

- Cost efficiency
- User controlled computing facilities, resulting in shorter response times
- Shared resources across locations, departments and people
- Economics
- Speed
- Inherent distribution
- Reliability
- Incremental growth

Data Centers: Cloud-centric Architecture

In this information age, organisations need to plan their data centers and networks with cloud computing as a focus.

Over the past several decades, data centers have evolved from single-point, concentrated processing centers to dynamic, highly distributed, rapidly changing, virtualised centers that provide a wide variety of services to highly distributed global user populations.

A powerful new cloud computing paradigm has emerged wherein users request and receive information and services dynamically over network from an abstract set of resources. The resources are somewhere out there in the cloud. The users don't care where or how the resources are provided; they only care that their applications, data, and content are available when needed, and at the desired levels of performance and security.

In order to optimise results, CIOs are looking to see if the lessons of the cloud can be extended to their own IT departments. With cloud computing, the network has become paramount. Everything now runs over a network, within and across systems in the data center, between data centers, and between data centers and users. Globally, the network serves as the delivery and access vehicle. Without the network, there is no cloud.

As demands for cloud computing services grow and change at an exponential pace, it becomes extremely critical for data center planners to address both current and evolving needs and to choose a flexible, dynamic cloud data center design that can effectively meet the complex challenges of the global information age.

Getting Ready

In the face of exponentially increasing complexity in compute and networking systems, it becomes critical to design data centers that reduce complexity.

Thus, we need an approach and products that greatly simplify data center design, deployment, and operation.

Simplify: The networks built on fragmented and oversubscribed tree structures have problems with scaling and consistent performance. Simplifying the data center network means minimising the number of network elements required to achieve a particular design, thus reducing both capital and operating costs. Simplifying also means streamlining data center network operations with consistently implemented software and controls, meaning fewer devices, a smaller operational footprint, reduced complexity, easier management operations, and improved application performance.

Share: The economic and agility imperatives of the cloud-ready data center require network resources to be allocated, expanded, and reallocated efficiently at scale. Sharing the data center network essentially means intelligently partitioning the infrastructure to support diverse applications and user groups, and interconnecting large pools of resources with maximum agility.

Secure: Securing the data center network extends protection to support the rich, distributed architectures that many applications currently use. This requires a robust, multi-dimensional approach that enhances and extends traditional perimeter defenses. Increasing the granularity and agility of security policies enables trusted sharing of incoming information and resident data within the data center, while complementing the functions embedded in operating systems and applications.

Automate: Automating means the ability to capture the key steps involved in performing management, operational, and application tasks, and embedding task execution in software that adds intelligence to the overall data center operation.

Conclusion

Everything now depends on network communications. And, with network complexity growing exponentially in tandem with the growth in demand for global services, distributed processing, logical systems, virtual machines, multi-tier architectures, and inter-data center communications, all placing extreme burdens on traditional networking infrastructures, a new approach to the network is essential for the introduction and success of cloud data centers.

Source: *Dataquest*, November, 2011

Disadvantages of Distributed Systems

- First, problems can occur with a DDP system if it is not managed properly. If organisational control over data-processing resources is lost, management will have difficulty in controlling costs and maintaining standards throughout the distributed areas of the organisation.
- The second problem that can arise is redundancy of resources and data. Without proper management and control, each distributed site may try to develop information systems to meet all of the site's needs, and several systems that are the same, or nearly the same, may result. This duplicity can lead to higher hardware and software costs than would exist if the distributed sites shared these resources. Uncontrolled data redundancy can lead to differences in data among the distributed sites, causing discrepancies in reports. This problem can be difficult and expensive to resolve.
- Third, if the distributed sites do not coordinate their selection of hardware and software, compatibility problems arises. The different protocols at certain distributed sites may result in the inability of that hardware to communicate with hardware at other distributed sites. Designing software to solve compatibility problems can be time consuming and costly.

- The fourth problem can occur if a site falls under the control of untrained and inexperienced users, resulting in poor selection of hardware and software, inferior programming techniques, and little, if any, documentation. This circumstance can lead to a costly and overly complex system, or, in some cases, to a system that is inappropriate for the job.
- Finally, obtaining timely support for a computer system can be difficult at some distributed sites because they are too far from the vendor's or the organisation's support staff. However, maintaining a separate support staff at each location may be too expensive for some organisations.

The DDP is not appropriate for all situations. The large, centralised computing systems are still essential in some cases. However, many applications can be completed more efficiently and cost-effectively with distributed systems. In order to ensure that DDP meets an organisation's needs, both central management and dispersed users should be integrally involved in the design of the system. Its success or failure ultimately depends on management planning, commitment, and control as well as user acceptance.

Thin Client C/S network is one where very little data processing is done on the client.

Client/Server Architecture: The Client/Server (C/S) architecture based networks are the best examples of distributed data processing models and have become very popular for enterprise computing. ***In C/S architecture, client is any PC or end user computer, which is connected using networking technologies to a server, which in turn manages the network and also the part of data processing, depending on how the C/S architecture is configured.*** The C/S architecture can be two-tier, three-tier, or n-tier depending on the size and spread of the organisation. In two-tier C/S network, presentation level processing is done at the client PC, while the other levels of processing like application and database level is done at the server level, as shown in Figure 5.30. One may also configure the two-tier C/S in such a way that the presentation and application level processing is done at client level and the database is done at server level, as per Figure 5.32. The three-tier client server architecture will have a client and two layers of servers as shown in Figure 5.31. In three-tier C/S architecture, presentation layer can run on the client, while application layer will run on the first server and the database on the second server. In three-tier network, at least two servers are used to divide the processing load and to increase the reliability of the network, as shown in Figure 5.32. As per the same logic, organisations have created n-tier client/server networks. The C/S network is also sometimes referred as Thin and Thick client/server networks. The Thin Client network is one where little data processing is done on the client, but instead data processing tasks are delegated to the supporting server. The clients' primary responsibility is merely to display data and collect input from the user for posting back to the server (presentation layer). The thick client is one where high degree of data processing is done on the client. This model can vary from no server involvement, to a fairly large amount of server processing. The idea though is that the client application is more 'intelligent' and capable to processing more data locally.

Thick Client C/S network is one where high degree of data processing is done on the client.

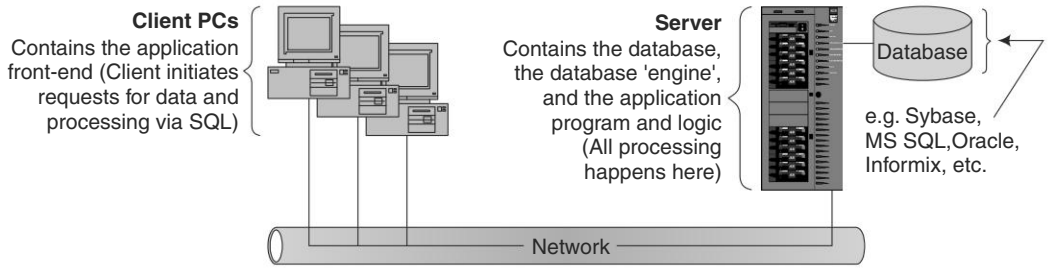

Figure 5.30 Two-tier C/S Architecture

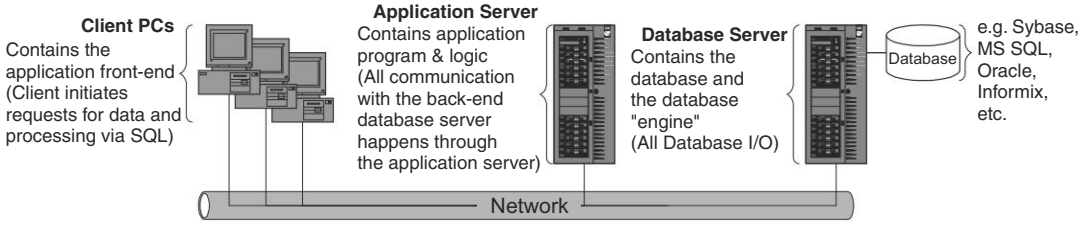

Figure 5.31 Three-tier C/S Architecture

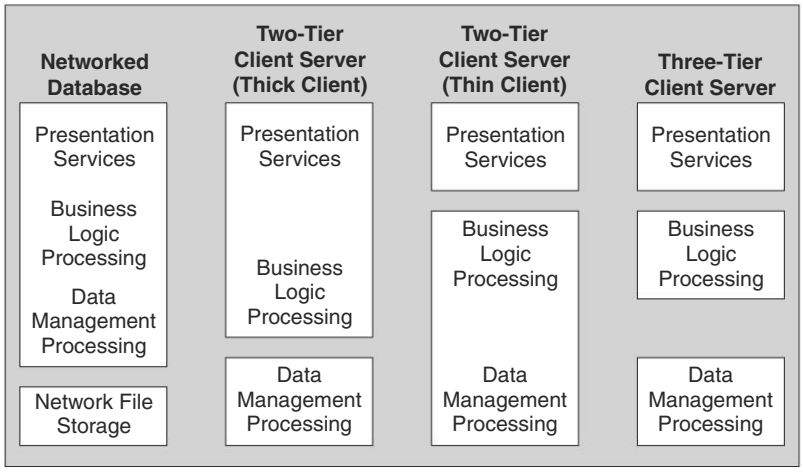

Figure 5.32 Different Types of Client/Server Networks

INTERNET, INTRANET AND EXTRANET APPLICATIONS

There is no organisation in the world which is not using some of these technologies. More and more businesses across the globe are becoming digital and online. The organisations always want to reach out to their customers, suppliers, employees, and other players in a more efficient

and effective manner. They want to remain connected to these players and want to involve them in business development. It is important for all organisations to implement these technology solutions.

Internet

The Internet is a global network using TCP/IP protocol having universal ownership.

The Internet is one of the technological revolutions of the twentieth century. The ***Internet is a universal network; it is a network of networks; it has universal ownership; it is available and accessible all the time from any part of the world.*** It has many definitions and many characteristics. What makes the Internet different from all other networks is the TCP/IP protocol, because of which one can access any hardware, any software, and any database from any part of the world without bothering about the standards. It is a public network, which means anyone can access the Internet from any where at any given time. The Internet carries various information resources and services, such as electronic mail, online chat, file transfer, file sharing, online gaming, and other resources of the World Wide Web (WWW).

The history of the Internet began with the ARPANET (or Advanced Research Projects Agency Networks) and connected mainframe computers on dedicated connections. The ARPANET was funded by the United States military after the cold war with the aim of having a military command and control centre that could withstand nuclear attack. The point was to distribute information between geographically dispersed computers. It used Network Control Program as its protocol. The second stage involved adding desktop PCs which connected through telephone wires. The third stage was adding wireless connections to laptop computers. Currently, the Internet is evolving to allow mobile phone Internet connectivity ubiquitously using cellular networks. In 1983, TCP/IP protocol was developed, which quickly became the most widely used network protocol in the world.

Prior to the widespread internetworking that led to the Internet, most communication networks were limited by their nature to only allow communications between the stations on the network, and the prevalent computer networking method was based on the central mainframe computer model. Several research programs began to explore and articulate principles of networking between separate physical networks. This led to the development of the packet switching model of digital networking.

The Internet has changed much in the two decades since it came into existence. It was conceived in the era of time sharing, but has survived into the era of personal computers, client server and peer-to-peer computing, and the network computer. It was designed before LANs existed, but has accommodated that new network technology, as well as the more recent ATM and frame switched services. It was envisioned as supporting a range of functions from file sharing and remote login to resource sharing and collaboration, and has spawned electronic mail, and more recently the World Wide Web. But most importantly, it started as the creation of a small band of dedicated researchers, and has grown to be a commercial success with billions of dollars of annual investment.

One should not conclude that the Internet has now finished changing. The Internet, although a network in name and geography, is a creature of the computer, not the traditional network of the telephone or television industry. It will, indeed it must, continue to change and evolve at the speed of the computer industry if it is to remain relevant. It is now changing to provide such new services as real time transport, in order to support, for example, audio and video streams. The availability of pervasive networking (i.e., the Internet) along with powerful affordable computing and communications in portable form is making possible a new paradigm of nomadic computing and communications.

This evolution will bring us new applications—Internet telephone and, slightly further out, Internet television. It is evolving to permit more sophisticated forms of pricing and cost recovery, perhaps a painful requirement in this commercial world. It is changing to accommodate yet another generation of underlying network technologies with different characteristics and requirements, from broadband residential access to satellites. The new modes of access and new forms of service will spawn new applications, which in turn will drive further evolution of the net itself.

Following commercialisation and introduction of privately run Internet Service Providers in the 1980s, and its expansion into popular use in the 1990s, the Internet has had a drastic impact on culture and commerce. This includes the rise of near instant communication by e-mail, text based discussion forums, and the World Wide Web. The investor's speculation in new markets provided by these innovations would also lead to the inflation and collapse of the Dot-com bubble, a major market collapse. But despite this, the Internet continues to grow.

History of Internet

History of Internet starting from 1957 to 2009 is given in the companion website *www.mhhe.com/behl2e*

Common Applications of Internet

1. **World Wide Web (WWW):** Internet and World Wide Web are the two terms that are being used interchangeably, but the two terms are different. The World Wide Web is a set of interlinked documents, images, and other resources, linked by hyperlinks and URLs. These hyperlinks and URLs allow the users to search these documents using the Hyper Transfer Protocol (HTTP).
2. **Remote Access:** The Internet allows its users to connect to other computers located in a remote location in any part of the world. This introduces a concept of virtual organisation, allows the users to work from home, or while they are on the move. This also helps in introducing the concept of collaborative work groups.
3. **File Sharing:** A utility that allows the user to share any kind of computer document over the network. It can be uploaded to a website, or File Transfer Protocol (FTP) server for easy download by others. It can be put into a 'shared location', or onto a file server for instant use by colleagues. The access to the file may be controlled by user authentication.
4. **Media Streaming:** The streaming media allow the user to do audio/video streaming over the network. One can do the live, or real-time streaming, or may do the delayed streaming. The Webcasting and Podcasting are two variations of media streaming.

5. **Online Media:** Interactivity is one of the most important characteristics of online news. The online news has allowed traditional one-way broadcasting to give way to two-way, or multi-way communication. The online news has resulted in the combination of several types of media. This means it is even more expressive and infective.
6. **Information Search:** The search engines are basic applications that allow users to acquire the information they demand online. The usage of search engines shows wide variation in relation to the age, education, and income of users as well as whether the users live in urban or rural areas.
7. **Online Communications:** The online communication like Email, Chat, Instant Messaging are growing. These allow sending and receiving electronic messages between users. The Internet e-mail provides global connectivity as compared to internal mails. It is the cheapest and efficient mode of communication.
8. **Online Communities:** The Internet is a medium for social networking and online community. The websites like Facebook, MySpace, Linkedin etc. are having maximum hits and Internet users are spending maximum time on these sites.
9. **Online Entertainment:** The online entertainment like online gaming, online music, and video are becoming part of our life styles.
10. **E-business:** The E-business is an application that is increasing. Except for online shopping, online sales and travel bookings have already established a beginning user base. Online payment systems, which are closely related to online shopping, have been developing extremely fast.
11. **Online Finance:** The online finance like Online Banking and Trading is spreading across users.
12. **Online Education:** The leading institutions worldwide are using this medium to impart education and training. It is a medium that has started complementing the traditional learning medium.

Social Networking, LinkedIn, Facebook, Twitter, Total Customer Value

The need to adapt to innovative marketing strategies is becoming more prominent with the social networking sites now gaining greater momentum. The social networking activities consume approximately twice as much as our online time, as compared to any other activity. According to a recent report by Nielsen, sites like Facebook and Twitter now account for 22.7% of the time spent on the web; the next closest activity is online games, which makes up 10.2%.

The report also further highlights the astonishing degree by which social networking is displacing other forms of communication, with email as a percentage of online time plunging from 11.5% to 8.3% from June, 2009 to June, 2010. This in itself reflects how social media is bringing a company closer to its customers, and more so even influence consumer decisions.

In the future, social networks are expected to become more powerful than the corporate websites and CRM systems, as individual identities and relationships will be built on this platform. The brands serve community interests and grow on the basis of community advocacy, as users continue to drive innovation in this direction. The social media networking is about interactions that offer a feedback for Indian users regarding business aspects.

Moving a step further from being a mere platform for interaction, social media networking enables Internet users to find jobs, gain knowledge, find partners for business purposes, etc. It is also worthwhile to mention that the average time spent on social networking sites is approximately 5.5 hours.

Internet Revolution

The Internet has evolved in three waves. The first being portals, which witnessed the use of email for communication, but this phase reflects presence of very little content on the portals. In the second phase, it was dominated by search engines like Google, for the collection of information. Meanwhile, in late 2003, the concept of social media started gaining prominence, where people were ready to talk and give feedback to unknown people they came across over the Internet. This phase can be called as that of the walled garden. The social networking is broadly classified into an activity of sharing photos, status updates, etc, while professional networking relates to building relations for taking the business aspects a step further. The presence of more than 80 mn people on LinkedIn and 7 mn professionals in India alone, speaks volumes about the relevance of this medium. In other words, it can be concluded that one professional is added every second, says Hari Krishnan, country manager, India, LinkedIn.

The younger generations that are growing up with social networking, will certainly lead the way for its adoption and incorporation for business purposes. This is likely to establish new boundaries in the perspective of managing a business and raking in moolah. The social media can help in brand building, customer engagement, offer tangible results, etc.

The Orkut is not exciting but LinkedIn is the most frequently visited site, which has managed to hook maximum number of Internet users. The Facebook is another success story, which has managed to attract more than 700 mn people, even more than the population of the US. But the bigger question is how do you connect social media with your business?

Capitalising On

Apart from the facilities offered on the social networking community, there are certain challenges that can be faced when it is used for the business purposes. There always exists a fear of being blasted on a social media network. The case of the GAP logo change is a great study to highlight this case. There were more than 1,000 posts on the Facebook page lambasting the new logo. Owing to an irritated fan following and bad response received for the change, it led to the decision from the company to go back to the original logo. This is the typical case where social media proved to be a savior for the company by saving them costs related to implementation of a new logo, and the following negative response. This move by the company is important as consumers build an emotional bond with the company, which cannot be disconnected.

The key to an effective use of the social media is identifying the business objectives, which would enable brand building and generation of sales. In order to chalk out effective business objectives, it is important to first highlight the correct objectives. It is always important to set out the correct objectives as the objectives change, the model to adopt to leverage it also differs. The marketing in the social space can also be driven by ensuring the fact that the site attracts more followers, fans, check-ins, etc. In other words, this will result in an increase in the return on investment that word of mouth can offer (which is tremendous). Apart from ensuring that the business brings in good profits, it is equally important to nurture high Total Customer Value (TCV), appraise customers on the basis of TCV, impact the right influencers to maximize spread and profitability, subject to the marketing budgets.

The online media is still an afterthought in the media plan. The Internet advertising spending is increasing, but still does not match the media consumption patterns. The social media can help brand

advertisers from online space to offline space. The mixing of online and offline advertising gives a perfect taste to the campaign.

Another measure that is of importance in the scenario of social media is the monitoring and measuring of the same. This measure can be brought into effect by adopting the art of listening to what people have to say. The social media offers a big advantage as it enables a business to reach out directly to its customers. Apart from increasing the reach of your business, it helps to bring in recommendations for your offerings thus giving you a first hand information. This could help you to decide on its improvement strategy.

In order to make social media effective for a business model, it is important to first listen to the information doled out by the consumers. Secondly, to loosen up a little, thus inviting employee feedback and ensuring that the marketing team takes a backseat. The last and the final stage is for the employees to immerse themselves in social media. In the future, social media will be a hot bed for research.

Source: *Dataquest*, November, 2010

Intranet

The Intranet is a corporate internet meant for defined user of an organisation. It is a private network created for the community of the organisation, which allowed them to access organisation data and databases using the browser from anywhere at any time. An intranet is a private computer network that uses Internet technologies to securely share any part of an organisation's information, or operational systems with its employees/users. Sometimes the term refers only to the organisation's internal website, but often it is a more extensive part of the organisation's computer infrastructure. The private websites are an important component and focal point of internal communication and collaboration. The intranet can be LAN based or WAN based, depending on how big is the organisation network.

An intranet is a private computer network that uses Internet technologies. It is private Internet.

An intranet is built from the same concepts and technologies as used for the Internet, such as client-server computing and the Internet Protocol Suite (TCP/IP). Any of the well known Internet protocols may be found in an intranet, such as HTTP (web services), SMTP (e-mail), and FTP (file transfer). The Internet technologies are often deployed to provide modern interfaces to legacy information systems hosting corporate data. Some of the characteristics that the intranet provide to organisations is as follows:

1. The Intranets allow its users to share the data and workspace, which help users to locate and view information faster as per the authorisation levels. It also helps to improve the services provided to the users.
2. The Intranets serve as powerful communication tool within an organisation, among its users across levels, across locations, and across projects.
3. The Intranet helps in electronic communication, for example it allows implementing electronic mode of communication as compared to traditional paper based communication. The web based communication is more effective in terms of cost, effectiveness and, efficiency as compared to older systems.
4. The Intranets are also being used as a platform for developing and deploying applications to support business operations, and decisions across the Internet worked enterprise.

5. It also helps in maintaining the transparent communication culture by sharing the same information within the intranet.
6. With information easily accessible by all authorised users, teamwork is enabled.
7. It helps in integrating wide variety of hardware, software, applications across the organisation network.
8. For productivity the Intranet technology provides fast information to employees and helps to perform their various tasks with responsibility.
9. An important benefit of Intranet is that it is cost-effective, thus it helps to reduce costs significantly.
10. While incorporated and distributed for computing environment, Intranet supports an active distribution of stored information through different types of operating systems and computer types, from which the employees can access information.
11. The Intranet results in distributing information at a lower cost due to the web architecture feature of intranet. As Intranet allows all employees to access data, this helps build team work within the organisation and thus create a platform for collaboration.
12. The Intranet helps in sharing human resource policies and procedures.
13. It acts as a corporate information repository provides employees access to the company strategy and key business objectives.
14. It remains a powerful tool for knowledge exchange, or facilitation – an area where employees can post questions and seek answers.

Extranet

The Extranet is an extended intranet. It is a private-private network between the defined users of two or more organisations. The Extranet allows interconnecting two or more intranets using Internet technologies. An extranet is a private network that uses Internet protocols, network connectivity, and possibly the public telecommunication system to securely share part of an organisation's information, or operations with suppliers, vendors, partners, customers, or other businesses. An extranet can be viewed as part of a company's intranet that is extended to users outside the company, normally over the Internet. The concept became popular when organisations started building long-term relationship with its business partners. It has also been described as a 'state of mind' in which the Internet is perceived as a way to do business with a pre-approved set of other companies business-to-business (B2B), in isolation from all other Internet users. In contrast, business-to-consumer (B2C) involves known server(s) of one or more companies, communicating with previously unknown consumer users.

The Extranet is an extended Intranet between businesses and its business partners.

Briefly, an extranet can be understood as an intranet mapped onto the public The Internet or some other transmission system not accessible to the general public, but managed by more than one company's administrator(s). Some of the characteristics of extranet are as follows:

1. It allows exchange of large volumes of data between business partners.
2. It allows organisations to collaborate for joint business development.

3. It offers specially negotiated services for the employees from different service providers like insurance, loans, etc.
4. It shares industry news and events with industry users.
5. It can be expensive to implement and maintain within an organisation.
6. The security of extranets can be a concern.

Why use an Extranet?

- The businesses of all sizes are under increasing pressure to use online ordering, electronic order tracking, and inventory management.
- At the same time small businesses are keen to meet the demands of larger companies in terms of working flexibly, adopting new technologies, and enabling the exchange of business information and transactions.
- The extranets offer a cheap and efficient way for businesses to connect with their trading partners.
- The ability of the extranet to automate the trading tasks between trading partners can lead to enhance business relationships and help to integrate one's business firmly within their supply chain.
- The extranet improves business relationships with business partners, and key clients by providing a single point of contact.
- It secure sharing of business information such as product development, or investment opportunities with business partners.
- It also streamlines business administration processes such as order tracking and inventory management.

VIRTUALISATION

The rising competition among infrastructure vendors is expected to result in market disruption, and consolidation with the technology undergoing a sea change. For any CIO, centralising administrative tasks and improving the scalability, and work loads has always remained a challenge, be it a large enterprise, or an SMB. The virtualisation as a disruptive technology has been able to address this issue. The virtualisation can be viewed as part of an overall trend in enterprise IT that includes autonomic computing, a scenario in which the IT environment will be able to manage itself based on perceived activity, and utility computing, in which computer processing power is seen as a utility that clients can pay for only as needed. The usual goal of virtualisation is to centralise administrative tasks while improving scalability and work loads. The virtualisation is the creation of a virtual version of something, such as an operating system, a server, a storage device or network resources.

Virtualisation is a technique for hiding the physical characteristics of computing resources from the way in which other systems, applications, or end users interact with those resources. This includes making a single physical

In computing, virtualisation is a broad term that refers to the abstraction of computer resources.

resource (such as a server, an operating system, an application, or storage device) appear to function as multiple logical resources; or it can include making multiple physical resources (such as storage devices or servers) appear as a single logical resource. The virtualisation is a framework or methodology of dividing the resources of a computer into multiple execution environments, by applying one or more concepts or technologies such as hardware and software partitioning, time-sharing, partial, or complete machine simulation, emulation, quality of service, and many others. The grid computing enables the 'virtualisation' of distributed computing.

Why Virtualisation?

- Too many servers for too little work
- Aging hardware reaching end of usable life
- High infrastructure requirements
- Limited flexibility in shared environments
- Low utilisation metrics in servers across the organisation
- High costs and infrastructure needs
- Heterogeneous environments

Benefits of Virtualisation

1. The virtual machines can be used to consolidate the workloads of several under-utilised servers to fewer machines, perhaps a single machine.
2. Virtual machines can be used to create operating systems, or execution environments with resource limits, and given the right schedulers, resource guarantees.
3. The virtual machines can be used to run multiple operating systems simultaneously: different versions, or even entirely different systems, which can be on hot standby.
4. Virtual machines make software easier to migrate, thus aiding application and system mobility.
5. The virtual machines can be used to create arbitrary test scenarios, and can lead to some very imaginative, effective quality assurance.
6. The virtual machines are great tools for research and academic experiments. Since they provide isolation, they are safer to work with. They encapsulate the entire state of a running system: you can save the state, examine it, modify it, reload it, and so on.
7. The virtualisation can enable existing operating systems to run on shared memory multiprocessors.
8. The virtualisation can also be used to simulate networks of independent computers.
9. The virtualisation can make tasks such as system migration, backup, and recovery easier and more manageable.
10. The virtualisation can be an effective means of providing binary compatibility.

Virtualisation: Ensuring Smooth Expansion

With the identification of challenges associated with technological upgradation, the deployment of virtual solution solved all the worries of Max New York Life Insurance

Max New York Life is a joint venture between Max India and New York Life International, the international arm of New York Life. After 7 successful years of operation, Max New York Life Insurance Company in 2008 made a strategic decision of countrywide expansion by opening various branches to penetrate deep into the Indian market. This business goal called for consolidated support from different departments and out of which upgradation of the organisations technological architecture turned out to be the biggest need. So many technology solutions and applications were adopted to cater to the need of the organisation, which made the organisation review in 2 years that its operational and maintenance cost are very high with the deployment of any new application.

In order to scale up the IT infrastructure and to serve the growing business need, MNYL assessed the increased need of servers, which implied increased budget on a regular basis. Further, arose the issue of convincing the management who questioned the sub-optimal usage of existing technology infrastructure. Later with the increasing volume of business, it became increasingly difficult to monitor any system crash or predict any unexpected breakdown. Two another major challenges surfaced when any new application was installed, it led to temporary halt of work and hence loss of business and due to decentralised applications system was at constant risk of breakdown owing to any application failure.

After the close evaluation, MNYLs IT management partnered with IBM for its IBM WebSphere Virtual Enterprise, a virtual solution to address the challenges posed by upgradation of IT infrastructure. The key features of this virtual solution helped the migration from decentralised to a centralised architecture. Therefore virtual architecture based run-time dashboards provides instant notifications to the system administrators to monitor whole IT infrastructure in one go and unified consoles enabled streamlining of the administration activities. The On-Demand Router (ODR) cluster was one of the major highlights of the intelligent routing rules, which aided in managing the entire organisations traffic efficiently.

Not only was the problem of risk of system breakdown posed due to any application failure got addressed as now all applications were independent of each other, but also the system was enabled with an autonomic computing feature, which can detect and connect application server problems efficiently.

The implementation partners for this virtual solution were IBM and Wipro Infotech. The virtualisation helped the organisation in expanding the MNYLs network to 135 cities and 215 branches. This virtual architecture enabled unified communication and bought down the IT spends in training and delivery and many overheads. MNYL successfully reduced approximately 110 servers and thereby storage cost also reduced.

Source: *Dataquest*, November, 2011

Broad Categories of Virtualisation

1. **Platform Virtualisation:** The simulation of whole computers.
   - Platform virtualisation is performed on a given hardware platform by host software (a control program), which creates a simulated computer environment, a *virtual machine*, for its guest software (refer Figure 5.33).

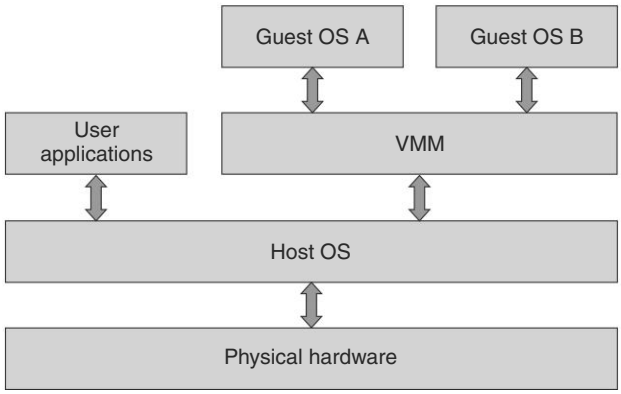

Figure 5.33 Virtual Machine Monitor

- The guest software, which is often itself a complete operating system, runs just as if it were installed on a stand-alone hardware platform.
- Typically, many such virtual machines are simulated on a single physical machine, their number limited only by the host's hardware resources.
- There is no requirement for a guest OS to be the same as the host OS.
- The guest system often requires access to specific peripheral devices to function, so the simulation must support the guest's interfaces to those devices. For example, Hard disk drive, CD/DVD drive etc.
- Implementing platform virtualisation includes:

  (a) **Application virtualisation:** It is the using of a software virtualisation layer to encapsulate a desktop, or server application from the local operating system. The application still executes locally using local resources.

  (b) **Emulation or simulation:** It is the virtual machine, which simulates the complete hardware, allowing an unmodified 'guest' OS for a completely different CPU to be run. It can be very slow!

  (c) **Native virtualisation:** It is the virtual machine, which simulates enough hardware to allow an unmodified 'guest' OS (one designed for the same CPU) to be run in isolation.

  (d) **Hardware enabled virtualisation:** It is the hardware, which provides architectural support that facilitates building a virtual machine monitor and allows guest OS to be run in isolation.

2. **Resource Virtualisation:** The simulation of combined, fragmented, or simplified resources.

   The types of resource virtualisation are:

   - Computer clusters, grid computing, and virtual servers use the above techniques to combine multiple discrete computers into larger meta-computers.

- Partitioning or splitting of a single resource (usually large), such as disk space or network bandwidth, into a number of smaller, more easily utilised resources of the same type. This is sometimes also called 'zoning,' especially in storage networks.
- Resource aggregation, spanning, or concatenation combines individual components into larger resources or resource pools.

Types of Virtualisation

1. **Hardware Virtualisation:** This is the most common and is used in IT departments in a company as well as in the data centers. The server's hardware is virtualised thus allowing being able to run different OS and different applications simultaneously on the same hardware. This allows implementing server consolidation. And the benefits are obvious:
   (a) Less number of servers required for the same number of applications.
   (b) Less power consumption.
   (c) Less maintenance overhead.
   (d) More resource utilisation.
   (e) Easier and faster to add more capacity.
   (f) Disaster Recovery Planning becomes easier.
2. **Desktop Virtualisation:** The virtual desktop infrastructure means storing of end user's computer's data into a virtual machine in a hosted environment, which could be hosted either by the company's IT in-house or hosted in a data center. Some of the benefits are:
   (a) Easier upgrades and patch management.
   (b) IT Desktop support process becomes much easier.
   (c) Scalable solution
   (d) Better resource utilisation and less power consumption.
   (e) Easier recovery management.
3. **Storage Virtualisation:** The storage virtualisation is the pooling of physical storage from multiple network storage devices into what appears to be a single storage device that is managed from a central console. The storage virtualisation is commonly used in storage area networks (SANs).
4. **Network Virtualisation:** This is a method of combining the available resources in a network by splitting up the available bandwidth into channels, each of which is independent from the others, and each of which can be assigned to a particular server or device in real time. The idea is that virtualisation disguises the true complexity of the network by separating it into manageable parts; much like your partitioned hard drive makes it easier to manage your files.
5. **Server Virtualisation:** This is the masking of server resources from server users. The intention is to spare the user from having to understand and manage complicated details of server resources while increasing resource sharing and utilisation and maintaining the capacity to expand later.

6. **Operating System Virtualisation:** This is the use of software to allow a piece of hardware to run multiple operating system images at the same time. The technology got its start on mainframes decades ago, allowing administrators to avoid wasting expensive processing power.

CLOUD COMPUTING

The cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks, to provide dynamically scalable infrastructure for application, data and file storage. With the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly.

The cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data center from a capital-intensive set up to a variable priced environment.

The idea of cloud computing is based on a very fundamental principal of "reusability of IT capabilities". The difference that cloud computing brings compared to traditional concepts of "grid computing", "distributed computing", "utility computing", or "autonomic computing" is to broaden horizons across organisational boundaries.

What is Cloud Computing?

The cloud computing is a service based delivery model for IT based on Internet protocols.

The cloud computing is a comprehensive solution that delivers IT as a service. It is an Internet-based computing solution where shared resources are provided like electricity distributed on the electrical grid. The computers in the cloud are configured to work together and the various applications use the collective computing power as if they are running on a single system. It extends the concept of virtualisation to "on demand" solutions.

The flexibility of cloud computing is a function of the allocation of resources on demand. This facilitates the use of the system's cumulative resources, negating the need to assign specific hardware to a task. With the advent of cloud computing, resources are used as aggregated virtual networks.

The cloud computing refers to applications and services offered over the Internet. These services are offered from data centers all over the world, which collectively are referred to as the "cloud."

Benefits of a Cloud

1. **Reduced cost:** The cloud computing can reduce both capital expense and operating expense costs because resources are only acquired when needed and are only paid for when used.
2. **Refined usage of personnel:** The using of cloud computing frees valuable personnel allowing them to focus on delivering value rather than maintaining hardware and software.

3. **Robust scalability:** The cloud computing also allows for immediate scaling, either up or down, at any time without long-term commitment.
4. **Increased satorage:** With the massive infrastructure that is offered by cloud providers today, storage & maintenance of large volumes of data is a reality. The sudden workload spikes are also managed effectively & efficiently, since the cloud can scale dynamically.
5. **Flexibility:** This is an extremely important characteristic. With enterprises having to adapt, even more rapidly, to changing business conditions, speed to deliver is critical. The cloud computing stresses on getting applications to market very quickly, by using the most appropriate building blocks necessary for deployment.

Cloud Computing Models

The cloud providers offer services that can be grouped into three categories.

1. **Software as a Service (SaaS):** In this model, a complete application is offered to the customer, as a service on demand. A single instance of the service runs on the cloud and multiple end users are serviced. On the customers side, there is no need for upfront investment in servers or software licenses, while for the provider, the costs are lowered, since only a single application needs to be hosted and maintained.
2. **Platform as a Service (PaaS):** Here, a layer of software, or development environment is encapsulated and offered as a service, upon which other higher levels of service can be built. The customer has the freedom to build his own applications, which run on the provider's infrastructure. In order to meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers.
3. **Infrastructure as a Service (IaaS):** The IaaS provides basic storage and computing capabilities as standardised services over the network. The servers, storage systems, networking equipment, data centre space etc. are pooled and made available to handle workloads. The customer would typically deploy his/her own software on the infrastructure.

Cloud Computing: A Magic Wand to Enhance Efficiency of the IT Department

Caught between shrinking resources and growing business needs, organisations in India and Asia Pacific have dwelt upon cloud computing to provide a more efficient, flexible, and cost effective model for computing, reveals a new study on cloud computing trends and challenges by Springboard Research. The cloud computing, if the study is to be believed, has been a focal point for enterprises in the last few months because of its capability to maximise RoI with limited IT resources. The organisations developed affinity to cloud computing during the recession when CIOs were under pressure to keep IT costs down and that too, without affecting the workflow.

The number of organisations viewing cloud computing relevant for their business have doubled (83%) over the last 18 months. Out of 6,953 respondents interviewed across the Asia Pacific region including India, 59% admitted to either using or planning to use cloud computing initiatives in their organisations. India had 693 respondents from various sectors, out of which 27% admitted to currently leveraging cloud

computing for their business processes whereas 43% are actively planning cloud initiatives. If the survey findings are to be believed, it is a significant trend for the future.

Enhanced Understanding of Cloud

The adoption and understanding go hand-in-hand. If one doesn't understand a technology, one will not adopt it. So, was the case with cloud computing, which was hardly understood and hardly adopted earlier. But, the study shows that there has been a significant rise in organisations that understand what cloud computing is. It underlines the fact that cloud computing is no more a confusing subject to organisations across the Asia Pacific. Many organisations have embarked on the cloud computing bandwagon in the last few months, given their indepth understanding of the technology and its benefits. With Japan and Australia heading, India features in the top 3 countries that have a good understanding about cloud computing. Thus, awareness about what cloud computing can do to their business has spurred the adoption. According to the survey, sectors that understand cloud better include insurance, telecom, and IT/ITeS. It is their understanding of the cloud that has led them to adopt it faster for their business. The confusion about what cloud computing is has significantly come down. The CIOs understand what cloud computing means to their business and what it can do for their business. In the Asia Pacific, India ranks 2nd with about 91% respondents agreeing that they understand cloud computing and its relevance. Japan tops the list with a margin of 1% that is 92%, according to Springboard Research India. Overall 83% organisations in the Asia Pacific know what cloud computing is.

The study shows that different markets look at cloud for different requirements. The highest proportion of organisations in Japan (86%), Singapore (84%), and Thailand (74%) associate cloud computing primarily with IT-as-a-service; while in Australia, Malaysia, and India, most firms (80%, 78%, and 75%, respectively) associate cloud mainly with applications-on-demand. In China, 80% of respondents look towards cloud for on-demand provision of storage and network.

Primary Drivers for Cloud Computing

Keeping costs down is the main purpose for enterprises when it comes to adopting cloud computing in their organisations. The study surfaces the fact that saving cost is the immediate incentive for adopting cloud computing for 57% of Asia Pacific firms. Only 39%, many of which are large firms with more than 10,000 employees, adopted or plan to adopt cloud as a long term strategic investment.

The survey reveals that in India, dynamic provisioning/capacity on demand, automated management, pay-per-use model, and applications that can scale on demand are considered essential building blocks for cloud computing. Driving IT costs down is the top priority for CIOs in India. They mainly look at reduced hardware infrastructure costs and scalability to meet business needs while considering cloud computing in India.

Hybrid Clouds on the Centerstage

The survey underlines the emergence of a trend called hybrid cloud, where a company chooses to adopt a mix of private as well as public cloud. In the survey, 38% companies in the Asia Pacific expressed their wish to deploy both public and private clouds, while a roughly equal amount, 37% preferred to consider only a private cloud. In India alone, 41% companies preferred to use a hybrid cloud and split workload between public and private clouds. The banking and government sectors prefer to use private cloud more. Even India is moving towards public cloud, but it would be a mix of both.

In terms of deployment plans for hybrid clouds, 93% of respondents say their upcoming cloud deployments would involve around areas such as web conferencing, instant messaging, collaboration, and emails.

Integration and Security Challenges

The security and integration issues still perturb organisations, according to the survey. While leveraging a cloud based offering, organisations want to see if the solution can be integrated with their existing IT setup. As many as 46% respondents still consider security and integration of cloud technologies with existing systems as the main obstruction. The integration with existing systems and traditional security concerns are still challenges that solution providers need to address while offering cloud.

Virtualisation Steers Cloud Adoption

In what has contributed most to the growth of cloud computing is the widespread awareness about virtualisation and its potential. The virtualisation is an essential part of cloud offering that helps organisations to fully utilize their hardware. The virtualisation lets organisations decouple critical business applications and information from underlying physical hardware, and in turn, provides a fast and cost effective way to the cloud. More and more Asia Pacific organisations are realising this and are moving to unlock more value from their virtualisation investments. The awareness about virtualisation is widespread in India, with 94% of respondents either leveraging or planning to adopt virtualisation technology.

According to the survey, most Asia Pacific firms use virtualisation for servers and data centers, with many organisations focused on leveraging virtualisation to drive business continuity/disaster recovery initiatives. The reports see the biggest growth opportunity for virtualisation in Asia Pacific in the end user computing space, although most organisations rank desktop virtualisation low in their list of priorities. It says that significant advantages can be gained from a new approach towards end user computing that virtualises the desktop by de-coupling operating system, user persona, and applications. Thereby, this will enable a greater flexibility in delivering applications and data to end users anytime and anywhere regardless of the access device. In India, there is more focus on desktop virtualisation at 68% as compared to China and Japan.

The cloud computing is a change agent rather than just an enabler. It is expected to help organisations at large with limited IT capabilities; thereby, maximising RoI of technology.

Source: *Dataquest*, December, 2010

Types of Clouds

The enterprises can choose to deploy applications on Public, Private or Hybrid clouds. The cloud integrators can play a vital role in determining the right cloud path for each organisation.

1. **Public Cloud:** The public clouds are owned and operated by third parties; they deliver superior economies of scale to customers, as the infrastructure costs are spread among a mix of users, giving each individual client an attractive low-cost, 'Pay-per-use' model. All customers share the same infrastructure pool with limited configuration, security protections, and availability variances. These are managed and supported by the cloud provider. One of the advantages of a public cloud is that they may be larger than an enterprises cloud, thus providing the ability to scale seamlessly, on demand.

2. **Private Cloud:** The private clouds are built exclusively for a single enterprise. They aim at addressing concerns on data security and offer greater control, which is typically lacking in a public cloud. There are two variations to a private cloud:
   - **On-premise private cloud:** The on-premise private clouds, also known as internal clouds are hosted within organisations own data center. This model provides a more standardised process and protection, but is limited in aspects of size and scalability. The IT departments would also need to incur the capital and operational costs for the physical resources. This is best suited for applications which require complete control and configurability of the infrastructure and security.
   - **Externally hosted private cloud:** This type of private cloud is hosted externally with a cloud provider, where the provider facilitates an exclusive cloud environment with full guarantee of privacy. This is best suited for enterprises that don't prefer a public cloud due to sharing of physical resources.
3. **Hybrid Cloud:** The hybrid cloud is a combination of both public and private cloud models. With a hybrid cloud, service providers can utilise 3rd party cloud providers in a full or partial manner thus increasing the flexibility of computing. The hybrid cloud environment is capable of providing on-demand, externally provisioned scale. The ability to augment a private cloud with the resources of a public cloud can be used to manage any unexpected surges in workload.

Cloud Computing Challenges

Despite its growing influence, concerns regarding cloud computing still remain. In our opinion, the benefits outweigh the drawbacks and the model is worth exploring. Some common challenges are:

1. **Data Protection:** The Data Security is a crucial element that warrants scrutiny. The organisations fear losing data to competition and the data confidentiality of consumers. In many instances, the actual storage location is not disclosed, adding onto the security concerns of organisations. In the existing models, firewalls across data centers protect this sensitive information. In the cloud model, service providers are responsible for maintaining data security and enterprises would have to rely on them.
2. **Data Recovery and Availability:** All business applications have service level agreements that are stringently followed. The operational teams play a key role in management of service level agreements and runtime governance of applications. In production environments, operational teams support
   - Appropriate clustering and fail over
   - Data replication
   - System monitoring maintenance (Runtime Governance)
   - Disaster recovery
   - Capacity and performance management

   If, any of the above mentioned services is under-served by a cloud provider, the damage and impact could be severe.

3. **Management Capabilities:** Despite there being multiple cloud providers, the management of platform and infrastructure is still in its infancy. There is huge potential to improve on the scalability and load balancing features provided today.
4. **Governance:** The governance is the primary responsibility of the owner of a private cloud and the shared responsibility of the service provider and service consumer in the public cloud. However, given elements such as transnational terrorism, denial of service, viruses, worms and the like—which do or could have aspects beyond the control of either the private cloud owner, or public cloud service provider and service consumer—there is a need for some kind of broader collaboration, particularly on the global, regional, and national levels.
5. **Bandwidth Requirements:** For the cloud framework, bandwidth, and the potential bandwidth; bottleneck must be evaluated as part of overall IT strategy.
6. **Other Possible Risks:**
   - Adverse impact of mishandling of data.
   - Unwarranted service charges.
   - Financial or legal problems of vendor.
   - Vendor operational problems or shutdowns.
   - Data recovery and confidentiality problems.
   - General security concerns.
   - Systems attacks by external forces.

With the use of systems in the cloud, there is the ever present risk of data security, connectivity, and malicious actions interfering with the computing processes. However, with a carefully thought out plan and methodology of selecting the service provider, and an astute perspective on general risk management, most companies can safely leverage this technology.

The cloud computing provides an almost unlimited capacity, eliminating scalability concerns. The cloud computing gives developers access to software and hardware assets that most small and mid-sized enterprises could not afford. The developers, using Internet-driven cloud computing and the assets that are a consequence of the configuration, will have access to resources that most could have only dreamed of in the recent past.

In this revolutionary new era, cloud computing can provide organisations with the means and methods needed to ensure financial stability and high quality service. Of course, there must be global cooperation if the cloud computing process is to attain optimal security and general operational standards.

Are We Ready for Adopting Cloud Computing? A Case of Pharma Industry

The cloud adoption in the pharmaceutical industry is steadily growing despite the posed challenges. Why? Because by embracing the cloud, pharmaceutical providers are able to access scalable storage solutions designed to handle massive amounts of digital information without overstretching IT budgets. The companies like GlaxoSmithKline have reduced their cost by 30% by adopting cloud based solutions and other players like Pfizer, Eli Lilly, Johnson & Johnson, and Genentech have already begun experimenting

with cloud computing. This article looks at the recent successes and provides insight into enabling pharmaceutical workloads on cloud platforms.

The leading pharmaceutical companies have started hosting complex genetic sequences, clinical trials, and biomarker data in the cloud. The cloud based computing is ideal for data storage and analytics of the vast amount of data scientists and biologists generate in research. Eli Lilly is using the cloud to provide high-performance computing and storage to hundreds of its scientists, enabling it to reduce the fixed IT costs without compromising with IT services.

Pharma and Cloud: The Challenges

- **Data Set Size:** The typical pharmaceutical workloads generate or consume huge amounts of data. The data store is generally collocated with the computation resources. Moving data from an enterprise location to the cloud and back is prohibitively expensive in terms of bandwidth and time. With a 4 Gbps network speed, it would take more than 2 hours to move a 4 TB data set. In data centers and enterprises, the data throughput is typically around 100 Mbps. The cost and actual time for data transmission could undermine this whole approach.
- **Regulatory Compliance:** In the pharmaceutical industry, there are strict regulations relating to personally identifiable information, where private data can be stored, how and what applications can access that data. One of the challenges is ensuring and proving regulations have been met. The cloud services come with a basic set of capabilities and building blocks to meet these needs. Any solution that has to go through strict due diligence, auditing, and certification processes is a high-cost activity.
- **Security Concerns:** Another aspect of regulatory compliance that needs to be addressed is the various security levels required of pharmaceutical data: Physical Security, End-point Security, Storage Security, Transport Security, Deletion Security, etc.

The leak age of company confidential information must also be addressed. In a multi-tenant environment, it's critical to ensure the application accessing data is trusted (signed and certified) and isn't running in a shared environment accessible by another company.

Cloud Applicability and Approaches

In order to commence, it's important to conduct an assessment to figure out which applications and data can be movedkeeping in mind the criticality of the information that needs to be moved.

Data Migration: An easy way to start is to move smaller data footprint workloads. Once the cloud stack is tested and acceptable, larger workloads can be moved to the cloud. The initial input data, currently within the firewall, has to move to the cloud. Once the data is secure on the cloud, it will remain there for future workloads and analysis as the cost for bringing it back is high and counterproductive.

Storage: Any workload and associated data should be checked for data access patterns. If its raw data from a study, the data access could be within a second and may recur frequently in a day. If its patient images, access time may be a few seconds or minutes, but the frequency of access could be once in a few weeks. If data stored is associated with a research query, then the access time can extend to hours and frequency may be 1-2 times per year. With this in mind, tiered storage can be created that has costs corresponding to the retrieval rate and responsiveness required.

Security: Its possible to address security requirements of the pharmaceutical industry via a few approaches:

- **Private Cloud:** Utilising a private cloud platform can meet regulatory and confidentiality needs. The consumers of the service can utilise the self-service to launch workloads and use the reporting framework to determine the expenses related to the execution. Maintainers of the service can

utilise the multi-tenancy model to reduce licensing fees, standardise on hardware, and achieve better economies of scale. Pfizer has been using cloud for its R&D projects and has adopted a virtual private cloud that builds an invisible wall around the companys servers within a shared or public cloud. These servers, hosted by Amazon, allow the company to extend its firewall and other security measures to the cloud. The use of thousands of offsite servers has helped Pfizer compress its computation time from weeks to hours.

- **Public Cloud:** The least sensitive and lowest strategic value workloads can be run on public clouds in an effective manner. If researchers around the world need access to data, the public cloud can act as a data center which can be accessed by researchers everywhere. Eli Lilly, a global pharmaceutical company, moved its newly commissioned research workloads to a public cloud rather than investing in buying extra servers for their data center.
- **Hybrid Cloud:** It is possible to retain sensitive data within a private cloud and use a public cloud to satisfy excess computing requirements that dont require access to sensitive data by using a virtual private cloud. This establishes a secure channel between the private and public clouds. Provided that the public instance does not persist data, this model can be used to create a hybrid cloud. Even if some sensitive data is required to be shared with the public cloud instances, a secure channel can be used to ensure transport security. The pharmaceutical companies conducting large-scale clinical trials can adopt hybrid clouds and continue maintaining storage for operational data inside their data centers. The companies can continue to run intensive clinical analysis computational processes on the cloud. This hybrid approach delivers scalability, while reducing computing costs at that scale on a pay-per-use model that a cloud computing environment offers without exposing mission-critical data to external vulnerabilities and threats.

Major Sources of RoI

Where the cloud can help pharmaceuticals reduce costs include:

- **Business Alignment:** With a cloud platform, it is easy to see the exact cost of a workload. This breakdown leads to better alignment of the IT resources with the business goals. If a workload costs a lot to run but doesn't yield a corresponding return, it can be reviewed for effectiveness. The R&D team can focus on reducing the costs of such instances. The management team can make informed decisions on product development strategy based on this information.
- **Data Access:** Once the data is on a cloud, it can be reused by multiple applications. This design can create data reuse not possible before. If the data is interesting to partners, allied research organisations, or even competitors, then it can be licensed out to these parties on a flat fee or utilisation basis.
- **Creation of Services:** A cloud technology platform certified by regulatory bodies and proven to scale to match pharma workloads is a valuable asset. This technology can be licensed, or provided on a hosted basis for the entire industry. A conglomeration of pharmaceutical companies can set up a joint working group to realise this vision.

Conclusion

With the industry needing to improve productivity, maximise existing investments in IT, monetise data assets, build a quicker road to product development, and focus on personalised drug creation, the cloud is no longer just an efficient way to manage IT functions, but the beginning of new business model for the industry. 2012 is the year pharmaceuticals will embrace and reap the benefits of cloud computing. Are you ready?

Source: *Dataquest*, January, 2012

SUMMARY

- A computer network is created when several computers and other devices, such as printers and secondary storage devices, are linked together by data communication channels. Each computer or device in a network is organised as per the topology. The network topologies include a star network, ring network, tree, mesh, and bus network.
- A wide area network (WAN) consists of two or more computers that are geographically dispersed but are linked by communication facilities provided by third party telecommunication service provider, such as the telephone system or microwave relays. A local area network (LAN) consists of two or more computers directly linked within a small, well-defined area, such as a room, building, or cluster of buildings. The LANs can be connected to WANs through the use of gateways, which convert the data codes, formats, addresses, and transmission rates of one network into a form that is usable by another network.
- Several methods are used to move data through a wide area network, including circuit switching, message switching, and packet switching.
- Other kinds of networks that are popular are MAN, Campus Area Network, Home Area Network, Virtual Private Network, and Storage Area Network.
- The Network Topology is the process of connecting different nodes in a network and are of different types like Ring, Bus, Tree, Star, and Mesh.
- There are three basic components to a backbone network; the network cable, wireless and the hardware devices that connect other network to the backbone. The cable is essentially the same as the one used in LANs, except that it is usually of higher quality to provide higher data rates. The hardware devices include hubs, bridges, switches, routers, brouters, and gateways.
- The hubs are very simple devices that pass all traffic in both directions between the LAN sections they link.
- The bridges connect two LAN segments that use the same data link and network segments. The switches are similar to bridges but connect more that two LAN segments.
- The routers connect two or more LANs that use the same or different data-link protocols but employ the same network protocol. The brouters are devices that combine the functions of both bridges and routers; they bridge same data-link layer LANs and route different data-link layer LANs. The gateways connect two or more LANs that use the same or different data-link and network protocols.
- The data communication is the process of sending data electronically from one point to another. Using communication facilities such as the telephone system and microwave relays to send data between computers is a type of data communication often referred to as telecommunications.
- The transmission of data takes one of the two forms: analog or digital. The analog data transmission is the passage of data in a continuous waveform. The digital data transmission passes data in distinct on and off pulses.
- The modulation is the process of converting a digital signal into an analog signal. The demodulation is the process of converting an analog signal into a digital signal. A modem (modulator-demodulator) is the device that converts the signals.
- A communication channel is the pathway along which data are transmitted between devices. The three basic types of communication channels are wire cable, microwave, and fibre optics.
- The multiplexing is the process of combining the transmissions of several computers, or other devices so that the transmissions can share the same communication channel. The concentration

allows a communication channel to be connected to serve more devices than the capacity of that channel normally allows. A front end processor is a computer that handles all data communication control functions, freeing the CPU of a main computer to work on other tasks.

- The data communication has allowed the linking of microcomputer to microcomputer and microcomputer to mainframe so that data and capabilities can be shared.
- The baud rate of a communication channel is the number of times per second that the transmitted signal changes (modulates or demodulates). The bandwidth, or band of a communication channel determines the speed at which that channel can transmit data.
- The broadband connectivity is becoming a reality and some of the common broadband examples include integrated services digital network (ISDN), T1 link, T3 link, Digital Subscriber Line (DSL), and many more.
- The asynchronous transmission transmits data having one character at a time. The synchronous transmission transmits data as a block of characters in timed sequences. The protocol is the set of rules and procedures defining the technical details of data transfer between two devices. The data transfer can occur in three modes: simplex, half duplex, and full duplex.
- The distributed data processing (DDP) is the concept of dispersing into the areas where the computers, devices, software, and data are connected through communication channels. The computers are organised on a functional and geographical basis and work together as a cohesive system to support user requirements.
- The Client/Server (C/S) architecture based networks are the best examples of distributed data processing models and have become very popular for enterprise computing. In C/S architecture, Client is any PC, or end user computer, which is connected using networking technologies to a Server, which manages the network and also the part of data processing, depending on how the C/S architecture is configured. C/S architecture can be two-tier, three-tier or n-tier depending on the size and spread of the organisation.
- The Internet, Intranet, and Extranet are three technological innovations that most of the organisations in the world started using. The Internet is a universal network that allows anyone to everyone a free and easy access. It is a public network. Intranet is a private internet meant for defined users of an organisation. The Extranet is an extended intranet that allows sharing of data across business partners. Both intranet and extranet uses internet technologies, which means they are created using TCP/IP.
- The data communication has allowed computers to share data in spite of the boundaries of time or distance and has found many applications in our society, including information services, database services, electronic funds transfer, electronic mail, telecommuting, reservation systems, and other business systems. Today, all businesses across the globe have moved into the network space. There is no business in the world that is not dependent on this technology.
- The virtualisation is a framework or methodology of dividing the resources of a computer into multiple execution environments, by applying one or more concepts or technologies such as hardware and software partitioning, time-sharing, partial, or complete machine simulation, emulation, quality of service, and many others. The virtualisation can be platform or resource virtualisation.
- The cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data center from a capital-intensive set up to a variable priced environment.
- The idea of cloud computing is based on a very fundamental principal of "reusability of IT capabilities". The difference that cloud computing brings compared to traditional concepts of "grid computing", "distributed computing", "utility computing", or "autonomic computing" is to broaden horizons across organisational boundaries.

- The Cloud Providers offer services that can be grouped into three categories: SaaS, PaaS, and IaaS.
- The enterprises can choose to deploy applications on Public, Private, or Hybrid clouds. The Cloud Integrators can play a vital role in determining the right cloud path for each organisation.

KEY TERMS

Amplitude Modulation (AM)
Analog Transmission
Asymmetric Digital Subscriber Line (ASDL)
Asynchronous Transfer Mode (ATM)
Asynchronous Transmission
Bandwidth
Bits per second (bps)
Blue Tooth
Bridge
Broadband Transmission
Brouter
Bus Topology
Campus Area Network (CAN)
Circuit switching
Client/Server
Cloud Computing
Coaxial Cable
Code Division Multiple Access (CDMA)
Concentrator
Data Communication
Digital Subscriber Line (DSL)
Digital Transmission
Distributed Data Processing
Ethernet
Extranet
Fiber Optics
Frame Relay
Frequency Division Multiple Access (FDMA)
Frequency Division Multiplexing (FDM)
Frequency Modulation (FM)
FTP
Full Duplex Mode
Gateway
Global Positioning System (GPS)
Half Duplex Mode
Home Area Network (HAN)
Hub
Hybrid Cloud
Infrared
Infrastructure as a Service (IaaS)
Internet
Intranet
ISDN
Local Area Network (LAN)
Mesh Topology
Message Switching
Metropolitan Area Network (MAN)
Microwave Transmission
Modem
Multiplexing
Narrow Band Transmission
Network Components
Network Topology
Networks
OSI
Packet Switching
Platform as a Service (PaaS)
Platform Virtualisation
Private Cloud
Protocol
Public Cloud
Resource Virtualisation
Ring Topology
Router
Satellite Transmission
Simplex Mode
Social Networking
Software as a Service (SaaS)
Star Topology
Storage Area Network
Switch
Synchronous Optical Network (SONET)
Synchronous Transmission
T1 Link
T3 Link
TCP/IP
Telecommunication Systems
TelNet
Thick Client
Thin Client
Time Division Multiple Access (ADMA)
Time Division Multiplexing (TDM)
Tree Topology
Twisted Pair
Virtualisation
Voice Band Transmission
Wide Area Network (WAN)
Wi-Fi
X.25

SELF-STUDY QUESTIONS

1. LAN Characteristics is NOT determined by
   (a) Topology
   (b) Transmission Medium
   (c) Size of Coverage
   (d) The number of employees in the organization
2. A _____ topology consists of several devices connected to one centralised computer.
   (a) Bus (b) Mesh (c) Star (d) Tree
3. Which one of the following does not provide network connectivity?
   (a) Coaxial cable (b) Twisted pair (c) Voice signals (d) Microwave
4. _____ is the process of combining the transmissions from several devices into a single data stream that can be sent over a single high speed communication channel.
   (a) Hub (b) Bridge (c) ISDN (d) Multiplexing
5. The sophisticated mode of transmission which allows a device to receive and send data simultaneously is known as
   (a) Simplex (b) Half Duplex (c) Full Duplex (d) Concentrator
6. _____ determines the physical pathway the data will take when they are communicated.
   (a) Physical Layer (b) Data Link Layer (c) Network Layer (d) Transport Layer
7. The Internet is a global network using _____ protocol.
   (a) TCP/IP protocol (b) OSI Model protocol (c) FTP protocol (d) SONET protocol
8. _____ is a technique for hiding the physical characteristics of computing resources.
9. _____is the pooling of physical storage from multiple network storage devices into what appears to be a single storage device that is managed from a central console.
   (a) Platform Virtualisation (b) Storage Virtualisation
   (c) Network Virtualisation (d) Operating System Virtualisation
10. _____refers to applications and services offered over the Internet.

REVIEW QUESTIONS

1. Define networks and its types.
2. List out different kinds of topologies that are used. Explain each of these topologies.
3. To create a wire based local area network, what are the different options available?
4. How switches are different from routers and hubs?
5. When will one use the Gateway and what are its benefits over routers?
6. Define wireless LANs. What network components are required to establish WLAN?
7. How TCP/IP protocols are different from OSI model?
8. Differentiate between Internet, Intranet, and Extranet.
9. How MAN is different from WAN?
10. What is Client/Server based model? How are they more secured over centralised networks?

QUESTIONS FOR DISCUSSION

1. If one organisation wants to connect its two LANs in two different buildings located in the same campus, how will it set up the network?
2. Describe the business benefits of intranets and extranet with examples.
3. What is Internet 2.0 and how it is different from Internet. Why organisations will move to Internet 2.0?
4. List two reasons to justify, why an organisation should implement MAN over WAN.
5. List the security concerns associated with Wi-Fi based LAN. How will one address these issues?
6. What are the strategic advantages of moving business transaction over the Internet?
7. List the business reasons of implementing star topology network over the tree network.

APPLICATION EXERCISES

1. You have been appointed as network administrator of a college, the college is spread over three floors and each floor has twenty rooms each. Each room has a computer system. Suggest the network topology the college should implement.
2. You need to link your intranet site to the Internet website. How will you achieve that? While doing so, you need to address the security concerns associated with it.

GROUP PROJECTS

1. Study your college/institution network structure and identify the gaps by visiting similar kind of colleges/institutions. Prepare a complete network structure report for your college/institution and present it to the network administrator.
2. It is a saying that one cannot transmit more than 56 Kbps of data over Wi-Fi access points in India. Search the Internet, discuss with your teacher, and experts to suggest your viewpoint. You must indicate the relevant sources that you use.

Caselets

1. Apollo Tyres

Apollo Tyres is a leading tyre manufacturer in India. The company has four manufacturing units in India, two in South Africa and two in Zimbabwe. It has a network of around 4,500 dealerships in India, of which over 3,000 are exclusive outlets, and nearly 230 multi brand Dunlop Accredited Dealers in South Africa and Zimbabwe.

'Unstoppable IT' is part of Apollo Tyres's overall IT strategy derived out of its philosophy of having services available at all times. This concept is woven around 'Anywhere, Anytime, Any Device', whereby a complete set of IT systems, processes and capability are deployed for availability, confidentiality, and integrity of information. As part of this strategy, Apollo aggregated, and centralised data for anywhere and anytime access through its employee and dealer portals.

Achieving Anywhere, Anytime connectivity was not a difficult task; the real challenge lay in identifying and determining an appropriate device which could fit into the company's IT deployment strategy. The key requirements were application deployment capability and remote device manageability, and the company considered various mobile devices and PDAs in these respects. Apollo Tyre was also looking at devices which could continue to work and store data locally in the network; the company's IT department did a few pilot tests to check the proof of the concept of some of these devices.

The key applications identified for such a deployment were the common baseline applications aimed at enabling the sales force, including e-mail access. Upon scanning the market for device capabilities, it was felt that an enterprise wide BlackBerry deployment met the requirements of access to e-mail and applications through a single device. When the evaluations were being carried out, BlackBerry scored in terms of e-mail. The e-mail access on the move was critical for management level executions within the company. Having homed in on the device, Apollo Tyres started looking at the application deployment capability for the BlackBerry. SAP is the transaction backend for Apollo Tyres. The e-mail enabled Blackberry devices were deployed internally with BlackBerry Enterprise Server which had been a success with Apollo. The company is also looking at the next phase for application deployment using the Enterprise Server.

There was relief within the middle and senior management after the deployment of Blackberry Enterprise Solution. This not only enabled the top management to stay in touch with the systems and people continuously, it also resolved the issue of management taking their laptops just to access their e-mail. The teams travelling abroad have benefited the most with this solution.

Questions for Discussion

1. One of the major problems for Apollo management was to keep the dealer network connected, how did they address this issue?
2. What was the enterprise IT strategy the company followed?
3. What is the role that Internet and Mobile technologies can play in building Apollo's IT strategy?
4. List the major benefits that the company has achieved.

Source: *Dataquest*, 28 Feb. 2007, Vol. XXV No. 04

2. IBM Daksh: A Virtual Success Story

Given the rate at which IBM Daksh has grown over the years, there can be little doubt regarding the problems or issues that came in the way of the organisation. Of these issues, perhaps the most significant one was that of achieving some sort of network synchronisation across various locations. As IBM Daksh grew significantly over the years, the organisation required scalability and flexibility in its technology platform across all delivery centers so that it would enable easy and seamless implementation of

any type of customer contract or technology solution, regardless of the geographic location.

There were a few things in this case that posed a huge challenge to the company. The primary one was something called the network habits of customers. Every customer operates and accesses his network in a different way. Thus synchronisation had to be achieved between the customers technology and the company's technology.

Thus IBM Daksh sought to find the most apt way by which the company could standardise the way every customer connects to the network. The solution was a fully virtualised network service delivery across all service delivery locations. The virtualisation drive has yielded tremendous results, though it was not devoid of challenges.

What existed earlier was a point to point delivery network. This complex implementation changed that and connected various delivery locations in a cloud. This helped them not only in strengthening their delivery processes but also in transmitting real time services. Unlike other industries, such as manufacturing or FMCG, the ITeS industry has the unique requirement that networks need to transmit voice and data in real time. Furthermore, the industry's unique delivery SLAs implies that there is a very low tolerance for even momentary glitches. The system also needs to be resilient and robust enough to support the on-boarding of a multitude of customers and their unique individual requirements for connectivity and SLAs. Moreover, the high volume of Personally Identifiable Information (PII) of end customers that the industry handles on a regular basis necessitates the integration of high-end, and impregnable security mechanisms.

All these standards are not only complex but also require tremendous effort to be inculcated in one system. But that is what the ATM network has managed to achieve for IBM Daksh. The fully-meshed Asynchronous Transfer Mode (ATM) network developed at IBM Daksh provides virtual voice and data connectivity for each client while simultaneously meeting all unique security, interoperability, and SLA requirements for different clients. This single virtualised network also meets all business requirements to service the flexibility required by both the end customer as well as IBM across all geographies. In addition, the virtual network provides built-in business continuity empowerment through seamless availability of all services at an alternate location via no more than managed configuration changes.

The network is also designed with built-in scalability and interoperability with other ATM networks, data networking devices, different versions of Private Branch Exchange (PBX). It also takes into account technology developments, such as Multiprotocol Label Switching (MPLS), without making further investments. This network solution has helped them on various fronts and added key differentiators to their business like flexibility, adaptability, reliability, security and speed of deployment.

The network also delivered some tangible results like achievement of high up-time for all clients, SLA commitments on packet loss and latency parameters, flexibility in ramp-up and ramp-down, et al. And all this was made possible within a span of eleven months.

Questions for Discussion

1. What were the inefficiencies of the existing system at IBM Daksh?
2. List the key benefits that the company achieved with the above technology.
3. Critically evaluate the problem and solution.

Source: *Dataquest*, February, 2009

3. Banking on the Cloud

Instituted around the 80s, the Nawanagar Cooperative Bank is one of the leading cooperative banks in Gujarat. But last month, it hits the headlines with the announcement to deploy core banking solutions on a hosted cloud services model. This was not only in sync with new RBI directive for implementing the internet and other banking services but also a plunge into the next-generation technology that lead to saving on the capex and opex side. It was going to automate its end-to-end operations with IBMs smart cloud resilience service for core banking solution and Intrasoft Techs OMNI Enterprise core banking solution hosted on IBMs data center.

While IBM will facilitate the implementation of the InfrasoftTech OMNI Enterprise core banking solution in the bank, the cloud offering helped the bank save over the capital expenditure and pay as per the use.

As a forward-looking bank, we felt the need to scale up our IT and improve operational efficiency for delivering consistent, uninterrupted services in a cost-effective, secure, and compliant manner. After considering several alternatives, bank decided on the IBM-InfrasofTech solution as the most appropriate solution to help us ride the transformation wave.

The bank was following time-consuming processes and inefficient operations, which were not in tandem with its aggressive expansion plans with more branches, and ATM centers. With the new core banking solution, that too on cloud, Nawanagar bank would have higher scalability and agility with lesser operating costs. Secondly, the core banking solution will bring centralised policy-making and control, connectivity across the branches and ATMs, teller system at the branches, transparent operations, provide on-demand MIS reports, flow of cash, borrowing, and funding.

With the core banking solution, it would provide anytime, anywhere banking with ATM and non-home branches, enable quick on-boarding of new customers, introduce system at branches and reduce the service time per customer, and provide SMS and internet banking to the customers.

Through IBMs SmartCloud Resilience solution, it could meet recovery time and recovery point objectives (RTO and RPO) and help mitigate the effects of a disaster. The suite includes SmartCloud archive, SmartCloud email management express, The SmartCloud managed backup, SmartCloud managed data vault, and The SmartCloud virtualised server recovery and help providing server recovery and data protection and back-up services, using time-tested tools to assess, plan, architect, and integrate an end-to-end solution which is critical for banking scenario.

Questions for Discussion

1. What were the inefficiencies of the existing system at the bank and why did they think of implementing Cloud?
2. List the key benefits that the bank achieved with the cloud based solution.
3. Visit the website of the bank and critically evaluate the problem and solution.

Source: *Dataquest*, December, 2011

Answers to Self-Study Questions

1. (d)	2. (c)	3. (c)	4. (d)
5. (c)	6. (c)	7. (a)	8. Virtualisation
9. (b)	10. Cloud computing		

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Section III

Information Technology for Decision-making

CASE III: IT for Decision Making

Management decision-making process is quite challenging for managers who do the public dealing. It becomes more complex, if the decision is dependent on substantial transaction data being collected by transaction processing system, which is being managed on a database. Most of the managers may not be quite familiar with the database environment. The same limitation is being faced by the hotel manager of Comfort Hotels, Mr. Alok Srivastava.

Comfort Hotels is a chain of hotels spread across India. Alok Srivastava is a manager with one of the units of Comfort Hotels located at the outskirts of Jaipur on the way to Delhi. It attracts business groups for recreational activities and business meetings. The hotel has a number of rooms of different sizes and with different facilities. The hotel also has conference halls, meeting rooms and auditorium facilities for business people. A majority of the customers of Comfort Hotels do their booking online well in advance using a powerful online booking system available on the hotel's website. All the data that is collected by the online booking system is saved as part of Microsoft database. The online system is robust. But the system generates only the predefined reports which do not fit with the desired needs of Alok.

Alok being the hotel manager was responsible for managing the daily activities of the hotel and to offer best possible services to its customers. To achieve this, Alok needs to generate some specific reports out of the database system. One of the challenges that he always faced was that of importing the data from the database and generate the specific reports to suit his requirements. Alok did not know how to work on database systems and was more comfortable with Excel-based spreadsheet.

As a hotel manager of Comfort Hotels, Alok was responsible for arranging the reservation of rooms and business facilities. The hotel has 100 single rooms, 200 double rooms, 50 suites, 10 conference rooms, 15 meeting rooms, two convention centres, and two auditoriums. Every day, the hotel manager does get calls from current as well as prospective customers about the type of rooms, their tariff and availability. For meeting rooms, conference rooms and auditoriums, customer also enquire about the capacity. Each facility is available with multiple rates option—standard rate, members' rate, discount rate, holiday special rate, etc. Normally all bookings are done on standard rate while business members get the booking done on member rate, discount rates are given to select class of members and holiday special rate is applicable during off seasons.

The data that is available in database comprises the following booking details:

- Reservation Number
- Date of Reservation
- Customer Number
- Type of Customer
- Reservation Commencement Date
- Reservation End Date
- Room Type
- Room Rate Code

Challenges and Need

Since the hotel data is available on the online database, the first challenge is to import the data to excel format. Second is to create the rate chart for the room type and rates. Third is to match the transaction data with the rate chart. All this is required because Alok is not familiar with Access.

To manage the hotel effectively, Alok wants to generate the reports showing:

1. Room category wise booking details
2. Room wise total booking amount to be charged
3. Most popular type of room for personal and business needs
4. Ratio of daily business between standard rates and member rates
5. Booking pattern for meeting rooms vis-à-vis auditorium
6. On an average, how many days in advance the booking is done?
7. Average booking period for different types of rooms
8. Profit of customer booking double rooms
9. What is the preferred choice of rooms for young customers
10. Preferred choice of business customers

To generate these kinds of reports, Alok takes your help. You are free to design the decision system using Excel or Access. You are also free to capture additional data.

So design the database structure as per the software tool to be used. Populate the database and generate the reports to support Alok's decision-making process.

This case is written to promote creative thinking on the part of the students. Therefore, it is the responsibility of the students to select the appropriate spreadsheet/database tool. In several instances, students can use one or more of the required skills to satisfy an information requirement. The ability to choose which tool to use demonstrates the software application's flexibility and does not force the students to use a particular tool to retrieve an answer. If one wants the students to use a particular tool to satisfy a specific information requirement, faculty can recommend which tools they should use.

Questions to Think About

1. Prepare a report for Alok Srivastava stating the booking pattern for the carrent week.
2. Prepare a report stating the contribution of bookings across multiple rates for last one month. You may also prepare a Pie chart to show the contribution.

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Chapter 6

Excel Based Decision Models

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What is competency in creating and modifying workbooks?
- How to manipulate worksheet data by applying mathematical formulas and functions?
- How to restructure and format worksheets?
- How to create and manage multiple worksheets?
- How to create reports with tables and graphics?
- How to organise and analyse data?
- How to do data auditing?
- How to perform what-if and sensitivity analysis?
- How to use Excel as a decision tool?

INTRODUCTION

The most of the decision-analysis tools in the market focus on one, or some of the specific analytical technique, like simulation or decision trees. Further, some of these tools are tailored to a specific industry need. One integrated set of tools that combines the best analytical methods and can also be applied to different problems: Microsoft® Office Excel® 2007 spreadsheet software. The Microsoft Excel is a powerful decision tools that allows managing the data and generating reports.

This chapter introduces you to Excel, a powerful spreadsheet program, and its use in handling data. The aim of this section is to provide a basic familiarity with Excel, particularly its usefulness in helping us to analyse time series data, statistics, produce charts and doing functional analytics. The Microsoft Excel makes it possible to analyze, manage, and share information in many ways,

helping the user to make better, smarter decisions. The analysis and visualisation tool helps to track and highlight important data trends. The Excel also supports an easy access to important data while on the move using almost any Web browser or smart phone. One can even upload the files to the Web and work simultaneously with others online.

This chapter focuses on only a part of Excel's functions, but these should be sufficient enough to allow one to continue independently, to find out perhaps more about the various shortcuts that have not been covered here. In this chapter emphasis is to create familiarity about the tool and to sensitise about the decision tools that Excel support.

The Excel is a powerful decision tool that can help decision-makers to capture data for wide range of sources and manipulate it using wide range of built-in or user defined formulas/functions/ tools. The Excel can also be used to manage small databases required for managing an application, or can be used to run a simulation. The number of executives worldwide uses this tool to manage their sales data, to do what-if analysis, to do sensitivity analysis, to find patterns, to manage better relationship with their customers and vendors, for generating summary reports, for optimisation of problems and many more decision applications. This chapter tries to cover most of the power of Excel required for business decision-making.

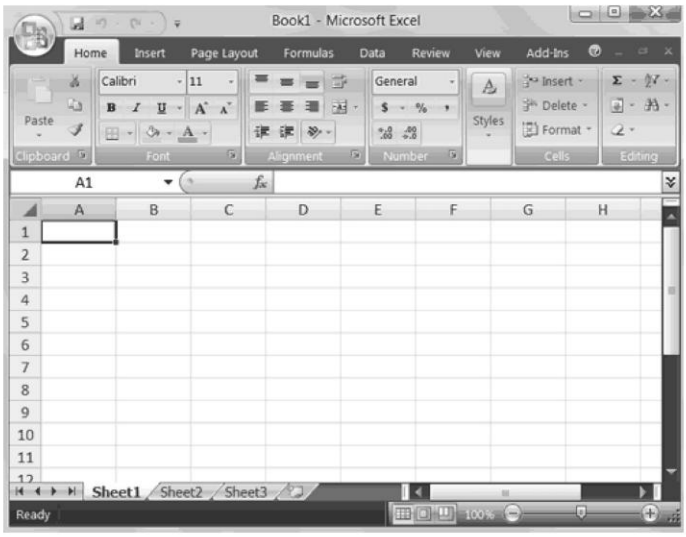
GETTING STARTED

The value of Microsoft Excel lies in its ability to manipulate numbers very well. That makes Excel useful for all those business applications that require data handling, manipulation, and analysis like accounting, sales, budget planning etc. The Excel allows creating spreadsheets much like paper ledgers that can perform automatic calculations. Each Excel file is a workbook that can hold many worksheets. The worksheet is a grid of columns (designated by letters) and rows (designated by numbers). The letters and numbers of the columns and rows (called labels) are displayed in grey buttons across the top and left side of the worksheet. The intersection of a column and a row is called a cell. Each cell on the spreadsheet has a cell address that is the column letter and the row number. The cells can contain text, numbers, or mathematical formulas. The data stored in the workbook can be easily used to create charts to be used as illustrations in other documents. Information can be saved and imported into other programs such as Microsoft Word, Powerpoint etc. The Excel 2007 allows storing large volume of data as it has over one million rows (1048576) and 16,384 columns, which permits the user to import data from a mid-size database for analysis purpose.

Microsoft Excel Screen Elements

In order to understand the Excel screen elements, start Microsoft Excel 2007. The Microsoft Excel window appears in the following manner as shown below:

In Excel 2007, how a window displays depends on the size of the window, the size of the monitor, and the resolution of the monitor. The resolution determines how much information the computer monitor can display.



The Microsoft Office Button

In the upper-left corner of the Excel 2007 window is the Microsoft Office button. When this button is clicked, a menu appears. One can use the menu to create a new file, open an existing file, save a file, and perform many other tasks.

The Quick Access Toolbar

Next to the Microsoft Office button is the Quick Access toolbar. The Quick Access toolbar gives the access to commands that the user use frequently. By default, Save, Undo, and Redo appear on the Quick Access toolbar. One can use Save to save file, Undo to roll back an action, and Redo to reapply an action that was rolled back.

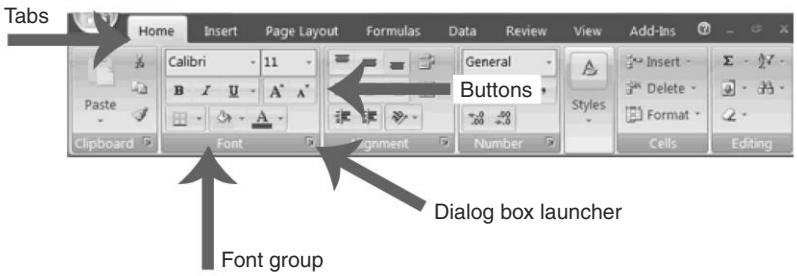
The Title Bar

Next to the Quick Access toolbar is the Title bar. On the Title bar, Microsoft Excel displays the name of the workbook that is currently being used. At the top of the Excel window, one could see 'Microsoft Excel - Book1' or a similar name.

The Ribbon

In Microsoft Excel 2007, the Ribbon is used to issue commands. The Ribbon is located near the top of the Excel window, below the Quick Access toolbar. At the top of the Ribbon are several tabs; clicking a tab displays several related command groups. Within each group are related

command buttons. One can click buttons to issue commands or to access menus and dialog boxes. One may also find a dialog box launcher in the bottom-right corner of a group. When the dialog box launcher is clicked, a dialog box displays an additional set of commands.



The Formula Bar

If the Formula bar is turned on, the cell address of the current cell is displayed in the Name box which is located on the left side of the Formula bar. The cell entries are displayed on the right side of the Formula bar. If the Formula bar is not active, one can perform the following steps to activate the formula bar:

1. Choose the View tab.
2. Click Formula bar in the Show/Hide group. The Formula bar appears.

The Status Bar

The Status bar appears at the very bottom of the Excel window and provides such information as the sum, average, minimum, and maximum value of selected numbers. One can change what displays on the Status bar by right-clicking on the Status bar and selecting the options from the Customise Status Bar menu. One can click a menu item to select it and click it again to deselect it.

Moving Around a Worksheet

By using the arrow keys, one can move around the worksheet.

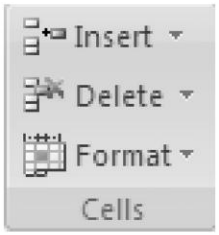
Handling Worksheets

The worksheets in a workbook are accessible by clicking the worksheet tabs just above the status bar. By default, three worksheets are included in each workbook, but one can insert additional worksheets or delete them as needed. One can also change the name of worksheets that appear by default in a new workbook. The name of a worksheet appears on its sheet tab at the bottom of the screen. By default, the sheets are named as Sheet1, Sheet2, and so on, but one can give any name to each of these worksheets as appropriate.

To **Insert** a new worksheet, do one of the following:

- To insert a new worksheet at the end of the existing worksheets, click the **Insert Worksheet** tab at the bottom of the screen.

- In order to insert a new worksheet in front of an existing worksheet, right click the tab of an existing worksheet, and then click **Insert**, and on the **General** tab, click **Worksheet**, and then click **OK**.



To **Rename** the worksheet:

- Right click on the Sheet tab and select **Rename** from the shortcut menu.

- Type the new name and press the **Enter** key.

To **Delete** the worksheet:

- Right click the tab of an existing worksheet that needs to be deleted, and then click **Delete** and then click **OK**.

SELECTING A CELL

When Excel is open, the empty worksheet is highlighted at cell A1 (it has a black outline). This outline shows that cell A1 is selected and one can enter some data. One can select any cell that one wants by moving the mouse and clicking the left-hand mouse button or by using the arrow keys.

Selecting Range of Cells

Often one wants to select more than one cell at a time. This is carried out by using a click-and-drag mouse movement. For example, to select cells A1 to E1:

1. Go to cell A1.
2. Press the F8 key. This anchors the cursor.

3. Note that 'Extend Selection' appears on the Status bar in the lower-left corner of the window. You are in the Extend mode.
4. Click in cell E7. Excel highlights cells A1 to E7.

One can also select a range of cells by holding down the left mouse button and dragging the mouse over the area. For example, if one wants to select cells A1, A2, A3, and A4. For that move the mouse pointer to cell A1 and press the left-hand mouse button and drag the mouse, whilst holding the left-hand button down, from cell A1 straight down to cell A4. Release the mouse button after one has selected the four cells. One can use the same procedure to select cells horizontally as well as vertically.

One can also select the entire rows or columns by moving the mouse arrow to the row number that identifies that row or column alphabet. Clicking the left-hand mouse button on that letter or number turns the entire row or column black. This is a useful process if one wishes to add or delete a column, or to change the format of all the data in the column or row.

Entering Data in a Selected Cell

In general, there are three types of information that one may want to enter into the selected cells: labels (text), values (numbers), and formulae

- **The Labels** (text) are descriptive text of information such as names, months, or other identifying statistics, and they usually include alphabetic characters.
- **The Values** (numbers) are generally raw numbers, or dates.
- **The Formulas** are instructions for Excel to perform calculations.

In order to enter data in a cell in Excel 2007, one selects the cell, type the data, and press Enter. The Excel moves the cell cursor down one cell. One can also click the Enter button (the check mark) in the Formula bar to enter data. The check mark appears only when one is in the process of entering (or editing) data. If one wants to move the cell cursor one cell to the right after data entry, press Tab or the right arrow key (instead of Enter) to complete the entry.

How Excel aligns the data (by default) — one can change it later depending on what type of data it is:

- **Label:** The Excel aligns text to the left side of the cell. If the text is too wide to fit, the Excel extends that data to the next cell on its right if the next cell is blank. If the next cell is not blank, Excel displays only enough text that fits the cell width.
- **Whole value:** If the data is a whole value, such as 34 or 5763, Excel aligns the data to the right side of the cell.
- **Value with a decimal:** If the data is a decimal value, Excel aligns the data to the right side of the cell, including the decimal point, with the exception of a trailing 0. For example, if one enters 246.75, then 246.75 displays; if one enters 246.70, however, 246.7 displays. You can change the display appearance, column width, and alignment of data.
- **Date:** If one enters a date, such 12/16, Dec 16, or 16 Dec, Excel automatically returns 16-Dec in the cell, but the Formula bar displays 12/16/2011.

In order to enter data into the worksheet follow the following steps:

- Move the cursor on A1 cell and use the keyboard to type the word 'Salary' and press Enter key.
- The cursor will automatically move to cell A2.
- Starting from cell A2, enter the following ten numbers in order, ending at cell A11. Numbers are typed in the same way as the labels.

445 589 441 641 777 346 782 881 990 567

The Excel has built-in function to find the sum, average, count etc. Before we discuss the built-in functions, let us discuss the simple arithmetic formulas in Excel. Whether one enter a number or a formula, one can reference the cell whenever the mathematical calculations such as addition, subtraction, multiplication, or division is to be performed. When entering a mathematical formula, precede the formula with an equal sign. One can find the following mathematical symbols on the keyboard: + – / *. For example:

=36*4 tells Excel to multiply 36 by 4.

=38.2/7.1 tells Excel to divide 38.2 by 7.1

=C10*.5 tells Excel to multiply the value in C10 by 0.5

=A2+A3 tells Excel to add the values of A2 and A3 cells

=A5–30 tells Excel to subtract 30 from the value of A5 cell

Excel performs calculations in the usual BODMAS way. Be sure to take care about the sequence in which Excel carries out the operations. For example:

1. Move to cell A7.
2. Type **= 3+3+12/2*4**.
3. Press Enter.

Note: Microsoft Excel divides 12 by 2, multiplies the answer by 4, adds 3, and then adds another 3. The answer, 30 is displayed in cell A7.

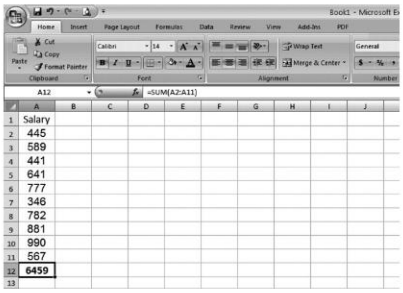
In order to change the order of calculation, use parentheses. Microsoft Excel calculates the information in parentheses first.

1. Double-click in cell A7.
2. Edit the cell to read **= (3+3+12)/2*4**.
3. Press Enter.

Note: Microsoft Excel adds 3 plus 3 plus 12, divides the answer by 2, and then multiplies the result by 4. The answer, 36 is displayed in cell A7.

Formulas

As indicated earlier, all formulas are entered in the worksheet cell and must begin with an equal sign "=". The formula then includes the addresses of the cells whose values will be manipulated with appropriate operands placed in between. All formulas are visible in the formula bar. The example below illustrates the formula for calculating the sum of daily salary of ten individuals.



In order to calculate the sum of salaries of ten individuals, one can use the following formula in A13 cell:

=Sum (A2: A11)

The total (6459) will appear in cell A13.

If one of the values in the participating cell changes, the formula will automatically update the result. For example, if the value in cell A5 is modified to 671 from 641, the sum in cell A13 will automatically be updated to 6489. Now, let us calculate the average of the salary. We do this by dividing the total salary in A13 by ten (as there are ten observations), using the following formula:

=A13/10

This will calculate the average daily salary of ten individuals as 645.9. One can also do the same process by using one of the other built-in functions called Average. Instead of calculating the average in two steps, one can directly use the average functions as follows:

=Average(A2:A11)

This will also give the same result as 645.9.

AutoSum

One can use the AutoSum button Σ on the Home tab to automatically add a column or row of numbers. When the AutoSum button Σ is selected, Excel automatically selects a range of data as per the reading direction. If one wants to change the range, one can do so by selecting it manually and press the Enter key.

1. Go to cell F1.
2. Type **3.**
3. Press Enter. Excel moves down one cell.
4. Type **3**.
5. Press Enter. Excel moves down one cell.
6. Type **3**.
7. Press Enter. Excel moves down one cell to cell F4.
8. Choose the Home tab.

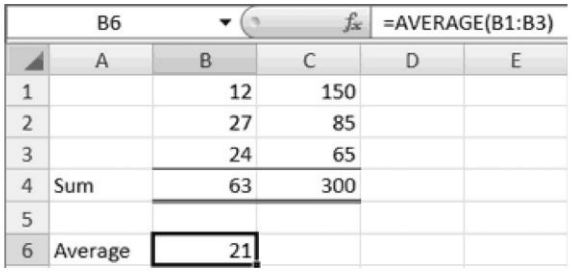
E	F	G
	3	
	3	
	3	
	9	

9. Click the AutoSum button in the Editing group. Excel selects cells F1 through F3 and enters a formula in cell F4.
10. Press Enter. Excel adds cells F1 through F3 and displays the result in cell F4.

By default, Microsoft Excel recalculates the worksheet as you change cell entries. This makes it easier to correct mistakes and analyze a variety of scenarios.

Calculate an Average

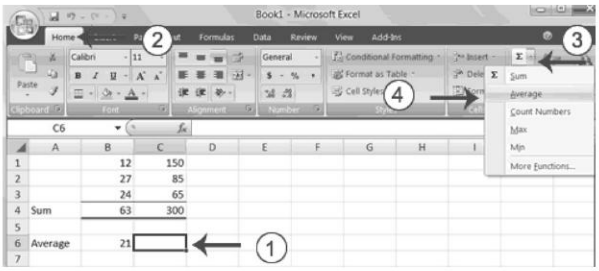
One can use the AVERAGE function to calculate the average of a series of numbers.



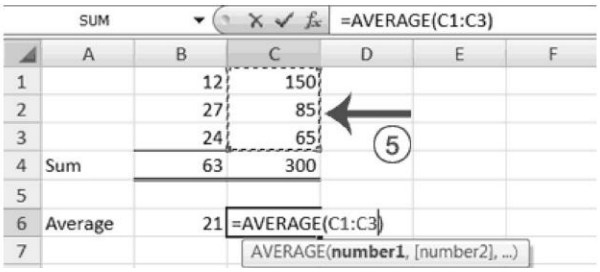
1. Move to cell A6.
2. Type **Average**. Press the right arrow key to move to cell B6.
3. Type **=AVERAGE(B1:B3)**.
4. Press Enter. The average of cells B1 to B3, which is 21, appears.

Calculate an Average with the AutoSum Button

In Microsoft Excel, one can also use the AutoSum button Σ to calculate an average, Max, Min and Count.



1. Move to cell C6.
2. Choose the Home tab.
3. Click the down arrow next to the AutoSum button Σ.
4. Click Average.
5. Select cells C1 to C3.
6. Press Enter. The average of cells C1 to C3, which is 100, appears.

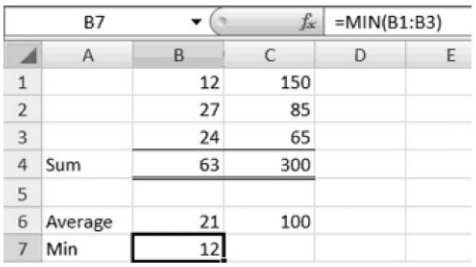


Find the Lowest Number

One can use the MIN function to find the lowest number in a series of numbers.

1. Move to cell A7.
2. Type **Min**.
3. Press the right arrow key to move to cell B7.
4. Type **= MIN(B1:B3)**.
5. Press Enter. The lowest number in the series, which is 12, appears.

One can also use the drop-down button next to the AutoSum button Σ to calculate minimums, maximums, and counts.

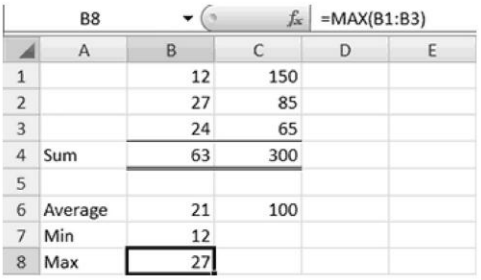


	A	B	C	D	E
1		12	150		
2		27	85		
3		24	65		
4	Sum	63	300		
5					
6	Average	21	100		
7	Min	12			

Find the Highest Number

One can use the MAX function to find the highest number in a series of numbers.

1. Move to cell A8.
2. Type **Max**.
3. Press the right arrow key to move to cell B8.
4. Type **= MAX(B1:B3)**.
5. Press Enter. The highest number in the series, which is 27, appears.

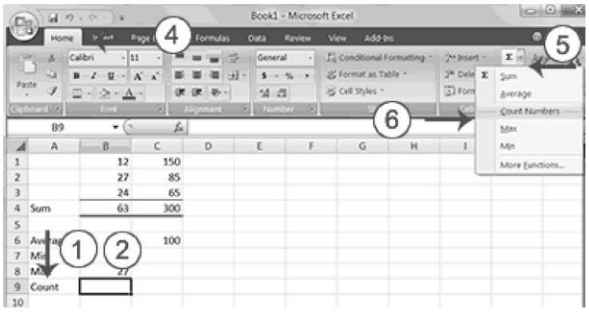


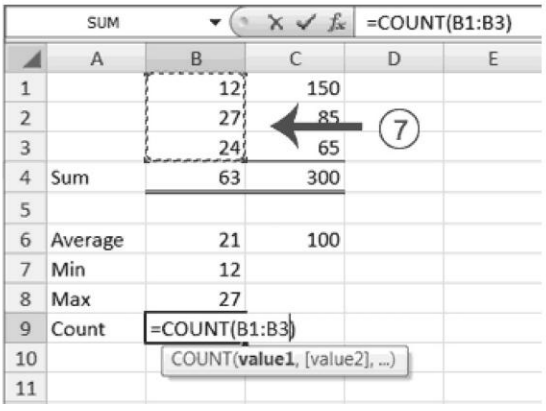
	A	B	C	D	E
1		12	150		
2		27	85		
3		24	65		
4	Sum	63	300		
5					
6	Average	21	100		
7	Min	12			
8	Max	27			

Count the Numbers in a Series of Numbers

One can use the count function to count the number of numbers in a series.

1. Move to cell A9.
2. Type **Count**.
3. Press the right arrow key to move to cell B9.
4. Choose the Home tab.
5. Click the down arrow next to the AutoSum button Σ.
6. Click Count Numbers. Excel places the count function in cell C9.





	A	B	C	D	E
1		12	150		
2		27	85		
3		24	65		
4	Sum	63	300		
5					
6	Average	21	100		
7	Min	12			
8	Max	27			
9	Count	=COUNT(B1:B3)			
10					
11					

7. Select B1 to B3.
8. Press Enter. The number of items in the series, which is 3, appears.

Some of the frequently used mathematical functions and examples are given in the table below:

Function	Example	Description
SUM	=SUM(A1:A100)	Finds the sum of cells A1 through A100
AVERAGE	=AVERAGE(B1:B10)	Finds the average of cells B1 through B10
COUNT	=COUNT(A1:A11)	Counts the filled cells between A1 through A11
MAX	=MAX(C1:C100)	Returns the highest number from cells C1 through C100
MIN	=MIN(D1:D100)	Returns the lowest number from cells D1 through D100
SQRT	=SQRT(D10)	Finds the square root of the value in cell D10
TODAY	=TODAY()	Returns the current date (leave the parentheses empty)

CELL REFERENCING

One can use three types of cell references in Excel 2007 formulas: ***relative***, ***absolute***, **and** ***mixed***. Using the correct type of cell reference ensures that formulas work as expected when they are copied to another location in the worksheet. The formulas and functions are at their most useful when using references, so one needs to understand them.

1. **Relative:** With relative cell addressing, when a formula is copied from one location of the worksheet to another, Excel records the position of the cell relative to the cell that originally contained the formula. Calling cells by just their column and row labels (such as 'A1') is called relative cell referencing. When a formula contains relative referencing and it is copied from one cell to another, Excel does not create an exact copy of the formula. It will change cell addresses relative to the row and column they are moved to. For example, if cell A3 that contains a simple addition formula =(A1+A2), is copied to cell B3, the formula would automatically change to =(B1+B2).
2. **Absolute:** With *absolute* cell addressing, when a formula is copied from one area of the worksheet to another, Excel references the same cells, no matter where the formula is copied. This is accomplished by placing dollar sign '$' within the cell addresses in the formula. The formula in A3 cell will be modified as =$A$1+$A$2 in absolute cell referencing. Now, if the formula is copied to B3 cell or any other cell, it will always refer to =$A$1+$A$2. Both column and row of both cells are absolute and will not change when copied.
3. **Mixed:** One can use mixed cell addressing to keep the row constant while the column changes, or vice versa. For example, the row can be absolute and the column relative. One can use the F4 key to create a mixed cell reference. Mixed cell referencing can also be used in situations when either only the row OR column needs to be fixed. For example, the formula =(A$1+$A2) in A3 cell, the row of cell A1 is fixed and the column of cell A2 is fixed. If this formula is copied from A3 cell to B3 cell, it will be modified to =(B$1+$A2). But if the same formula is copied to B4 cell, it will be modified to =(B$1+$A3). In mixed

cell referencing, if one wants to fix the row, one must prefix the row number of cell address by dollar ($) sign, and if one wants to fix the column, prefix the column of cell address by dollar ($) sign.

Cell Reference Types

Reference Type	*Formula*	*What Happens After Copying the Formula*
Relative	=A1	Both the column letter A and the row number 1 can change.
Absolute	=$A$1	The column letter A and the row number 1 do not change.
Mixed	=$A1	The column letter A does not change. The row number 1 can change.
Mixed	=A$1	The column letter A can change. The row number 1 does not change.

Lets consider the following exercise to understand the concept.

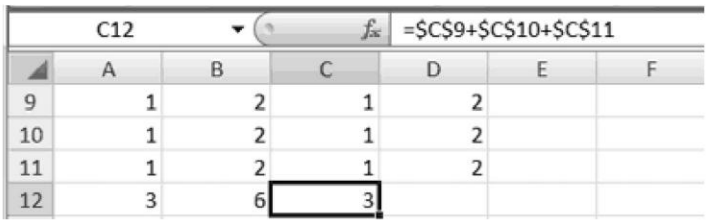
	A	B	C	D
9	1	2	1	2
10	1	2	1	2
11	1	2	1	2
12	3	6		

Absolute Cell Addressing: One can make a cell address an absolute cell address by placing a dollar sign in front of the row and column identifiers. One can do this automatically by using the F4 key. To illustrate:

1. Move to cell C12.
2. Type =.
3. Click cell C9.
4. Press F4. Dollar signs appear before the C and the 9.
5. Type +.
6. Click cell C10.
7. Press F4. Dollar signs appear before the C and the 10.
8. Type +.
9. Click cell C11.
10. Press F4. Dollar signs appear before the C and the 11.
11. Click the check mark on the formula bar. Excel records the formula in cell C12.

Copy and Paste with Keyboard Shortcuts: Keyboard shortcuts are key combinations that enable to perform tasks by using the keyboard like Press ***Ctrl+c.***

1. Move to cell C12.
2. Press Ctrl+c. Excel copies the contents of cell C12.
3. Press the right arrow once. Excel moves to D12.



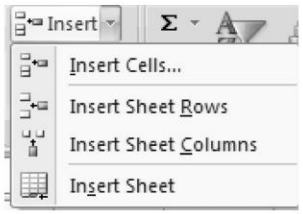
	A	B	C	D	E	F
9	1	2	1	2		
10	1	2	1	2		
11	1	2	1	2		
12	3	6	3			

4. Press Ctrl+v. Excel pastes the contents of cell C12 into cell D12.
5. Press Esc to exit the Copy mode.

Compare the formula in cell C12 with the formula in cell D12 (while in the respective cell, look at the Formula bar). The formulas are exactly the same. The Excel copied the formula from cell C12 to cell D12. Excel copied the formula in an *absolute* fashion. Both formulas sum column C.

Working with Excel

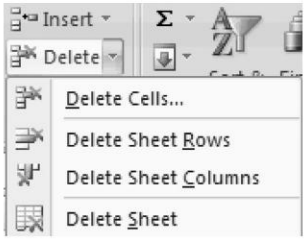
Insert Cells, Rows, and Columns



To insert cells, rows, and columns in Excel:

- Place the cursor in the row below where you want the new row, or in the column to the left of where you want the new column
- Click the **Insert** button on the **Cells** group of the **Home** tab
- Click the appropriate choice: **Cell, Row, or Column**

Delete Cells, Rows, and Columns



To delete cells, rows, and columns:

- Place the cursor in the cell, row, or column that needs to be deleted
- Click the **Delete** button on the **Cells** group of the **Home** tab
- Click the appropriate choice: **Cell, Row, or Column**

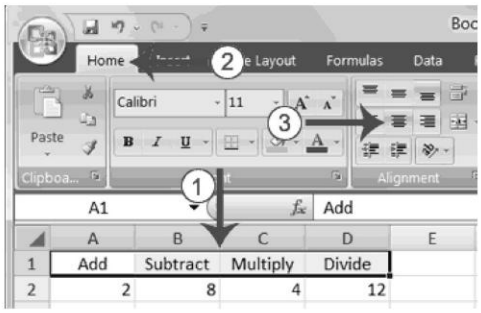
Align Cell Entries

When the text is typed into a cell, by default the entry aligns with the left side of the cell. When numbers are typed into a cell, by default the entry aligns with the right side of the cell. One can change the cell alignment to center, left-align, or right-align for any cell entry. For example, consider cells A1 to D1. Note that they are aligned with the left side of the cell.

	A	B	C	D
1	Add	Subtract	Multiply	Divide
2	2	8	4	12

Center: To center cells A1 to D1:

1. Select cells A1 to D1.
2. Choose the Home tab.
3. Click the Center button in the Alignment group. The Excel centers each cell's content.



Left-Align: In order to left-align cells A1 to D1:

1. Select cells A1 to D1.
2. Choose the Home tab.
3. Click the Align Text Left button in the Alignment group. The Excel left-aligns each cell's content.

Right-Align: In order to right-align cells A1 to D1:

1. Select cells A1 to D1. Click in cell A1.
2. Choose the Home tab.
3. Click the Align Text Right button. The Excel right-aligns the cell's content.
4. Click anywhere on your worksheet to clear the highlighting.

Cut, Copy, and Paste

The Excel allows to move, copy, and paste cells and cell content through cutting and pasting and copying and pasting.

Select Data

To select a cell or data to be copied or cut:

- Click the **cell**
- Click and drag the cursor to select many cells in a range

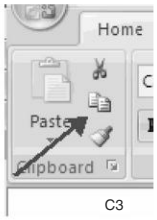
	A	B	C	D	E	F
1		Widgets	Customers	Sales	Price	
2	2-Jun					
3	4-Jun	2	4	2	5	
4	6-Jun					

Select a Row or Column

In order to select a row or column click on the **row** or **column header**.

	A	B	C	D	E	F
1		Widgets	Customers	Sales	Price	
2	2-Jun					
3	4-Jun	2	4	2	5	
4	6-Jun					
5						

Copy and Paste



In order to copy and paste data:

- Select the cell(s) that is to be copied
- On the **Clipboard** group of the **Home** tab, click **Copy**
- Select the destination cell(s), where the data is to be copied
- On the **Clipboard** group of the **Home** tab, click **Paste**

Cut and Paste

To cut and paste data:

- Select the cell(s) that is to be copied
- On the **Clipboard** group of the **Home** tab, click **Cut**
- Select the destination cell(s) where the data is to be copied
- On the **Clipboard** group of the **Home** tab, click **Paste**

Undo and Redo

To undo or redo your most recent actions:

- On the **Quick Access Toolbar**
- Click **Undo** or **Redo**

Auto Fill

The Auto Fill feature fills cell data or series of data into a selected range of cells. If one wants the same data to be copied into the other cells, one may only need to complete one cell. If one wants to have a series of data (for example, days of the week) fill in the first two cells in the series and then use the auto fill feature. In order to use the Auto Fill feature:

- **Click** the **Fill Handle**
- **Drag** the **Fill Handle** to complete the cells

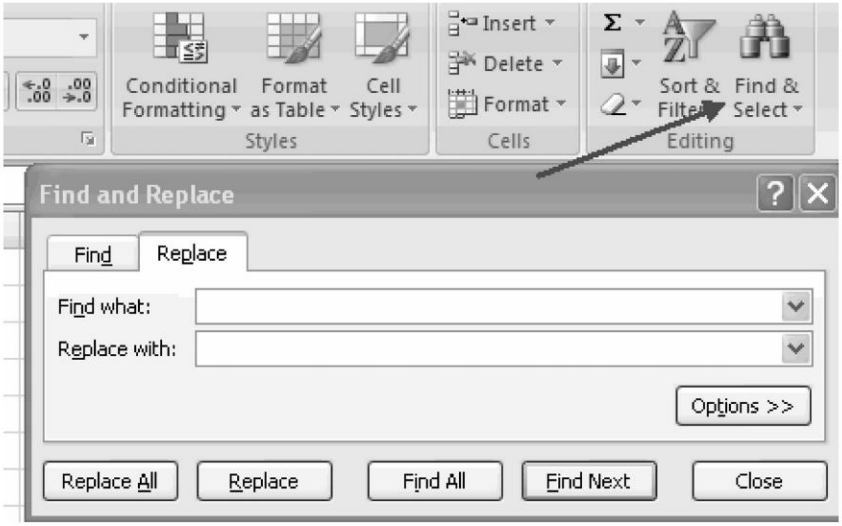
	A	B	C	D
1		Widgets	Customers	Sales
2	2-Jun			
3	4-Jun	2	4	
4	6-Jun			

Find and Replace

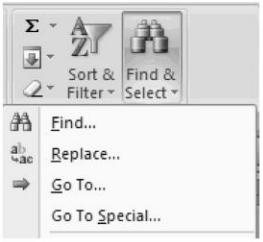
In order to find data or find and replace data:

- Click the **Find & Select** button on the **Editing** group of the **Home** tab

- Choose **Find** or **Replace**
- Complete the **Find What** text box
- Click on **Options** for more search options



Go To Command



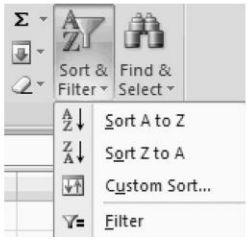
The Go To command takes to a specific cell either by cell reference or by cell name.

- Click the **Find & Select** button on the **Editing** group of the **Home** tab
- Click **Go To**

SORTING AND FILTERING DATA

In order to execute a basic descending or ascending sort based on one column, highlight the cell that will be sorted and click the **Sort Ascending** (A-Z) button or **Sort Descending** (Z-A) button on the standard toolbar. One can apply sort states with up to sixty-four sort conditions to sort data.

Basic Sorts



In order to execute a basic descending or ascending sort based on one column:

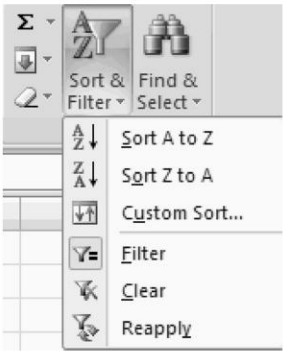
- Highlight the cells that will be sorted
- Click the **Sort & Filter** button on the **Home** tab
- Click the **Sort Ascending** (A-Z) button or **Sort Descending** (Z-A) button

Custom Sorts

In order to sort on the basis of more than one column:

- Click the **Sort & Filter** button on the **Home** tab
- Choose which column you want to sort by first
- Click **Add Level**
- Choose the next column that needs to be sorted
- Click **OK**

Filtering



The filtering allows displaying only data that meets certain criteria. In order to filter:

- Click the column or columns that contain the data to be used for filter
- On the **Home** tab, click on **Sort & Filter**
- Click **Filter** button
- Click the **Arrow** at the bottom of the first cell
- Check the **Words** that you wish to Filter
- To clear the filter click the **Sort & Filter** button
- Click **Clear**

The charts allow you to present information contained in the worksheet in a graphic format. The Excel offers many types of charts including: Column, Line, Pie, Bar, Area, Scatter, and more. In order to view the charts available click the Insert Tab on the Ribbon.

SAVING, OPENING AND CLOSING FILES

The data entered into an Excel workbook is stored in files. These files can be opened, saved, closed, and printed by following the correct procedures.

In order to save the file:

1. Click the **Microsoft Office Button** , and then click **Save**, or press CTRL+S.
2. If one is saving the file for the first time, file name needs to be given.
3. One can also use the **Save As** command to rename a file or change the location of the file.
4. Click the **Microsoft Office Button** , and then click **Save As**, or, press CTRL+S.
5. In the **File name** box, enter a new name for the file.
6. Click **Save**.

In order to open a saved file:

1. Click the **Microsoft Office Button**  , and then click **Open**.
2. In the **File of type** list, click **OpenDocument Spreadsheet**.
3. Click the file needs to be open, and then click **Open**.

CREATING AND MANAGING CHARTS

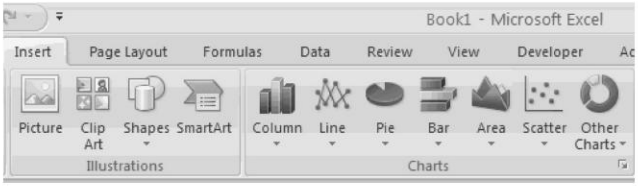
The charts allow to present data entered into the worksheet in a visual format using a variety of graph types like Column, Line, Pie, Bar, Area, Scatter and more. Before one can make a chart, one must enter the data into a worksheet for which one needs to create a chart. In Excel 2007, creating and managing charts is very easy.

- Select the data for which, one wants to create a chart
- Select the appropriate chart type from the Insert Menu
- Chart is created and pasted in the same worksheet with chart tools on the top, as follows:

Create a Chart

In order to create a chart:

- Select the **cells** that contain the data requires for the chart
- Click the **Insert** tab on the Ribbon
- Click the type of **Chart** desirable to create

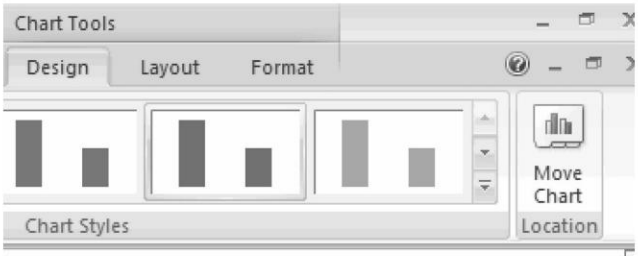


Modification of a Chart

Once the chart is created, one can do several things to modify the chart.

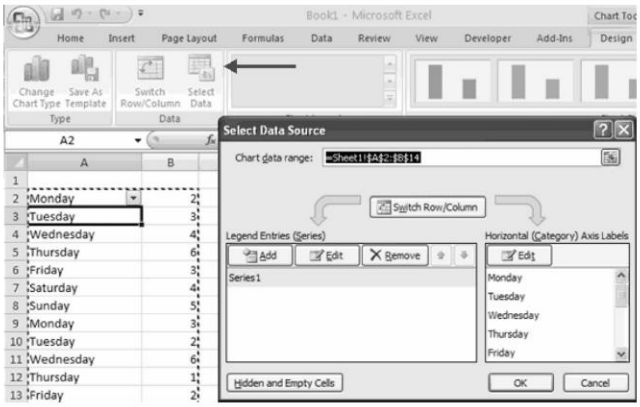
To move the chart:

- Click the **Chart** and **Drag** it another location on the same worksheet, or
- Click the **Move Chart** button on the **Design** tab
- Choose the desired location (either a new sheet or a current sheet in the workbook)



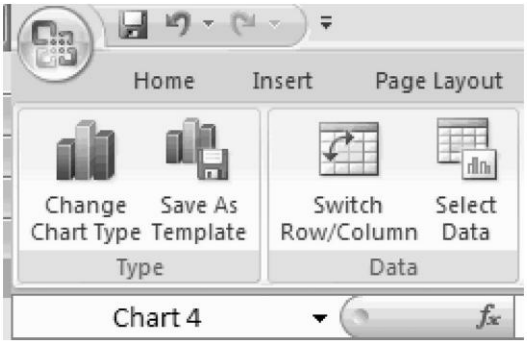
In order to change the data included in the chart:

- Click the **Chart**
- Click the **Select Data** button on the **Design** tab



In order to reverse which data are displayed in the rows and columns:

- Click the **Chart**
- Click the **Switch Row/Column** button on the **Design** tab



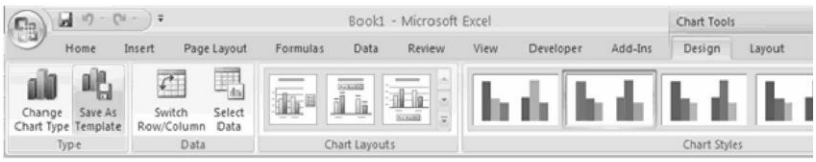
In order to modify the labels and titles:

- Click the **Chart**
- On the **Layout** tab, click the **Chart Title,** or the **Data Labels** button
- Change the **Title** and click **Enter**

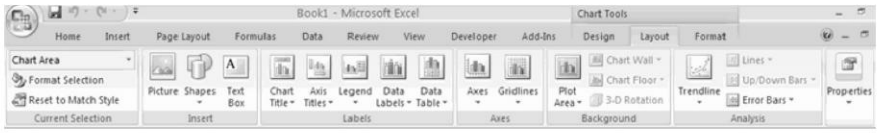
Chart Tools

The Chart Tools appear on the Ribbon when one clicks on the chart. The tools are located on three tabs: Design, Layout, and Format.

Within the **Design** tab one can control the chart type, layout, styles, and location.



Within the **Layout** tab one can control inserting pictures, shapes and text boxes, labels, axes, background, and analysis.



Within the **Format** tab one can modify shape styles, word styles and size of the chart.

Copy a Chart to Word

- Select the **chart**
- Click **Copy** on the **Home** tab
- Go to the **Word** document where you want the chart located
- Click **Paste** on the **Home** tab

WORKING WITH MULTIPLE WORKSHEETS

In business situations, sometimes the data is so vast that it spreads across multiple worksheets. In these situations, one may need to use the value from cells across different worksheet. This can be done using the formula **'sheetname!celladdress'**.

Example 1: If the value of cell A1 in the current worksheet (Sheet 1) and cell A1 in the second worksheet (Sheet 2) needs to be added. The formula for this example would be **'=A1+Sheet2!A1'** where the value of cell A1 in the current worksheet is added to the value of cell A1 in the 'Sheet2'.

Example 2: If a workbook consists of monthly sales profit data in A2 of monthly worksheet. How would one gets the consolidated quarterly sale and half-yearly sales? The monthly sales worksheets are named as January, February, March and so on.

- In a cell where one wants the quarterly sales profit, type in the following formula, which will help to link the three sheets and also consolidate the quarterly sales profit.

  =January!A2+February!A2+March!A2

This example seemed to be easy as the data was spread only in three sheets. What happens if the data is spread across six or ten or more number of sheets? In that situation, best method is to use the Sum function, as follows:

=SUM(January:March!A2) for quarterly sales profit
=SUM (January:June!A2) for half-yearly sales profit

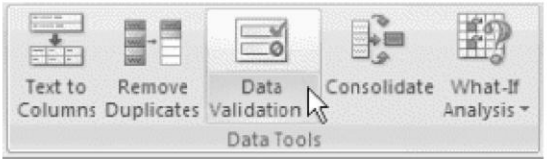
This will add the A2 cells of all the sheets within the range specified on either side of the first colon sign in the formula, which means that it will add A2 cell of January, February, and March sheets.

VALIDATING DATA

Using the validation functions in the Data Menu of Excel, it is possible to check ranges of numbers or the lengths of strings entered, and also to customise the messages that appear when the validation fails. One can even add prompts so that the user is told what to enter when he or she clicks on the cell. Probably the most useful type of validation is List. This checks entries against a list of valid entries, either typed into the Validation dialogue or from a range on the spreadsheet. More usefully, however, it creates a combo box on the spreadsheet that allows the user to select from the valid entries using the mouse.

In order to validate a cell to restrict data entry to values in a drop-down list follow these steps:

1. Select the cell that need to be validated.
2. On the **Data** tab, in the **Data Tools** group, click **Data Validation**.



3. The **Data Validation** dialog box will open.
4. In the **Data Validation** dialog box, click the **Settings** tab.
5. Click on the **Allow** box then select **List** from the drop-down list.

6. Click the **Source** box and then type the valid values separated by the appropriate list separator character depending on your installation (by default a comma "," or semicolon ";"). For example, if the cell is for a color of a car, one can limit the values by entering: Silver, Green, Blue.
7. Instead of typing the list manually, one can also create the list entries by referring to a range of cells in the same worksheet or another worksheet in the workbook.

PROTECTING CELLS

If one has created a datasheet with lot of data, formulas and decision models and wants to restrict changes in some of the data values, there is always a possibility that intentionally or unintentionally one may modify or delete the data or some formulas. What one can do is protect the cells that contain important data or formula that one does not want to change accidentally. In fact, one can also protect all of the cells into which the user does not need to enter any values; it will add the extra benefit of assisting navigation, as the TAB key moves the cursor only between unprotected cells.

The protecting cells is a simple two step process. Each cell of Excel has a locked property, which one can activate or de-activate. By default every cell of Excel has a locked property activated. The first step, therefore, is to uncheck the Locked property for all those cells that one wants the user to modify after the protection is activated. Next step is to switch on the protection, which can be done from the **Review** menu. While protecting the sheet, one can also give the password.

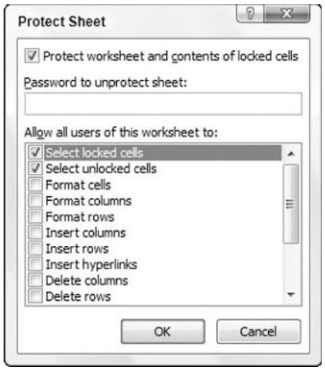
Unlocking cells: In order to unlock cells in a worksheet, follow these steps:

1. If the worksheet is protected, click the Unprotect Sheet button in the Changes group on the Review tab (type the password, if prompted).
2. Select the cells you want to unlock. These are the cells that are allowed for editing when the worksheet is protected.
3. Press Ctrl+1 to open the Format Cells dialog box and click the Protection tab.
4. Click the Locked check box on the Protection tab to remove its check mark.
5. Protect the worksheet as per the following steps.

To protect cells follow these steps in the worksheet:

1. Click the Protect Sheet command button in the Changes group on the Review tab.

   Excel opens the Protect Sheet dialog box in which one selects the options.

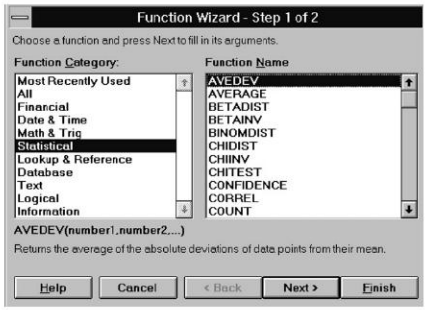


Select protection settings in the Protect Sheet dialog box.

2. Select any of the check boxes in the Allow All Users of this Worksheet to list box. The Select Locked Cells and Select Unlocked Cells check boxes are selected by default, but one can change these as per the need.
3. Click OK.

FUNCTION WIZARD (FX)

As described earlier, Excel has number of built-in functions for various business applications, which can be accessed using the function wizard f_x available on the formula bar or from the Formula Menu in case one is using Excel 2007. This will open the function windows and help to insert the selected functions. In order to insert the function, follow the undernoted steps:



- Select the cell where one wants to insert the function.
- Click the Function Wizard button on the toolbar.
- From the Insert Function dialog box, browse through the functions by clicking in the Function category menu on the left and select the appropriate function.
- Click OK to select the function, which will open the function wizard, allowing the user to type-in the variable values required for the function.
- In the example below, Excel automatically selected cells B4 and C4 for the sum function. The cell values {2, 3} are located to the right of the Number 1 field where the cell addresses are listed. If another set of cells, such as B5 and C5, needed to be added to the function, those cells would be added in the format "B5:C5" to the Number 2 field.
- Click OK when all the cells for the function have been selected.

IF FUNCTION

One can communicate decisions in the spreadsheet using the =if() function. IF function can be used for testing of one or more conditions. The syntax of IF is

```
=IF(logical test, True Value, False Value)
```

- **The Logical Test** is any condition that one wants to test to communicate the decision.
- **The True Value** is the decision action that Excel would take if the logical test is true or satisfied.
- **The False Value** is the decision action that Excel would take if the logical test is failed or false.

For example, A student will get "A" grade if scores more than 85 otherwise "F". Assuming the total marks of the student are written in A1 cell, the IF functions to test this is:

=IF(A1>=85,"A","F")

One can also test multiple If functions. One can nest IFs maximum upto 64 levels.

For example, if one wants to show whether the value in A1 is positive, negative or zero, one could write the If condition in the following manner:

=IF(A1>0,"Positive", IF(A1<0,"Negative","Zero"))

Consider another example consisting of student marks list starting from B2 cell. Each student will get a grade as per the following grading scale:

A If the student scores 80 or above

B If the student scores 60 to 79

C If the student scores 45 to 59

D If the student scores 30 to 44

FAIL If the student scores below 30

The IF function to solve this would be:

=IF(B2>=80, "A", IF(B2>=60, "B", IF(B2>=45, "C", IF(B2 >=30, "D", "Fail"))))

WHAT-IF ANALYSIS

The what-if analysis is the process of changing the values in cells to see how those changes will affect the outcome of formulas on the worksheet. Three kinds of what-if analysis tools are supported by Excel:

- **Goal Seek:** The Goal seek helps in achieving a known result by determining possible input values that produce that result. If one know the result that one wants from a formula, but one is not sure what input value the formula requires to get that result, one can use the Goal Seek.
- **Data Table:** A data table works only with one or two variables, but it can accept many different values for those variables. If one have a formula that uses one or two variables, or multiple formulas that all use one common variable, one can use a data table to see all the outcomes in one place. Using data tables makes it easy to examine a range of possibilities at a glance. Because one will focus on only one or two variables, results are easy to read and share in tabular form. If automatic recalculation is enabled for the workbook, the data in data tables immediately recalculates; as a result, you always have fresh data.
- **Scenarios:** A scenario can have multiple variables, but it can accommodate only up to 32 values. A scenario is a set of values that Excel saves and can substitute automatically in cells on a worksheet. One can create and save different groups of values on a worksheet and then switch to any of these new scenarios to view different results.

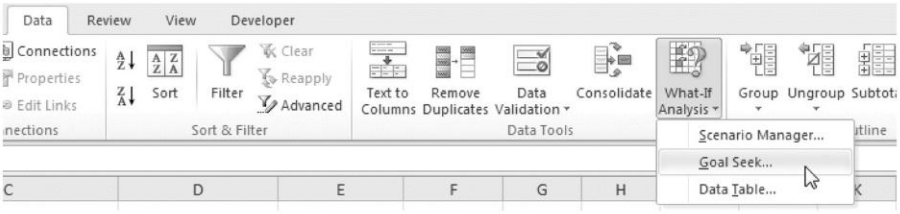
In addition to these three tools, one can also install add-ins that helps in performing what-if analysis, such as the Solver add-in. The Solver add-in is similar to Goal Seek, but it can accommodate more variables. One can also create forecasts by using the fill handle and various commands that are built into Excel.

Achieving Defined Goals (Goal Seek)

Problem 1: A retail company is thinking of opening a new stationery store in the local mall. The fixed cost to open and manage a store is Rs. 45,000, unit price that they want to charge for each item is Rs. 10 and average unit cost is Rs. 2. Management wants to find the optimal demand, so that they are able to break even.

The Goal Seek feature in Excel helps in computing a value for a spreadsheet input that makes the value of a given formula match the goal you specify. Essentially, Goal Seek embeds a powerful equation solver in your spreadsheet. To use Goal Seek:

1. On the Data tab, click What-If Analysis and select Goal Seek from the list.

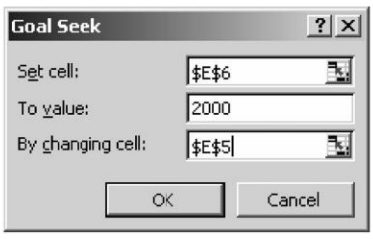


2. In a Goal Seek window, Enter:
   - **Set Cell:** This cell contains the formula that calculates the information you are seeking.
   - **To Value:** This cell includes the numerical value for the goal that is calculated in the set cell.
   - **By Changing Cell:** This is the input cell that Excel changes until the set cell calculates the goal defined in the To Value cell.
3. Click OK.

Goal Seek allows you to change one variable in a defined formula. For the given problem, Sample Worksheet is in **EX1 sheet of Chapter 6 workbook**. To get a solution to the problem, one will use the Goal Seek Function to solve, by setting the Profit Cell to Value Zero by changing the Demand Cell.

Problem 2: You borrow some money that you want to pay back in 60 months. The annual interest rate is 8 percent. As per your paying capacity you can afford monthly payments of Rs. 2000. How much can you borrow?

In order to solve this problem, first we need to set the spreadsheet to compute the monthly payment on a 60-month loan using PMT function of Excel. Refer data sheet **EX2 of Chapter 6 workbook.** As per the solution in the sheet, cell E6 has the formula *–PMT(annual_int_rate/12,years,amt._borrowed)* that computes the monthly payment associated with the amount borrowed, which is listed in cell E5. Fill in



the Goal Seek dialog box as shown below, with the E6 cell as set cell to value of Rs. 2000 for monthly payments by changing cell as E5.

SENSITIVITY ANALYSIS (DATA TABLES)

A data table cannot accommodate more than two variables. If one want to analyse more than two variables, one can use scenarios. Although it is limited to only one or two variables, a data table can use as many different variable values as one wants. A scenario can have a maximum of 32 different values, but one can create as many scenarios as one wants.

Most spreadsheet models contain assumptions about certain parameters or inputs to the model. Working on the same retail outlet model, before opening the store, you need to answer many questions like:

- The price at which they should sell
- The variable cost of procuring the items
- The sensitivity of demand for the price charged

Based on input assumptions, we often compute outputs of interest. For the above problem, the outputs of interest might include:

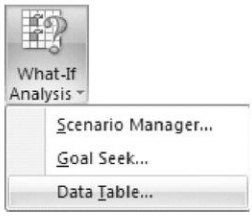
- Annual profit
- Annual revenue
- Annual variable cost

Despite best intentions, assumptions about input values and the output you get may not be correct. For example, our best guess about the average variable cost of procuring an item might be Rs. 1.00, but it is possible that our assumption will be wrong. The sensitivity analysis determines how a spreadsheet's outputs vary in response to changes to the spreadsheet's inputs. For example, we might want to see how a change in product price affects yearly profit, revenue, and variable cost. A data table in Excel makes it easy to vary one or two inputs and perform a sensitivity analysis. `Data Table` can be accessed from the `What-if Analysis` option under `Data Menu`. A one-way data table enables you to determine how changing one input will change any number of outputs. For example, one can find how change in price will affect the profitability. A two-way data table allows you to determine how changing two inputs will change a single output. This can be accessed from the Data Menu of Excel.

Problem 3: In the problem 1, what happens if one wants to change the price as well as the cost to see how it impacts the total profitability? Perform a sensitivity analysis by changing the price from Rs. 10 to Rs. 15 in a step of one and changing the cost from Rs. 1 to Rs. 5 in a step of one.

One can refer to **EX3 sheet of Chapter 6 workbook** and follow the following steps:

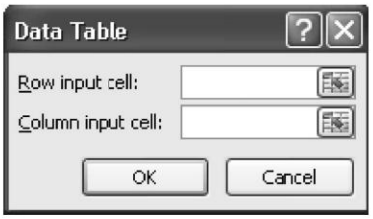
- Select the range B7:G13
- From the Excel menu bar, click on **Data**
- Locate the **Data Tools** panel



- Click on the "What-if Analysis" item:

Select the Data Table option from the 'What-if Analysis' item menu:

Click on **Data Table** to get this small dialogue box:



In the dialogue box, there is only a **Row input cell** or a **Column input cell**. We want Excel to fill downwards, down a column, so use the dialogue box, 'Column input cell'. If we were filling across in rows, we would use the "Row input cell" text box. If one wants to fill on both sides then one has to select both "Row" and "Column" Input cell.

As per the problem, the Input Cell for the Cost that is typed in a row of a table, so Row Input cell is B3 (as B3 represent cost in the original formula) and the Price, which is typed in a column of a table, so Column Input cell is B1 (as B1 represent price in the original formula). Click OK. Excel will do the necessary calculation and present the result in a table.

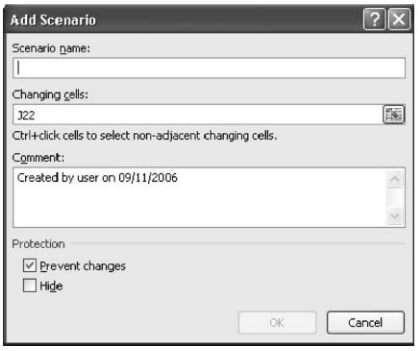
SENSITIVITY ANALYSIS WITH SCENARIO MANAGER

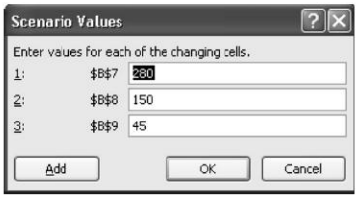
Problem 4: Referring to the same problem 1, what happens if one wants to see an impact of changes in more than two numbers of variables on the profitability? Refer sheet EX4 of Chapter 6 workbook.

The Scenario Manager enables the user to perform sensitivity analysis by varying as many as 64 input cells. In order to perform scenario analysis follow the steps:

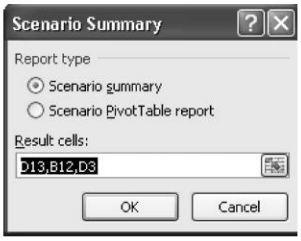
- From the **Data** menu, locate the **Data Tools** panel
- Click on the **What-if Analysis** item, and select **Scenario Manager** from the menu
- When one clicks **Scenario Manager**, one gets the following dialogue box:

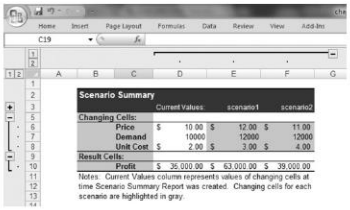
In order to create new scenario, if one click the **Add** button, one will get another dialogue box:





- First, one can type a Name for the Scenario in the **Scenario Name** box.
- Select the cells for which one wants to change the values and wants to perform scenario analysis. One can select one or more cells (maximum upto 64 cells).
- Once OK button is clicked, the Excel will wait for the new values for the selected cell(s), as per example shown below:
- Once the new values for the selected cells are entered, one should click OK. A new scenario with selected name is created and would appear in the scenario manager menu.
- Keep creating the desired number of scenarios, as per the steps explained above.
- Once all the scenarios are created, one can generate summary report by selecting summary button from the scenario manager.
- Select the Result cells on which various scenarios are to be evaluated.





Scenario Summary

	Current Values:	scenario1	scenario2
Changing Cells:			
Price	$ 10.00	$ 12.00	$ 11.00
Demand	10000	12000	12000
Unit Cost	$ 2.00	$ 3.00	$ 4.00
Result Cells:			
Profit	$ 36,000.00	$ 63,000.00	$ 39,000.00

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

EVALUATING INVESTMENTS (NET PRESENT VALUE (NPV))

Problem 5: Presume you invest Rs. 8,000 today with a financial company and the company pays you Rs. 1,000 in the 1st year, Rs. 1,500 in the second year, Rs. 2,000 in the 3rd year, Rs. 2,500 in the 4th year and Rs. 3,000 in the 5th year at 5 per cent rate. Is this a good investment?

In order to get an answer to this question, as to whether it is a good or bad investment, will depend on the returns that one gets over the period. If the present value of the future returns is more than the investment, it will be a good investment otherwise it is a bad investment decision. The best method to solve these kind of problems is to understand the concept of Net Present Value (NPV).

What is Net Present Value?

The Net Present Value (NPV) of a series of cash flows received at different points in time is simply the present value measured in today's rupees of the series of cash flows. NPV analysis is sensitive to the reliability of future cash inflows that an investment or project will yield.

Suppose, we have Rs. 1.00 today and we invest this at an annual interest rate of r per cent. This will grow to $1 + r$ Rupees in the first year, $(1 + r)^2$ in two years, and so on. We can say in some sense that Rs. 1 now equals Rs. $(1 + r)$ a year from now and Rs. $(1 + r)^2$ two years from now. In general, we can say that Rs. 1 now is equal to Rs. $(1 + r)^n$ in n years from now. As an equation, we can express this calculation as follows:

Rs. 1 now = Rs. $(1 + r)^n$ received n years from now

If we divide both sides of this equation by $(1 + r)^n$, we get the following important result:

Now = Rs. 1 received n years from now

The NPV is the difference between the present value of cash inflows and the present value of cash outflows. The NPV is used in capital budgeting to analyse the profitability of an investment or project.

The Excel has a built-in NPV function that uses the syntax **NPV(rate, range of cells)**. It helps to calculate the Net Present Value for a series of cash flows as per the given rate. The function assumes that each cash flow is as per the regular intervals for a defined period. One point which needs to clarified that the NPV function of Excel doesn't really calculate NPV. Instead, the NPV function is really just a present value of cash flow function. In Excel, there are two common ways to calculate the real NPV that are explained below using the following worksheet:

	A	B
1	Required Return	12%
2		
3	**Period**	**Cash Flow**
4	0	(800)
5	1	100
6	2	200
7	3	300
8	4	400
9	5	500
10		
11	Net Present Value (Method 1)	$ 200.18
12	Net Present Value (Method 2)	$ 200.18
13	Net Present Value (Array Formula)	$ 200.18

The spreadsheet demonstrates three methods of calculating NPV in Excel. The formulas used are:

1. Method 1: Use the NPV function, but leave out the initial outlay. Then, outside of the NPV function, subtract the initial outflow, which is often entered as a negative number. The formula used is = NPV(B1, B5:B9) + B4
2. Method 2: Use the NPV function and include the initial outflow in the range of cash flows. In this case, the "NPV" will be in period -1 so we must bring it forward one period in time. So, multiply the result by $(1 + i)$, where i is the per period discount rate. The formula used is = NPV(B1, B4:B9)*(1 + B1).
3. Method 3: Use an array formula that is somewhat different. Use the PV function, but as an array instead of the usual way of using the function. This way help in getting the NPV in one step. The formula in B13 is: =SUM(PV(B1,A4:A9,0,-B4:B9)). Remember to enter it by pressing Ctrl+Shift+Enter, otherwise you will get a #VALUE error. The

above formula runs the PV function six times – once for each cash flow – and then adds the results. However, notice that the initial outlay is included in range of cash flows. This works because the NPER argument of the PV function is 0 for the initial outlay so the formula calculates the net present value as of period 0, instead of period-1 as shown in "Method 2."

On the basis of NPV value, if it is zero or more than zero, then it is a good investment decision as one is able to at least recover the investment. If the NPV value is negative, then it is a bad investment decision.

For the problem mentioned above, the NPV equation can be formed as follows:

$$NPV = -8{,}000 + + + ...$$

Entering the formula NPV(5%, B2:B6) in cell B6 will determine the NPV for a return at the end of year 1, year 2, year 3, year 4 and year 5. We have not included the investment in the NPV function for the simple reason that the investment is being done in the beginning of year 1 and need not be discounted. Solution to the problem is given in **EX5 sheet of Chapter 6 workbook**.

What happens if we include the initial investment also in NPV function? One will do so, only if one is making the actual investment at the end of year 1 and the returns are going to happen at the end of year 2, year 3, year 4, year 5 and year 6. In that scenario, the NPV value would also change. One can see the difference in the output in **EX6 sheet of Chapter 6 workbook**. In both cases the decision point is beginning of year 1. In first case, the investment is being done in the beginning of year 1 and in the second case the investment is being done at the end of year 1.

What happens when cash flows are received at irregular intervals? The Excel **XNPV** function helps in computing the NPV of cash flows received at irregular intervals. The XNPV built-in function uses the syntax **XNPV(rate,values,dates).** The date series must start with the earliest date and subsequent dates may or may not be in increasing order. Rest of the process is same as one calculates the NPV. In order to illustrate the use of the XNPV function, consider the following problem:

Problem 6: Suppose that on 08/04/06 we invested Rs. 5,000 and expect to get the returns in the following manner:

- Rs. 1,100 on 15/08/06
- Rs. 1,400 on 15/01/07
- Rs. 2,200 on 25/06/07
- Rs. 2,100 on 03/07/09

If the annual interest rate is 8 per cent, what is the NPV of these cash flows? Refer **Sheet EX7 of Chapter 6 workbook** for solution.

EVALUATING PROJECT INVESTMENT DECISIONS USING IRR

Problem 7: Two project investment options are available and one needs to select the best. First option demands an investment of Rs. 1,00,000 and will get the return of Rs. 25,000 at

the end of the 1st year, Rs. 27,500 at the end of 2nd year, Rs. 40,000 at the end of 3rd year and Rs. 43,000 at the end of 4th year. Whereas, in the second option, on investment of Rs. 70,000, one will get Rs. 18,000, Rs. 25,000, Rs. 30,000 and Rs. 32,000 at the end of 1st, 2nd, 3rd and 4th year respectively. Evaluate which project is better.

In order to get an answer to the problem, find the rate of return for each of the two alternatives; whichever alternative gives higher return, one should select that. If a project has a unique IRR, the IRR has the best interpretation. **Refer Sheet EX8 of Chapter 6** to find that first option has an IRR of 12 per cent, whereas the second option has an IRR of 17 per cent. As per this, second project is better alternative. Sometimes, however, a project might have more than one IRR or even no IRR.

The Internal Rate of Return (IRR) of a project is the rate at which the NPV of the project is equal to zero.

The Excel has built-in function to calculate IRR. The syntax of IRR function is **IRR(range of cash flows, [guess]),** where guess is an optional argument. To calculate IRR for a series of cash flows, just select the range including the investment cell, which will always have a negative value (to indicate cash outflow). Normally, one need not enter the Guess value, in that case. The Excel begins its calculations with a guess that the project's IRR is 10 per cent and then varies the estimate of the IRR until it finds an interest rate that makes the NPV of the project equal to zero. If Excel is unable to find the appropriate rate that makes the project NPV equal to zero, Excel returns #NUM. This does not mean the function that one has typed is wrong, but the numbers of iterations are not sufficient to calculate the IRR with 10 per cent as its initial guess. If one gets #NUM instead of IRR, one must use the guess value and re-calculate the IRR. The guess value has to be any value other than 10 per cent. One cannot change the number of iterations while calculating IRR. The maximum number of iterations allowed is 100.

There is a possibility that a project might have more than one IRR. In order to check whether a project has more than one IRR, one can vary the initial guess value. There are peculiar instances, when a particular project may not have any IRR. When a project has multiple IRRs or no IRR, the concept of IRR loses all meaning. Despite this problem, however, many companies still use IRR as a major tool for ranking investments.

Like NPV, IRR function also works on the major assumption that all the cash flows are happening after regular pre-defined intervals. What happens if these cash flows happen at irregular intervals? Same like XNPV, Excel has another function called **XIRR**. The syntax for this functions is **XIRR (cash flow, dates, [guess]).** The XIRR function determines the IRR of a series of cash flows that occur on any set of irregularly spaced dates. Here again, guess is an optional argument. You may try doing the same example of XNPV.

LOOKUP FUNCTIONS

Problem 8: Given the income tax slabs, how would one calculate the tax for all its employees? At the sales counter, how would one find the unit price of a product from a product master table?

The Excel has a powerful built-in Lookup functions that facilitates to look for values from worksheet ranges. The Excel allows the users either to perform vertical lookups (using VLOOKUP functions) or horizontal lookups (using HLOOKUP functions). One will use the vertical lookup, if the decision table (lookup table) is arranged in the vertical manner and the lookup operation is performed on the first column of the decision table from top to bottom. In horizontal lookup, the decision table is arranged in horizontal manner and lookup operation is performed in the first row of the decision table from left to right. The functioning of Vlookup and Hlookup is same.

The syntax of VLOOKUP function is as follows.

```
VLOOKUP(lookup value, table range, column index, [range lookup])
```

- **The Lookup value** is the value that we want to look up in the first column of the table range (decision table).
- **The Table range** is the range that contains the entire lookup table (decision table). The table range includes the first column, in which we try and match the lookup value, and any other columns in which we will look up formula results.
- **The Column index** is the column number in the table range (decision table) from which the value of the lookup function is obtained.
- **The Range lookup** is an optional argument. If range lookup is true or is omitted, the first column of the table range must be sorted in ascending order. If range lookup is True or omitted, Excel will do the closest or partial match or the range based match. This option is good where one has range based decisions like the income tax slabs. If range lookup is False, an exact match to the lookup value is found in the first column of the table range. This option is good when one wants to do the perfect matching like finding the exact product price. In case no exact match is found, Excel will return an #N/A response (Not Available).

The syntax of HLOOKUP function is as follows:

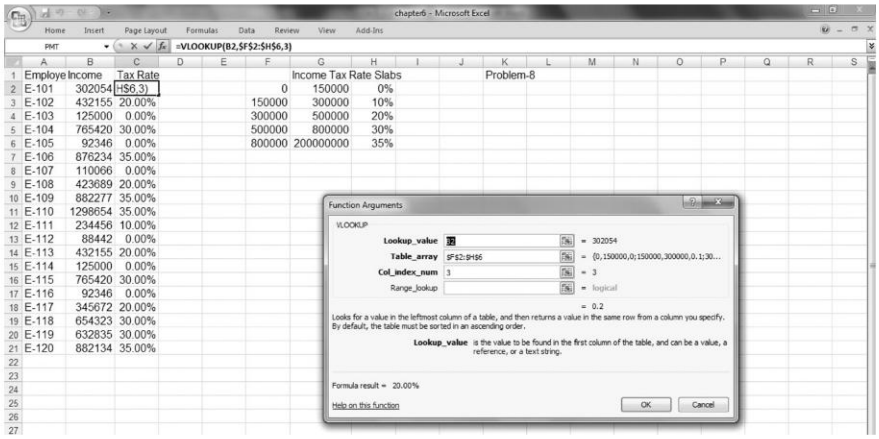
```
HLOOKUP(lookup value, table range, row index, [range lookup])
```

As described earlier, for HLOOKUP function, simply change 'column' to 'row'. Thus, in an HLOOKUP function, Excel tries to locate the lookup value in the first row (not the first column) of the table range.

Given the income tax slabs, how would one calculate the tax for all its employees? Suppose that the tax rate depends on the following income slabs:

Income Level	Tax Rate
Less than Rs. 1.5 lakh	No Tax
Rs. 1.5 lakh to Rs. 3.00 lakh	10 per cent
Rs. 3.00 lakh to Rs. 5.00 lakh	20 per cent
Rs. 5.00 lakh to Rs. 8.00 lakh	30 per cent
Rs. 8.00 lakh and above	35 per cent

We refer to **sheet EX9 of Chapter 6** workbook to see how to write a formula that computes the tax rate for any income level. The corresponding screen shot is also given below:

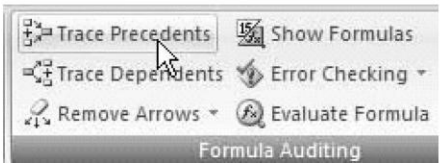


If one refers to the EX9 sheet, one will find the decision table is defined as f2:h6, which is a three column table. The first column of this table consists of lookup value on which the decision is dependent, column two is added just to increase readability and column three consists of actual decision, i.e. the tax rate. One can avoid using the second column, as in Vlookup, lookup value always match from column one only.

AUDITING TOOL

Problem 9: While creating a monthly budget sheet, the accountant realised that the sales revenue is wrongly entered in cell. Before making the necessary correction in the sheet, the accountant wants to find which all cells get affected, if the change is made?

The Auditing Tool of Excel helps in solving the accountant's problem. The Excel auditing tool provides an easy method for documenting the structure of a spreadsheet, which makes it easy to understand and modify the complicated formula based sheet. Formula Auditing tools are available under the Formula Menu and show various Auditing Tools as shown below:

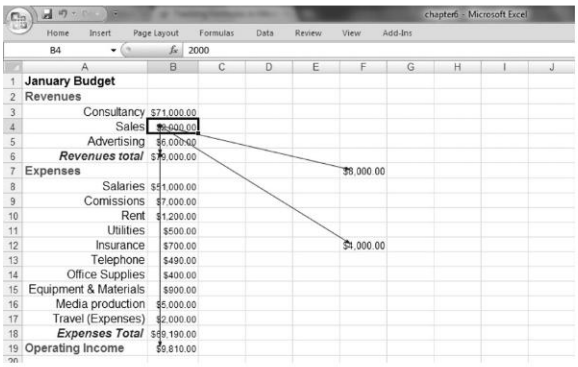


The Formula Auditing command is a very powerful tool of Excel that helps in finding the precedents, dependents for spreadsheet cells or formulas, evaluating the formula, and displaying the complete formula.

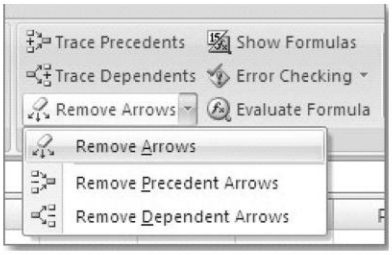
Trace precedent helps in finding any cell whose value is needed to compute a selected formula value by drawing blue arrows. For example, if total revenue is calculated on the basis of total sales, consulting income, advertising then all these variable values are precedents of the total revenue formula cell.

Trace dependent traces any cell containing a formula whose values cannot be computed without the selected cell. In the given problem (refer sheet **EX10 of Chapter 6 workbook**), the cell containing the total sales, consultancy and advertising are the dependent of the cell containing

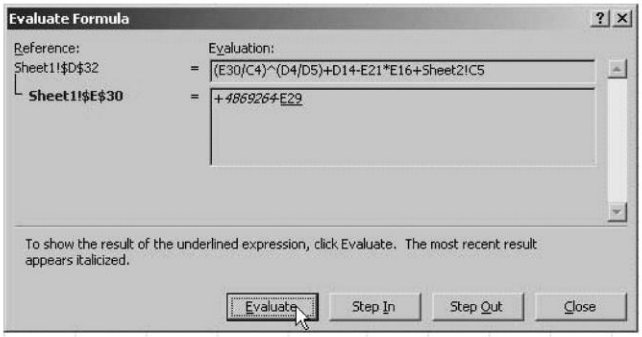
the total revenue. The Excel marks precedents and dependents with blue arrows when you use the auditing tool as shown in the figure below.



Removing Arrows: Though these arrows are removed automatically after sometime, but one can use the Remove Arrows button to remove all the arrows used in Formula Auditing.



Evaluating Formula: It allows to see the formula get calculated step-by-step. The command is under Formulas ribbon in Excel 2007. Select a cell and choose Evaluate Formula. The dialog shows the formula. The term that is underlined is the term that Excel will evaluate next. One can either evaluate that term or Step In. In this example shown below as part of the screen shot, Stepped In is used to see the formula in E30. The first term of the stepped in formula is evaluated and is about to evaluate the second term. Once the result of E30is seen, one can Step Out and keep calculating.



COUNT FUNCTIONS

Problem 10: How to find number of blank cells in a selected range? How to find the number of sales transactions above Rs. 6,000? How to find the number sales transactions done by a specific salesperson?

While working with lot of data, one often wants to count the number of cells in a range that meet a given criterion. Excel offers an assortment of counting functions — including COUNT, COUNTA, COUNTBLANK, and COUNTIF — that enables to count the number of cells that contain numeric values, that are nonblank (and thus contain entries of any kind), or whose values meet the specified criteria. For example, if a spreadsheet contains filled and empty cells, one may use the simple COUNT function to count the number of filled cells.

COUNT: The COUNT function counts the number of cells in a range containing numbers. The syntax of Count function is:

```
COUNT(range).
```

COUNTIF: If the worksheet has sales data about the sales done by the various salespersons, one may find the number of sales transactions that are above Rs. 6,000. One can use the COUNTIF function to get the answer. The COUNTIF function helps in counting the number of cells in a range that meets the defined criteria. The power of COUNTIF function is dependent on the powerful criteria that one uses. For example, let us load the **EX11 sheet from Chapter 6 workbook**. The syntax of the COUNTIF function is:

```
COUNTIF(range, criteria).
```

- The Range refers to the range of cells on which one wants to test the given criterion.
- The criteria can be a number, date, or expression.

COUNTA: The COUNTA function counts the number of non-blank cells in a range.

COUNTBLANK: The COUNTBLANK function counts the number of blank cells in a range.

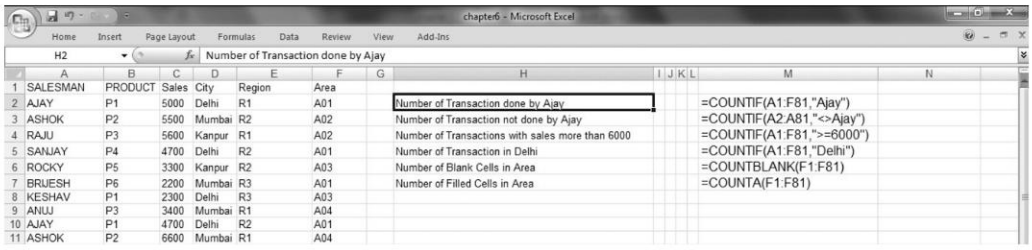
Some of the examples given below illustrates how to use these Count functions:

- To find the number of sales transactions done by salesperson 'Ajay', one will use the function as follows:
  - =COUNTIF(A1:F81,'Ajay')
- To find the number of sales transactions done by salesperson other than 'Ajay', one will use the function as follows:
  - =COUNTIF(A2:A81,'<>Ajay')
- To find the number of transactions with sales more than 6000:
  - =COUNTIF(A1:F81,'>=6000')
- To find the number of sales transactions in Delhi:
  - =COUNTIF(A1:F81,'Delhi')
- To find the number of blank cells in the Area Column:
  - =COUNTBLANK(F1:F81)

- To find number of non-blank cells in the Area Column:
  - =COUNTA(F1:F81)

THE SUMIF FUNCTION

Problem 11: Given the sales data, how will one find the total sales done by 'Ajay'? How will one find the city specific or region specific or area specific sales? What is the sale of a specific product 'P1'? What is the total sale done by salespersons other than 'Ajay'?



	A	B	C	D	E	F
1	SALESMAN	PRODUCT	Sales	City	Region	Area
2	AJAY	P1	5000	Delhi	R1	A01
3	ASHOK	P2	5500	Mumbai	R2	A02
4	RAJU	P3	5600	Kanpur	R1	A02
5	SANJAY	P4	4700	Delhi	R2	A01
6	ROCKY	P5	3300	Kanpur	R2	A03
7	BRIJESH	P6	2200	Mumbai	R3	A01
8	KESHAV	P1	2300	Delhi	R3	A03
9	ANUJ	P3	3400	Mumbai	R1	A04
10	AJAY	P1	4700	Delhi	R2	A01
11	ASHOK	P2	6600	Mumbai	R1	A04

If one wants to find solutions to the above mentioned problems, one needs to use the SUMIF function of Excel. The syntax of this function is

`SUMIF(range, criteria, [sum range]).`

- The range refers to the range of cells on which one wants to test the given criterion.
- The Criteria can be a number, date, or expression.
- The Sum range is the range of cells that needs to be added. If sum range is omitted, it will take the complete range as specified in the range.

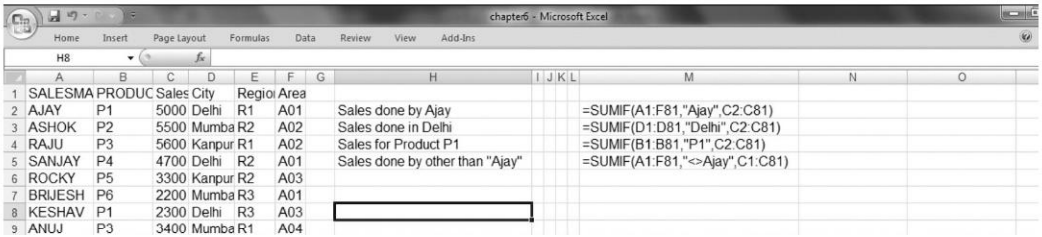
The rules to define the criteria are the same as one defines it for the COUNTIF function.

The answers to the above mentioned problems are given in the sheet **EX12 of Chapter 6 workbook**.

One can notice that in all the examples, sum range have been used to tell Excel to sum the cells from the sum range only.

CREATING SUBTOTALS

Problem 12: On sales data, what happens if one wants to find the salesperson wise, product wise total sales? How the city wise, region wise, area wise sales will be determined?



	A	B	C	D	E	F
1	SALESMA	PRODUC	Sales	City	Regio	Area
2	AJAY	P1	5000	Delhi	R1	A01
3	ASHOK	P2	5500	Mumba	R2	A02
4	RAJU	P3	5600	Kanpur	R1	A02
5	SANJAY	P4	4700	Delhi	R2	A01
6	ROCKY	P5	3300	Kanpur	R2	A03
7	BRIJESH	P6	2200	Mumba	R3	A01
8	KESHAV	P1	2300	Delhi	R3	A03
9	ANUJ	P3	3400	Mumba	R1	A04

The SUMIF function helps to calculate the total sales done by any individual salesperson or for one product or for one city. From a sales database, one might want to create a summary of sales done by each salesperson, or summary of sales by region, a summary of sales by product, and a summary of sales by salesperson. If the sales database is sorted in a specific order, SUBTOTAL function of Excel helps in summarising the data as per the need. In order to use SUBTOTAL function of Excel, one needs to first sort the database in the same order in which one wants to summarise the database. For example, if one wants to find sales summary as per salesperson and product sold, then one must sort the database first by salesperson and then by product. Once the database is sorted, one can use the SUBTOTAL option as per the following steps:

1. Select the data on which subtotal needs to done.
2. Sort the data as per the subtotal order
3. From the Data command tab, in the Outline group, click SUBTOTAL 

   The Subtotal dialog box appears
4. Select the 'Salesperson' Column 'At each Change in' pull-down list. It is important to select the field on which the data was sorted.
5. Use Sum function from the function list. Subtotal function of Excel supports eleven different mathematical functions like Average, Count, Max, Min, Sum, etc. One can select any one of these functions while generating subtotals.
6. Select sales field under 'Add subtotal to' option and select OK.

When the subtotals are applied to the selected data range, an outline bar appears to the left of the row numbers. The 1|2|3 represents levels of detail in the view

- **Level 1:** grand total
- **Level 2:** subtotals and grand total
- **Level 3:** all data in range

Refer to **EX13 of Chapter 6 workbook** for the solution to the above problem.

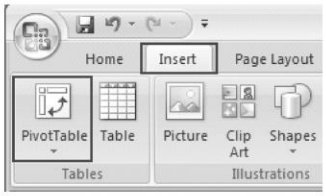
PIVOTTABLES TO DESCRIBE DATA

Problem 13: A market research company conducted the customer satisfaction survey for a leading public sector bank to find out the attitude of bank customers towards bank services. The data was collected from seventy different customers with respect to their age, education qualifications, income group, gender, etc. As part of the analysis the research company wants to find how age, education, income and gender influence the satisfaction levels?

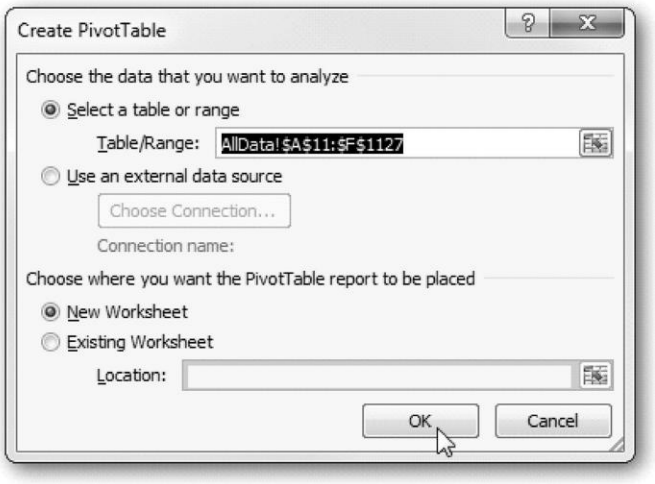
In number of business situations, one needs to analyse the large amount of data to get important business insights. Sometimes, one may also need to slice or dice the data available to get more clarity about the relationships between data elements. In the case of the above problem, one

would like to slice the data to find whether the age or gender or income or education affects the user satisfaction levels. The PivotTable in Excel is an incredibly powerful tool that can be used to slice and dice data. The PivotTables can be created in Excel using Insert Menu.

A PivotTable organises and then summarises large amounts of data from any range that has labelled columns. One can alternatively choose to create a PivotChart, which will summarise the data in chart format rather than as a table. It is called a PivotTable because the headings can be rotated around the data to view or summarise it in different ways. One can also filter the data to get the focused display. It is always better to create the pivot into a new worksheet. If one wants the PivotTable to be in the same worksheet, select Existing Worksheet and then select a blank cell where the left corner of the PivotTable will appear. In order to create pivot tables,:



1. Select the data range on which the pivot is to be created
2. From the `Insert Menu` click the `PivotTable` option and following screen may appear.



In order to find the customer satisfaction by gender, one will have to drag the gender variable from the field list and either drop it on 'Drop Row Field Here' or drop it at the Row Area or may simply select the Gender variable. Next one has to select the Confidence Group (confgrp) and drop it either at 'Drop Data Field Here' or at 'Values'. It will automatically give you the PivotTable results. If one analyses the pivot, it is evident that 20 out 33 female respondents are satisfied, while 17 out of 37 male respondents are satisfied. Data for the problem is given in sheet **EX14 of Chapter 6 workbook**.

In this example, we have used the count function to find the number of respondents meeting specific objective. One can double click on the count function to get more alternatives like sum, average, max, min, etc. The Pivot supports eleven built-in functions to compare variables on, and also offer an option of creating a user defined formula under the PivotTable Tools. With the formula option, the user can create any Excel valid formula using the selected variable list.

By just dragging a field from row to column or vice versa, one can easily switch the layout of the pivot view. By clicking on the drop down arrow next to Gender, one can select just male or female results if one wants to focus on one or more variable value options. This option helps the user to filter the pivot output.

Similarly, one can try creating pivot to find how age or income or education influences the satisfaction level of the bank users. In order to avail this, one can simply uncheck the Gender and select one of these variables or may be more than one variable. One can also depict the same analysis in a graphical format using the chart option under Pivot menu toolbar. Both PivotChart and PivotTable are dynamically linked, which means any change carried on the chart will automatically be reflected on the table also.

If there are number of variables to be summarised and one wants to have a multidimensional view of the data, Pivot supports Page Fields option. This will help to filter the data on a broader level while giving comparative summary among multiple variables. For example, if one wants to compare sales person versus products sales, with comparison city wise.

Grouping Items: Often one wants to group data in a PivotTable. For example, one wants to combine sales for various quarters. To create a group, select the items that needs to be grouped, right click the selection, and then choose Group. An additional column is created with a group heading in the PivotTable. One can always disband a group by selecting Group and then Ungroup.

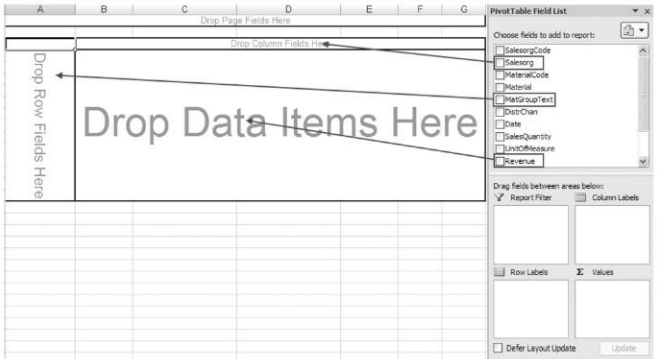
Drilling Down: If one double-clicks on a cell in a PivotTable, it will drill the data to the detailed data that is used for summarising that field.

Refreshing a PivotTable: One can always refresh the PivotTable or Pivot Chart by clicking the refresh data button on the PivotTable Toolbar.

Case: Intelligent Reporting using Pivot Tables

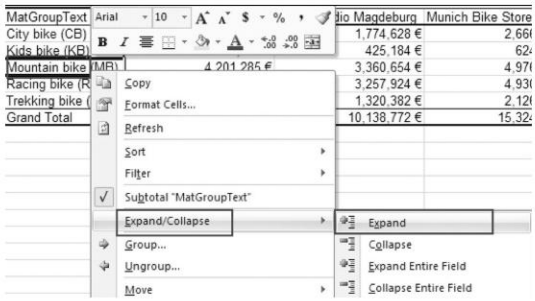
You are a manager of a several sales organisations and one of your responsibilities is monitoring and managing sales activities. You have a number of OLTP systems to assist with the recording of day-to-day transactions. At the end of each month, you are provided with a report which displays each sale. The purpose of this case is to create a PivotTable in Microsoft Excel to analyse the data using multi-dimensional reporting. A number of multi-dimensional navigational techniques will be introduced.

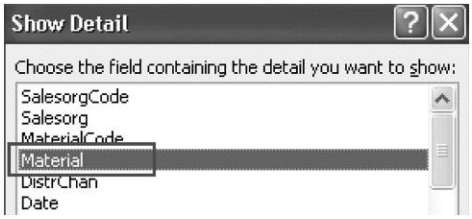
1. Open the Microsoft Excel sheet **EX15 from Chapter 6** workbook.
2. Create a PivotTable to determine the total revenue for material groups in each sales organisation.



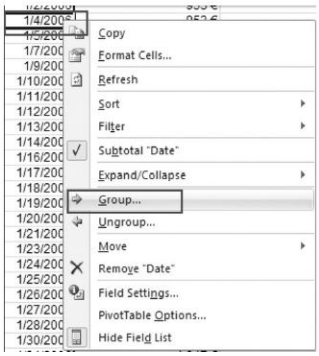
3. Slice the data to restrict the output to internet sales. Move the Distribution Channel to the Report filter and select Internet from the drop down list.

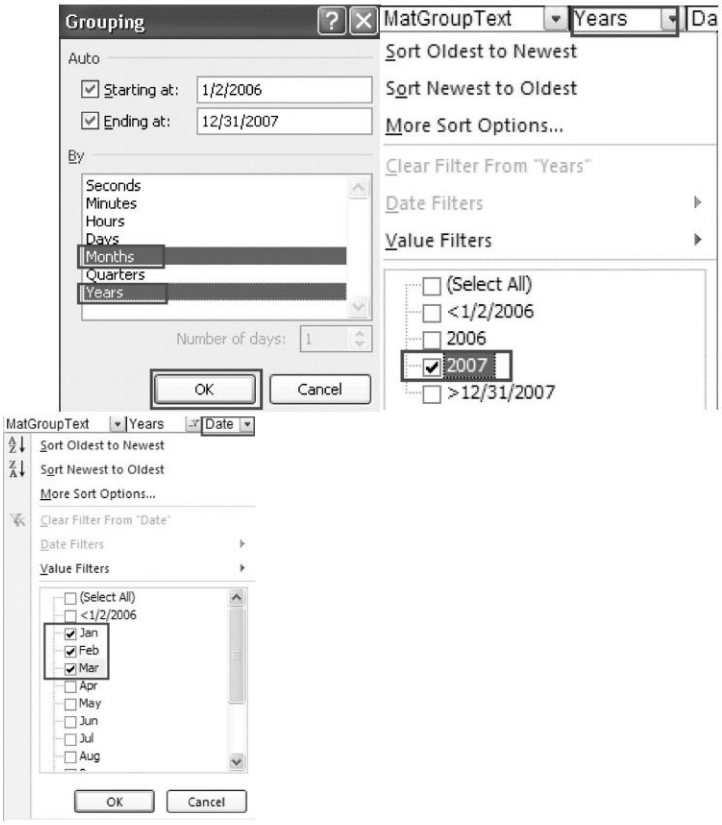
4. Drill-Down the report to show all products for mountain bikes.





5. Remove Drill-Down for material and Dice to restrict to first quarter of 2007 by adding field Date to rows first and use grouping.

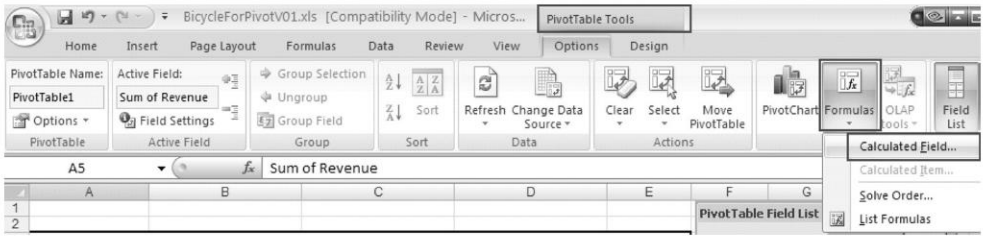


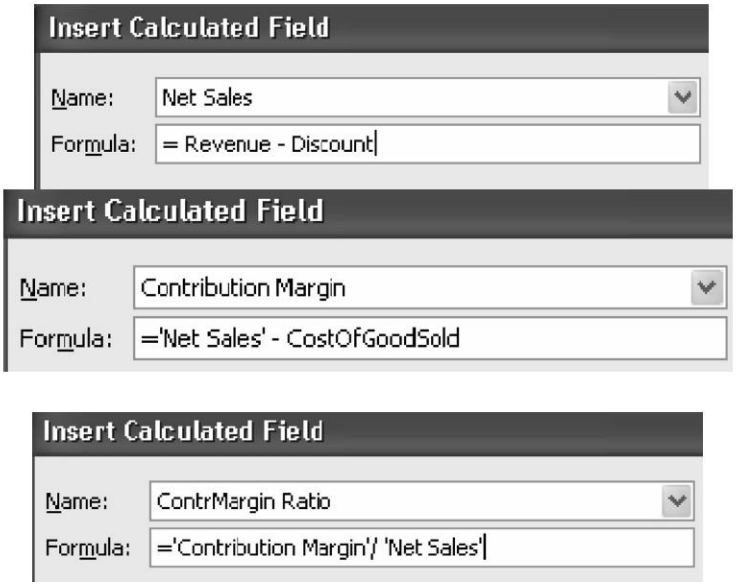


	A	B	C	D	E
1	DistrChan	Internet			
2					
3	Sum of Revenue			Salesorg	
4	MatGroupText	Years	Date	Bikes Studio Berlin	Bikes Studio Magdeburg
5	⊞City bike (CB)			121,466 €	91,512 €
6	⊞Kids bike (KB)			27,932 €	22,294 €
7	⊟Mountain bike (MB	⊟2007	Jan	61,340 €	34,313 €
8			Feb	70,387 €	61,340 €
9			Mar	120,152 €	82,604 €
10	Mountain bike (MB) Total			251,879 €	178,257 €
11	⊞Racing bike (RB)			233,067 €	161,094 €
12	⊞Trekking bike (TB)			103,489 €	76,876 €
13	Grand Total			737,833 €	530,033 €

6. Which product provided the most Contribution Margin Ratio?

   The Contribution Margin Ratio is defined as Percentage of Contribution Margin over Net Sales, where Net Sales is Revenue – Discount and Contribution Margin is Net Sales – Cost of Good Sold.





RESOURCE OPTIMISATION

The managers often have to make decisions on how best to allocate scarce resources among competing activities. The limited resources such as machinery, time, materials, labour, and money are used to manufacture various products, or provide services such as investment plans and advertising strategies. Typically, there are many different ways to produce these products or services. The management's problem is to find the best way, given the limitations of the resources.

The Linear Programming (LP) is a widely used mathematical technique designed to help in the planning and allocation of key organisational resources. The word 'linear' refers to the fact that all equations and inequalities associated with an LP problem must have linear relationships. The 'programming' part refers to the iterative process that is used to derive an optimum solution. All LP problems have two main aspects, namely:

- Maximise or minimise some quantity such as profit or cost. Having decided upon the objective to be optimised, it is then necessary to define it mathematically, i.e., to formulate the 'objective function'. Typical objectives include:

  - how to find the optimal allocation of parts inventory to minimise production costs,
  - how to create the most efficient personnel schedule to minimise costs while meeting business needs and individual scheduling requests,
  - how to optimise allocation of funds in an investment portfolio to maximise profits.
- The use of scarce resources places restrictions on the alternative courses of action available to a manager. These resource limitations, called 'constraints', are described in terms of linear inequalities, expressed either as ≥ (greater-than-or-equal-to) or ≤ (less-than-or-equal-to). It is the presence of these resource inequalities that creates alternative solutions, with (usually) only one solution being optimal.

The linear programming problems fall into two main categories: (i) blending or product mix problems (ii) transportation problems. The blending or product mix problems focus on achieving an optimum combination of resources in order to maximise profits or minimise costs. A popular business mix problem relates to portfolio management, whereby a bank wants to allocate funds in order to achieve the highest possible return on its investment.

The transportation problems involve a number of supply sources (e.g., warehouses) and a number of destinations (e.g., retail shops). The objective is to minimise the transportation costs involved in moving wholesale products from warehouses to shops. The transportation problems are therefore concerned with selecting minimum cost routes in a product-distribution network between sources and destinations. The special case of the transportation problem known as the 'assignment method', involves assigning employees or machines to different tasks on a one-to-one basis. In this situation, only one source item is assigned to each of the various destinations. Both transportation and assignment problems belong to the wider class of LP problems known as 'network flow problems'.

In many situations, solutions to LP problems make sense only if they have integer (whole number) values. The quantities such as $27^2/_3$ employees or 22½ tables are unrealistic. Simply rounding of the LP solution to the nearest whole number may not produce a feasible solution. 'Integer programming' (IP) is the term used to describe an LP problem that requires the solution to have integer values.

One of the limitations of linear programming is that it allows only one objective function to be optimised. Thus, the decision-maker must focus on a single objective or goal at a time. However, managers frequently want to optimise several conflicting goals at the same time, e.g., how to maximise both production and profits or to maximise profits while minimising risk. 'Goal programming' (GP) is a variation of linear programming that provides for multiple objective optimisation. The GP involves making trade-offs among several goals or objectives until a solution is found that satisfies the decision-maker (GP differs from LP in that it does not produce an optimum solution. Rather, it provides a method whereby the decision-maker can explore alternative solutions and then choose that solution which comes closest to meeting the goals under consideration.

While all LP problems contain only linear relationships, problems do exist in which equations and/or inequalities are non-linear. Non-linear programming (NLP) is a technique, which can solve problems containing non-linear relationships. A simple definition of a non-linear relationship is

any equation which does not conform to the straight-line relationship, y = a + bt. Formulating an NLP problem is exactly the same as formulating an LP problem, except that the objective and/or constraints may be non-linear.

A **Solver** is a powerful tool for analysing and solving various types of linear programming problems which contain many variables and constraints. The Excel's solver can analyse and solve three types of problems, namely linear programming (LP), integer programming (IP), and non-linear programming (NLP).

Problem 14: A leading Manufacturing company that manufactures two products wants to decide the appropriate product mix to maximise its profitability.

The Mace Oil Company manufactures two products—High Octane and Low Octane gasoline. The company earns a profit of Rs. 4 per box for high octane and Rs. 6 a box for low octane. Each product is manufactured and packaged. It takes 13 minutes to manufacture a box of high octane and 22 minutes for a box of low octane. The packaging department can package a box of high octane in 16 minutes, while a box of low octane takes 10 minutes. Mace wants to find out what combination of boxes of high and low octane will maximise total profit, given that there is a maximum of 2,100 hours available in manufacturing line and also 2,100 hours in the packaging department. The company has decided to see if Excel's Solver can provide a satisfactory solution, so the first step is to formulate the problem as an LP problem. In order to formulate any LP problem, one needs to be clear about the Decision Variables, Objective Function and the Constraints.

Let x_1, x_2 be the optimum number of boxes of high octane and low octane. So the decision variable that needs to be determined is x_1 and x_2. Mace's objective is to maximise profit, i.e., profit (Z) maximisation, where

$$Z = 4x_1 + 6x_2 \text{ (Maximise)}$$

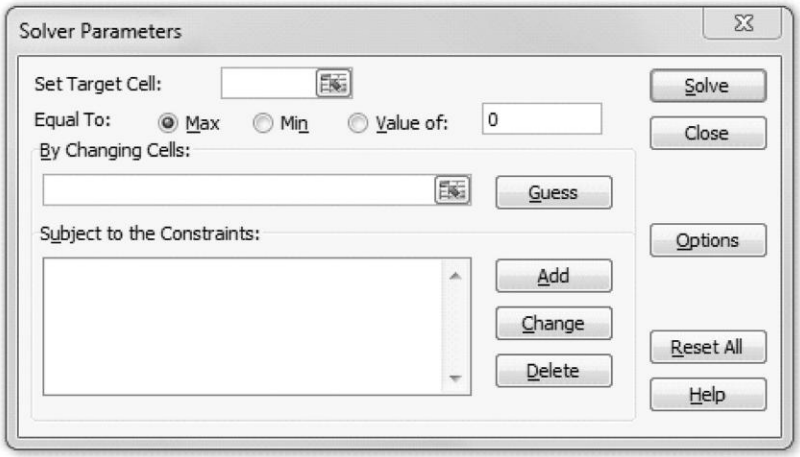
Subject to the following four constraints:

- $13x_1 + 22x_2 \leq 126{,}000$ minutes
- $16x_1 + 10x_2 \leq 126{,}000$ minutes
- $x_1, x_2 \geq 0$ (x_1, x_2 must be positive values)
- x_1, x_2 = int(eger) (x_1, x_2 must be integer values)

The Excel's Solver uses the same approach as defined in the above formulation, except that it uses cell references instead of X_1 and X_2. Another thing, which one needs to keep in mind before using solver function is that all formula needs to be defined within the Excel sheet, as solver does not allow any formula to be typed within the tool. `Solver tool` can be loaded from the `Data menu`.

The **Target cell** in Solver is always the objective function cell, i.e., the cell that contains the objective function formula, which is to be either maximised, or minimised.

The **Changing cells** in Solver are the decision variable cells. As per the Mace example, these are those cells where high and low octane values needs to be calculated. In Excel, the changing cells are usually assigned an zero or one value.



The **Constraints** in Solver are the cells where the limiting formulas are defined.

The Complete formulation of the Mace problem is done in **EX16 sheet of Chapter 6 workbook**. Note that the 'Solver Parameters' details and formula used are given on lines 14 to 24. These are not part of the model and are provided only for better understanding. For example, the target cell used in the model is F11 and changing cells are G5 and G6. By using the define constraints, model generated an optimal solution of manufacturing 6,810 units of high octane and 1,703 units of low octane gasoline with profit maximisation of Rs. 37,458. If one looks at the resource utilisation, company will utilise 125,996 minutes from total 126,000 minutes available in the manufacturing department and will utilise 125,990 minutes in the packaging department out of 126,000 minutes available.

SUMMARY

- The Microsoft® Office Excel® 2007 spreadsheet software is an integrated decision-making tool for decision makers who rely on working with information efficiently and productively. The Excel is a powerful tool to create and format spreadsheets, to analyse and share information to make more informed decisions. It has number of built-in functions and tools that allow user to organise the data and analyse it. The user can also create own formulas and functions. In Excel, one can define formula in three different manners using – Relative, Absolute, and Mixed cell referencing.
- The organising and working with large databases is always a challenging task. The Excel, row and column capacity do not pose any such limits and make it easy to analyse large amounts of data. The user friendly features of Excel offer most of the advanced tools and capabilities in menus and sub-menus, allowing users to find these commands and work on them without any assistance. The data becomes more meaningful if it is presented in chart formats—Excel allows the users to present the data either in tabular or chart formats. The professionaly designed reports and charts are now simple to create.
- The Excel can be used to manage business applications like payroll for a small organisation or monthly budgets or monthly accounts. In order to manage these applications effectively and

efficiently, one can always create templates and update only the required data set without changing the formulas and functions. In order to minimise the errors and risk, Excel supports the data validation tools, data protection tools, and decision tools on the basis of pre-defined rules using if() and lookup functions.

- A decision-maker is one who takes decisions, but while taking these decisions always does lot of permutations and combinations. The Excel is a powerful tool that supports the decision-maker with different decision methodologies whereby one can do backward calculations using Goal Seek, if the output is known. One can also do what-if analysis using Data-tables or Scenario Manager and minimise the error or the risk associated with the decision.
- The Excel has number of financial, statistical, mathematical, date, logical, and many other built-in functions. Depending on the business problem, one can make use of these functions. Like one uses some of the common financial functions such as NPV and IRR for evaluating project investment decisions. One may also use Countif or Sumif functions to selectively perform the count or sum function based on certain criteria.
- When large amount of data is collected, finding patterns out of that data is always expert dependent. Users used to usually struggle to discover patterns or trends, or to reorder the data to make more informed decisions. Sorting, Filtering, Subtotals, and PivotTable are some of the tools that help the user in summarising the data and finding hidden patterns out of it. The PivotTables and Charts are powerful tools for reorienting large amounts of data to answer different questions that were difficult to create, putting them out of reach for all but the most advanced Excel users. The sorting and filtering are two of the most important types of basic analysis that one can do with data.
- The Excel can also be used for solving resource optimisation problems using Solver. This tool helps in solving linear, non-linear, transportation and integer problems. One needs to define the objective functions comprising of decision variables that one wants to determine under the known constraints.

KEY TERMS

Auditing Tools
Auto Sum
Basic Functions
Cell Referencing
Cells
Charts
Closing Files
Copying Formula
Count
CountA
Countblank
Countif
Evaluating Project Investments
Formatting Cells
Formula
Functions
Goal Seek
Hlookup
If
IRR
Linear Programming
Linking Worksheets
Lookup
NPV
Optimisation
Pivot Charts
PivotTables
Protecting Cells
Saving Files
Scenarios
Sensitivity Analysis
Solver
Sort
Subtotals
Sum
Sumif
Transportation Models
Validating Data
Vlookup
What-if
Workbook
Worksheet
XIRR
XNPV

SELF-STUDY QUESTIONS

1. In Microsoft Excel 2007, _____ is used to issue commands.
   (a) Office Button (b) Ribbon (c) Command Bar (d) Title Bar
2. Which one of the following information you cannot enter in Excel worksheet?
   (a) Labels (b) Values (c) Formulas (d) Charts
3. Which one of the following functions is not part of Auto Sum button?
   (a) Average (b) Max (c) Min (d) IF
4. With _____cell addressing, when a formula is copied from one area of the worksheet to another, Excel references the same cells, no matter where the formula is copied.
5. One can apply sort states with up to _____ sort conditions to sort data.
6. To refer to A5 cell of sheet2 worksheet in the current cell of sheet1, one needs to type:
   (a) =sheet1!A5 (b) =sheet2!A5 (c) =sheet1#A5 (d) =A5!sheet2
7. _____ is the process of changing the values in cells to see how those changes will affect the outcome of formulas on the worksheet.
8. _____ allows to change multiple variables to generate multiple alternatives.
9. The NPV is the difference between the present values of _____ and present values of _____.
10. The Excel _____ tool provides an easy method for documenting the structure of a spreadsheet, which makes it easy to understand and modify the complicated formula based sheet.

REVIEW QUESTIONS

1. List five business applications for which one can use Excel.
2. List some of the sensitivity tools of Excel.
3. Why one needs to sort the data to perform subtotals?
4. Solver of Excel is used to solve what kind of resource optimisation problems.
5. Describe the complete process to link two or more worksheets.
6. How NPV is different from XIRR?
7. While using NPV, in what scenario one can say the project is viable?
8. When does one use the Vlookup and when is the Hlookup function used?
9. How one can find the number of blank cells from a given range?
10. What is the relevance of Auditing Tools in Excel?

QUESTIONS FOR DISCUSSION

1. Rahul wants a housing loan for construction of a house. The estimated construction cost is Rs. 20 lakhs. Rahul can contribute Rs. 4 lakhs from his own savings and the balance he needs to get it financed from a bank @ 8 per cent per annum for 10 years. What will be the monthly EMI that he needs to pay to the bank to repay the loan?

2. The monthly instalment as per the above conditions is not suitable and does not fit into Rahul's monthly budget. The maximum that he can pay is Rs. 18,000 per month. He is ready to increase the repayment period. Find the repayment period that fits into Rahul's budget (assuming all conditions remain same).
3. Sonia has just won a lottery. At the end of each of the next 10 years, she will receive a payment of Rs. 60,000. If the cost of capital is 10 per cent per year, what is the present value of Sonia's lottery?
4. I am going to organise a conference. My fixed costs are Rs. 25,000, and I must pay the catering company Rs. 300 per participant. Each of the 10 speakers must be paid Rs. 1,500. I am charging my participants Rs. 2,000. How many paid participants need to attend my conference to break even my costs?
5. You invest Rs. 8,000 today with a financial company and the company pays you Rs. 1,000 in the 1st year, Rs. 1,500 in the 2nd year, Rs. 2,000 in the 3rd year, Rs. 2,500 in the 4th year and Rs. 3,000 in the 5th year at 5 per cent rate. Is this a good investment?
6. For a payment of Rs. 10,000, a finance company will pay back Rs. 3000 every year for next four years. Whereas, bank offers 5 per cent interest rate in its saving bank account. Find out where one should invest?
7. Two investment options are available to you. In the first option, for Rs. 1,000 of investment, you will get Rs. 450 at the end of the 1st year, Rs. 325 at the end of 2nd year, Rs. 400 at the end of 3rd year and Rs. 300 at the end of 4th year. Whereas in the second option, for Rs. 700 of investment, you will get Rs. 250, Rs. 300, Rs. 500 and Rs. 200 at the end of 1st, 2nd, 3rd and 4th year respectively. Evaluate which scheme offers better returns.
8. A company produces two products that are processed on two assembly lines. Assembly line 1 has 100 available hours, and assembly line 2 has 24 available hours. Each product requires 10 hours of processing time on line 1, while on line 2, product 1 requires 2 hours and product 2 requires 3 hours. The profit for product 1 is Rs. 6 per unit, and the profit for product 2 is Rs. 4 per unit. Formulate a linear programming model for this problem and solve.
9. The National Fertilizer Company makes a fertiliser using two chemicals that provide nitrogen, phosphate, and potassium. 100 gm of ingredient 1 contributes 10 gm of nitrogen and 6 gm of phosphate, while 100 gm of ingredient 2 contributes 2 gm of nitrogen, 6 gm of phosphate, and 1 gm of potassium. Ingredient 1 costs Rs. 30 per 100 gm, and ingredient 2 costs Rs. 50 per 100 gm. The company wants to know how many 100 gm packs of each chemical ingredient to be put into a bag of fertilisers to meet minimum requirements of 20 gm of nitrogen, 36 gm of phosphate, and 2 gm of potassium while minimising cost. Formulate the problem and solve.
10. Total marks scored by the students of the Engg. College is as follows: 79, 82, 61, 51, 43, 36, 88, 62, 31, 26, 48, 84, 92, 73, 64, 66, 81, 95, 67, 55, 34, 49, 59, 65, 34, 85, 92, 71, 57 and 82. Grading scheme followed by the college is as follows:

    A—more than 90

    B—more than 70 but less than or equal to 90

    C—more than 50 but less than or equal to 70

    D—more than 35 but less than or equal to 50

    F—less than or equal to 35

    Find the letter grade for each student as per the grading scheme.

APPLICATION EXERCISES

1. Suppose you decide to buy a premium segment car, which is worth Rs. 9.2 lakhs. Financer is ready to finance upto 90 per cent of the cost at 9 per cent per annum for a period of three years. Find out what will be the monthly instalment that you need to pay to the financer. The monthly instalment as per the above conditions is not suitable and does not fit in your budget. The maximum that you can pay is Rs. 20,000 per month. You are ready to increase the repayment period. Find the repayment period that fits your budget (assuming all conditions remains the same). While you were searching for best loan option, you found that the ABC Finance offers multiple loan schemes, which are as follows:

Company	Rate	Period
ABC Finance	9.0%	Upto 5 years
ABC Finance	8.5%	5 to 10 years
ABC Finance	8.25%	10 to 15 years
ABC Finance	8.0%	15 years and more

   You decided to do the what-if analysis to find the best possible option.
2. On the 10th birthday of Joy, his parents decided to invest Rs. 4000 every year till the 17th birthday. Return available on this investment is 8 per cent per year. From the 18th birthday onwards to the 21st birthday they want to withdraw Rs. 20,000 every year for Joy's education. You need to find whether Rs. 4,000 investment every year was sufficient to meet Joy's education expenses after the 18th birthday. If it is not, find how much they should have invested every year?
3. The project head of a leading infrastructure company gets a project proposal on 16 Feb, 2009 with following cash flows:

15th Apr, 2009	(2000)
11th Jan, 2010	600
7th April, 2011	950
15th July, 2012	1525

   All cash flows are in crores. The project head needs to take a decision whether to invest in the project or not. He needs to take the decision on the same day i.e, on Feb. 16, 2009 assuming the rate is 12 per cent. What decision he should take?
4. One of the low cost airlines flight from Delhi to Mumbai at 9.00 am has a capacity of 300 passengers. 370 tickets have been sold for the flight at a price of Rs. 2,000 per ticket. Tickets are non-refundable. The variable cost of flying a passenger is Rs. 500 per passenger. If more than 300 people show up for the flight, the Airlines must pay overbooking compensation of Rs. 3,000 per person to each overbooked passenger. Develop a spreadsheet that computes the Airlines profit based on the number of passengers who show up for the flight.
5. You have a liability of Rs. 10,00,000 due in 10 years. The cost of capital is 8 per cent per year. What amount of money would you need to set aside at the end of each of the next 10 years to meet the liability?
6. At the end of each year for next 10 years, Raju is going to put Rs. 20,000 in his retirement fund. What rate of return on investments does Rahul need so that he will have Rs. 20,00,000 available for retirement when he retires in 40 years? Use Goal Seek to solve.

7. Currently we sell 60,000 units of a product for Rs. 55. The unit variable cost of producing the product is Rs. 12. We are thinking of cutting the product price by 20 per cent. We are sure this will increase sales by an amount between 10 and 50 per cent. Perform a sensitivity analysis to show how profit will change as a function of the percentage increase in sales, if product price changes from Rs. 55 to Rs. 30 in units of Rs. 5. Ignore fixed costs.
8. You have Rs. 250000 in your bank. At the end of each of the next 20 years, you withdraw Rs.15000 to live on. If you earn 8 percent per year on investments, how much money will you have in 20 years?
9. You deposit Rs. 1000 per month (at the end of each month) over the next 10 years. Your investments earn 0.8 percent per month. You would like to have Rs. 1000000 in 10 years. How much money should you deposit now?
10. I expect to earn 10 percent per year on my retirement investments. At the end of each of the next 40 years, I want to put the same amount of money in my retirement portfolio. I am going to retire in 40 years. How much money do I need to put in each year if I want to have Rs. 2000000 in my account when I retire?
11. Consider two projects with the following cash flows. For what rate of interest will project 1 have a higher NPV?

	Year 1	*Year 2*	*Year 3*	*Year 4*
Project 1	–Rs. 1,000	Rs. 400	Rs. 350	Rs. 400
Project 2	–Rs. 900	Rs. 100	Rs. 100	Rs. 1,000

12. Let's assume that at the end of each of the next 40 years, we will put the same amount in our retirement fund and earn the same interest rate each year. Show how the amount of money we will have at retirement changes as we vary our annual contribution between 3 percent and 15 percent.
13. Consider the following set of cash flows over a four-year period. Determine the NPV of these cash flow assuming r =.15.

Year	*1*	*2*	*3*	*4*
	Rs. 600.00	Rs. 550.00	Rs. 680.00	Rs. 1,000.00

14. Consider the following cash flows. If today is November 1, 2012, and r=.15, what is the NPV of these cash flows?

Date	*Cash Flow*
12/15/12	Rs. 1,000.00
1/11/13	Rs. 300.00
4/07/14	Rs. 600.00
7/15/15	Rs. 925.00

15. Find all IRRs for the following project:

Year 1	*Year 2*	*Year 3*
–Rs. 100	Rs. 300	Rs. 250

16. Find all IRRs for a project having the given cash flows on the listed dates

1/10/2013	*7/10/2013*	*7/25/2014*	*7/18/2014*	*3/20/2015*	*4/1/2015*	*1/10/2016*
–Rs. 1,000	Rs. 900	Rs. 800	Rs. 700	Rs. 550	Rs. 500	Rs. 350

17. A personnel manager must schedule the security force in such a way as to satisfy the staffing requirements shown in the Table below:

Security Staffing Requirements	
Time	*Minimum Number of Officers Required*
Midnight – 4 A.M	5
4 A.M – 8 A.M	7
8 A.M – Noon	15
Noon – 4 P.M	7
4 P.M – 8 P.M	12
8 P.M – Midnight	9

The officers work eight-hour shifts. There are six such shifts each day. The commencing and closing times for each shift are given in the Table below

Security Staffing Requirements		
Shift	*Commencing Time*	*Closing time*
1	Midnight	8:00 A.M
2	4:00 A.M	Noon
3	8:00 A.M	4:00 P.M
4	Noon	8:00 P.M
5	4:00 P.M	Midnight
6	8:00 P.M	4:00 A.M

The personnel manager wants to determine how many officers should work each shift in order to minimise the total number of officers employed, while still satisfying the staffing requirements.

18. At a chip manufacturing plant, four technicians (A, B, C, and D) produce three products (products 1, 2, and 3). The chip manufacturer can sell 80 units of product 1 this month, 50 units of product 2, and at most 50 units of product 3. Technician A can make only products 1 and 3. Technician B can make only products 1 and 2. Technician C can make only product 3. Technician D can make only product 2. For each unit produced, the products contribute the following profit: product 1, Rs.6; product 2, Rs.7; product 3, Rs.10. The time (in hours) each technician needs to manufacture a product is as follows:

Product	*Technician A*	*Technician B*	*Technician C*	*Technician D*
1	2	2.5	Cannot do	Cannot do
2	Cannot do	3	Cannot do	3.5
3	3	Cannot do	4	Cannot do

Each technician can work up to 120 hours per month. How can the chip manufacturer maximize its monthly profit?

19. A computer manufacturing plant produces mice, keyboards, and video game joysticks. The per-unit profit, per-unit labor usage, monthly demand, and per-unit machine-time usage are given in the following table:

	Mice	*Keyboards*	*Joysticks*
Profit/unit	$8	$11	$9
Labor usage/unit	.2 hour	.3 hour	.24 hour
Machine time/unit	.04 hour	0.55 hours	.04 hour
Monthly demand	15,000	25,000	11,000

Each month, a total of 13,000 labor hours and 3000 hours of machine time are available. How can the manufacturer maximise its monthly profit contribution from the plant?

20. The distances between Boston, Chicago, Dallas, Los Angels, and Miami are given in the following table. Each city needs 40,000-kilowatt hours (kwh) of power, and Chicago, Dallas, and Miami are capable of producing 70,000 kwh. Assume that shipping 1000 kwh over 100 miles costs $4.00. From where should power be sent to minimise the cost of meeting each city's demand?

	Boston	*Chicago*	*Dallas*	*LA*	*Miami*
Chicago	983	0	1205	2112	1390
Dallas	1815	1205	0	801	1332
Miami	1539	1390	1332	2757	0

21. A grocery store operates seven days a week. A minimum number of employees is required each day, depending upon the day of the week (as per Table below). The store requires staff to work five consecutive days, followed by two days off, e.g., an employee working Monday through Friday gets Saturday and Sunday off. Formulate and solve so as to minimise the number of employees needed, while meeting the minimum staff requirements (remember that employee numbers must be integers).

Day	*Minimum no. of staff required*
Monday	15
Tuesday	13
Wednesday	13
Thursday	15
Friday	19
Saturday	14
Sunday	9

22. Mr. Raju is president of a one-person investment firm that manages stock portfolios for a number of clients. A new client has just requested the firm to manage a Rs. 500,000 portfolio. The client would like to restrict the portfolio to a mix of the three stocks shown in the following table. Formulate the problem to show how many shares of each stock Raju should purchase for his client to maximise the estimated total annual return.

Stock	*Price Per Share (Rs.)*	*Estimated Annual Return Per Share (Rs.)*	*Maximum Possible Investment (Rs.)*
IGL	155	17	2,00,000
India Oil	258	30	1,25,000
Videsh Petro	128	12	3,00,000

23. Create the following worksheet.

Student	*QT*	*Economics*	*Rank*	*Class size*
A	510	695	11	298
B	645	125	30	137
C	470	300	490	506
D	595	610	250	440
E	598	780	103	160
F	801	690	53	800
G	598	715	12	410
H	318	525	42	77
I	435	295	10	240
J	475	515	15	137

Evaluate the candidates as per the following criteria for admission:

(a) If any subject score is 680 or more, the applicant is accepted.

(b) If any of the test score is less than 270, the applicant is rejected.

(c) If the average of QT and Eco is above 600 and the applicant is in the top 20 per cent of the graduating class, the applicant is admitted.

(d) If the applicant is in the bottom 20 per cent of the graduating class and one of the score is less than 400, applicant is rejected.

(e) Otherwise applicant is in the waiting list.

All conditions need to be evaluated before the candidate is accepted or rejected for admission. Use Nested IF to solve this problem.

24. Using the following sales data sheet calculate the commission to be paid to each salesperson as per the rules defined below in the table. You may need to use IF and/or Lookup function.

First Name	*Quota*	*Department*	*Sales*
Amit	3,000	Men's	Rs. 4,000.00
Robin	4,000	Men's	Rs. 10,065.23
Binod	200	Men's	Rs. 456.76
Parvinder	500	Men's	Rs. 450.98
Elizabeth	1,000	Children's	Rs. 650.75
Jullie	1,000	Children's	Rs. 1,500.00
Astha	100	Children's	Rs. 0.00
Sunny	3,000	Children's	Rs. 1,402.98

Contd...

Contd...

Pamela	4,000	Children's	Rs.0.00
Komal	200	Children's	Rs.873.08
Daisy	500	Furniture	Rs.0.00
Veena	1,000	Furniture	Rs.4,500.67
Ricky	1,000	Furniture	Rs.356.26
Jerry	100	Furniture	Rs.1,500.25
Promod	3,000	Furniture	Rs.1,469.78
Jonny	4,000	Furniture	Rs.7,502.03
Patricia	200	Furniture	Rs.0.00
Kitu	500	Furniture	Rs.890.47
Walden	1,000	Furniture	Rs.0.00
Russell	1,000	Children's	Rs.1,100.00
Bobby	100	Children's	Rs.1,202.02

If the salesperson has met the quota only then they are entitled for the commission as per the following rate:

(i) For Men's department:

No commission for first 500 in excess of quota

5 per cent of sales in excess of quota for sales that exceed the quota beyond 500 but upto 1,500.

10 per cent of sales in excess of quota for sales that exceed quota by 1,500 but upto 4,000

15 per cent of sales in excess of quota for sales that exceed quota by 4,000

For children's department: Same rules as Men's department except that salespersons are entitled for extra 2 per cent commission.

(ii) For Furniture department:

Same rule as Children's department except that salespersons are entitled for Rs. 1,500 bonus.

GROUP PROJECTS

1. Search the Internet and try to find the add-in tools available for decision-making. Describe each one of these tools with problems and solutions.
2. The Monte-carlo simulation is a simulation technique, which is being developed by number of users using Excel. Search the Internet to find Excel based simulation tools and how it can be useful for decision-making. Write a complete report with examples.
3. The number of decision tools like decision tree, decision tables, and OLAP techniques are quite prevalent among the decision-makers. Search your library and also the Internet to write a report—how one can use these tools and techniques for effective decision-making using Excel.

Caselets

1. Jigg's Pizza Kitchen

Jigg's Pizza Kitchen is one of the popular fast food chains in India. Jigg's Pizza Kitchen (JK) started out in the year 2000 as a venture by two chefs who wanted to do something different. They decided to sell 'Indian Sliced Pizza' in which the pizza dough is used for exotic food toppings such as Indian Tandoori chicken, Bhuna Gosht, Paneer Masala, Roasted Fish, and many other typical Indian preparations. Jigg's offer stylish Indian Pizzas each costing less than Rs. 100. JK mushroomed into a national chain of 100 restaurants in less than three years.

The success did not come easily to this Delhi based chain. The restaurant business is a high-risk industry presenting restaurants and fast food chains with many factors that are beyond their control including competition, changing customer tastes, and rising real estate costs. In order to remain competitive in this market, restaurants need to tightly control food and labour costs to remain profitable – without affecting the quality of their food or service.

Joginder Sidhu owns the chain of pizza delivery stores. The customers often remark on the quality, variety, and value for money of Jigg's pizzas. For each store, Joginder has four delivery vehicles. During the last couple of years, Joginder has noticed an increase in the repair and maintenance costs associated with several of his delivery vehicles. Under normal circumstances, Joginder would purchase three cars each year. However, because of the increased repair and maintenance problems, he must now purchase at least five new vehicles.

After visiting several dealerships, he determines that each vehicle will cost approximately Rs. 6,00,000. He knows that he can borrow up to Rs. 30,00,000 from a local bank; the interest rate is about nine per cent; he will need to arrange financing for at least four years, and he has Rs. 5,00,000 available for a down payment. Organise this information in a spreadsheet. If Joginder decides to borrow the money from the local bank, calculate what is his approximate monthly payment?

If Joginder finances his new pizza delivery vehicles for five years instead of four years, what will be his new monthly payment? If Joginder wishes to keep his payment below Rs. 55,000 a month, should he finance the loan for five years instead of four years? What is the difference in monthly payments? Also, what is the difference in total interest between the two years? After speaking with a loan officer at the local bank, Joginder is told that the available interest rates vary between eight and nine per cent in units of 0.25 per cent. Using Excel tools outline the interest rates and associated monthly payments. Prepare a what-if analysis of your findings. What recommendations would you give to Joginder?

2. Satisfaction Survey

A leading market research company conducted the satisfaction survey among the customers of a public sector bank. The survey was conducted only in Delhi. Each respondent was asked to rate the services being offered by the bank on a seven point scale (1 = Extremely Poor and 7 = Excellent). There are other variables mentioned below on which data was collected. These are

1. Gender of the respondent
   - Male - M
   - Female - F
2. Marital status
   - Married - M
   - Single - S
3. Income of the respondent (in rupees)
4. Age of the respondent (in years)
5. Educational background of the respondent
   - Below higher secondary - 1
   - Higher secondary - 2
   - Graduation - 3
   - Postgraduation - 4
   - Others - 5

The data was collected from 70 respondents and given to you in an Excel sheet. As an analyst you are to analyse the data as per the following parameters:

(a) Assuming a score of 5 to 7 represents satisfied towards the bank services and a score of 1 to 4 denotes not satisfied towards bank. Find the relationship between Gender and Satisfaction towards banking services.

(b) Similarly, find the relationships between:

(i) Confidence versus Marital status

(ii) Confidence versus Education

(iii) Confidence versus Age (age less than 35 are treated as young and greater than or equal to 35 as old)

(iv) Confidence versus Income

The respondents are classified into following income groups

(i) Less than 8,000

8,000 – 12,000

12,000 – 16,000

16,000 – 20,000

Greater than or equal to 20,000

(c) Prepare a frequency distribution for income variable using the following class intervals:

4,000 – 8,000

8,000 – 12,000

12,000 – 16,000

16,000 – 20,000

20,000 – 24,000

24,000 – 28,000

Compute the relative frequencies and cumulative frequencies. Draw histogram for the above data.

For the income and the age data given in the above exercise compute arithmetic mean, median, mode, standard deviation, variance, and skewness of the distribution.

The data to be used is given below:

Respondent No.	*Satisfaction Score* for Bank	*Sex*	*Marital Status*	*Income* (Rs.)	*Age*	*Education*
1.	5	M	M	7,000	53	1
2.	6	M	S	12,500	20	2
3.	5	M	S	9,200	26	3
4.	4	M	S	22,000	32	4
5.	4	M	S	18,200	40	5
6.	1	M	S	5,000	21	5
7.	7	F	S	11,500	29	4
8.	5	F	M	17,400	40	3
9.	4	M	M	12,200	26	2
10.	4	M	M	12,800	29	1
11.	7	F	M	7,000	42	1
12.	6	F	M	7,500	31	1
13.	2	F	M	22,000	50	3
14.	1	F	S	24,000	55	4
15.	5	M	M	18,000	33	5
16.	2	F	M	17,000	28	2
17.	7	M	M	15,000	30	2
18.	6	F	M	14,000	34	3
19.	7	F	M	9,200	34	5
20.	6	F	S	9,500	27	1

Contd...

Contd...

21.	4	F	S	10,000	25	4
22.	1	M	M	7,800	44	5
23.	7	M	M	6,800	25	2
24.	6	F	M	16,200	24	2
25.	5	M	M	6,000	20	2
26.	7	M	S	21,000	25	3
27.	2	M	M	27,000	47	4
28.	3	F	S	9,400	23	5
29.	5	F	M	16,200	32	1
30.	6	F	S	9,200	22	3
31.	6	M	M	5,400	46	4
32.	7	F	M	9,300	21	2
33.	1	F	M	6,700	32	1
34.	1	M	M	25,000	23	1
35.	3	M	S	5,000	21	3
36.	4	M	S	7,900	24	5
37.	5	F	M	9,700	21	1
38.	5	M	M	24,300	51	2
39.	6	M	M	22,500	34	2
40.	1	M	S	27,000	54	2
41.	2	M	M	9,400	32	3
42.	3	F	M	16,200	43	4
43.	4	F	M	9,200	45	5
44.	5	F	M	23,670	54	5
45.	6	F	M	12,800	43	5
46.	7	F	S	25,000	54	5
47.	7	M	S	5,400	23	1
48.	1	M	S	9,300	50	1
49.	1	M	S	5,430	32	1
50.	2	M	M	6,980	65	1
51.	3	M	S	7,345	32	2
52.	4	M	M	18,000	40	4
53.	4	M	M	19,500	34	5
54.	5	F	S	23,450	26	5
55.	5	M	M	13,240	43	3
56.	6	F	S	20,560	32	2
57.	6	M	S	8,600	37	3
58.	7	M	M	11,800	43	1
59.	7	F	S	12,000	34	4
60.	1	F	S	13,090	43	5

3. Amarpalli Constructions

Amarpalli Constructions is one of India's leading international property consultants. Amarpalli is an equity partnership between Crow Company, one of the largest diversified commercial real estate services companies in the world with Amarpalli Group, a private financial services company, with diverse business interests and Sun Developments, a real estate investment company from the US. Established in 1985 as Amarpalli Constructions, it is a real estate consultancy covering the needs of commercial business, manufacturing and warehousing, the retail sector and housing. It specialises in delivering property services to industry—both multinational and national. The company has facilitated many corporates and institutions to better manage their existing property portfolio. Amarpalli has a widespread network of full service offices across the country in cities like New Delhi, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Pune, Chandigarh, and Lucknow. Its Head Office for India is in Mumbai. During the last couple of years the company has grown very fast and has a workforce of about 2,000.

One of the major problems that the company started facing with its growth is managing the employee payroll systems. Company has hired you to manage their employee's salaries as per the computing rules given below. The sample employee database is also attached.

Emp. No.	*Employee Name*	*Department*	*Basic Salary p.m.*
101	Ajay Kumar	Sales	18,000
102	Sahil Kapoor	Production	12,000
103	Neeraj Tandon	Sales	19,000
104	Naresh Gupta	Finance	19,000
105	Rita Basu	Sales	25,000
106	Vivek Kaul	Production	24,500
107	Shubha Kumar	Sales	19,500
108	Raj Merchant	Finance	16,500
109	Krishana Kumar	Sales	19,600
110	Rajeev Arya	Production	25,500
111	Vineet Jain	Sales	26,000
112	Anoop Handa	Production	18,700
113	Dennis Arnum	Finance	19,000
114	Siddharth Birla	Finance	19,000
115	Jaswinder Ahuja	Finance	16,800

Calculate the Total Gross Salary and Net Salary as per the following details (make assumptions, if necessary):

(a) Dearness Allowance is 50 per cent of Basic Pay

(b) House Rent Allowance is 35 per cent of (Basic Pay + DA)

(c) Provident Fund is deducted at 12 per cent of (Basic Pay + DA)

(d) Conveyance Allowance is paid

(i) at 5 per cent of Basic Pay to those employees who are drawing Basic Pay between Rs. 12,000 and Rs. 20,000

(ii) at 7.5 per cent of Basic Pay to those employees who are drawing Basic Pay more than Rs. 20,000

(iii) to sales people, who get an additional allowance of Rs. 1,000 p.m.

(e) Income Tax is deducted as per the following rules:

(i) No Tax if taxable salary is less than Rs. 2 lakh per annum
(ii) 10 per cent Tax if taxable salary is between Rs. 2 lakh and Rs. 3 lakh
(iii) 20 per cent Tax if taxable salary is between Rs. 3 lakh and Rs. 4 lakh
(iv) 30 per cent Tax if taxable salary is above Rs. 4 lakhs

(f) The Employees working with Finance department will get non-taxable allowance of 2 per cent on Basic Pay.

(g) Employees working with Production Department will get security hazard allowance of 5 per cent of Basic plus DA. This allowance is taxable.

(h) Arrange the data according to highest net salary and then by name of the employee.

(i) Find the total salary bill department wise.

(j) Find only the name of the department for which the total salary bill is lowest.

(k) Using Filters, extract only the name of these employees:
(i) Drawing maximum Net salary
(ii) Drawing minimum Net salary
(iii) Paying maximum tax
(iv) Drawing Net salary between Rs. 20000 and Rs. 30000
(v) Having 'Kumar' in their names
(vi) Having names starting with alphabet 'R'

Answers to Self-Study Questions

1. (b)	2. (d)	3. (d)	4. Absolute
5. 64	6. (b)	7. What-if	8. Scenarios
9. Cash inflows and cash outflows		10. Auditing	

The McGraw·Hill Companies

Chapter 7

Access Based Database Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What is data processing and what are the different forms of data processing?
- What is File Organisation and its types?
- What are the different forms of data management?
- Why should organizations invest in database management solution?
- What are the different types of database solutions that exists?
- How to create and manage databases using the Microsoft Access?

INTRODUCTION

The information systems that are being used by all kinds of organisations are dependent on the quality of data. The data which should be of good quality is managed by powerful database management system. It is not exaggerated to say that success of a good information system solution depends on powerful database management systems. It is important to understand what these databases are all about? What can they offer and how one can manage these databases effectively? The Database Management Systems (DBMS) that gives a complete framework for creating, managing, and manipulating data is an important concept for integrating technology into business.

The need to store data was felt by organisations when they started building information systems solution—paper, or computer based. If one tries to scan history, one will find that organisations started collecting and storing data in computer readable format during 1950s, around the same time when the computerisation started. The need at that time was more to capture and manage inventory, accounting, and sales data. In that era, organisations created independent application software systems, one to manage sales, one for inventory and the other for accounting. The data

needs were also addressed in the same manner. The data was captured and stored keeping the application software needs in mind, which led to high dependence of data on application software programs. If one needs to change some data definition, one needs to change the associated software program. This method was known as file management system, which had its limitations.

The concept of database was introduced for the first time in late 1960 but put into commercial use in 1970s. The database concept tried to overcome most of the problems that are associated with the file management system. One of the major advantages of databases is that it delinked the data and its definition from the application software program. The objective was to design databases that were relatively independent of the application software program that were using them.

A separate software package was developed by number of software vendors to create, store, and manage data in databases, called Database Management System (DBMS). The different types of DBMS were created using different database models. The different database models are Hierarchical, Network, and Relational. The relational DBMS is the most widely used database structure, even today. The object oriented data models are somewhat new phenomena, which allowed users to manage objects instead of plain data.

In today's competitive environment, managers are seeking to use knowledge derived from databases for gaining competitive advantage. Many organisations started storing the historic organisation data and through it, the concept of data warehousing emerged. Newer business information concept like business intelligence, customer relationship management, and supply chain management, all were highly dependent on data.

Though still, many organisations have proliferation of incompatible databases that were developed using various technologies over a period of time. Much of the data is hidden in the legacy systems that the organisations have built over a period of time and the data available in these systems are not of good quality. As a technology expert one needs to understand the data requirements for designing and implementing databases, keeping these requirements in mind.

DATA PROCESSING

The data processing refers to the process of performing specific operations on a set of data or a database. The data processing operations, which, includes, handling, merging, sorting, and computing are performed upon data in accordance with strictly defined procedures, such as recording and summarising the financial transactions of a business. In automatic, or electronic data processing the operations are performed by a computer. In distributed data processing some, or all of the operations are performed in different locations at computer facilities connected by telecommunications links.

The data processing refers to processing of data to obtain usable information.

The data processing primarily is performed on information systems, a broad concept that encompasses computer systems and related devices. In addition, an information system provides for feedback from output to input. The input mechanism gathers and captures raw data and can be either manual, or automated. The processing, which also can be accomplished manually

or automatically, involves transforming the data into useful outputs. This can involve making comparisons, taking alternative actions, and storing data for future use. The output typically takes the form of reports and documents that are used by managers. The feedback is utilised to make necessary adjustments to the input and processing stages of the information system.

The processing stage is where management typically exerts the greatest control over data. It is also the point at which management can derive the most value from data, assuming that powerful processing tools are available to obtain the intended results. The most frequent processing procedures available to management are basic activities such as segregating numbers into relevant groups, aggregating them, taking ratios, plotting, and making tables. The goal of these processing activities is to turn a vast collection of facts into meaningful nuggets of information that can then be used for informed decision making, corporate strategy, and other managerial functions.

- ***The data is a collection of raw facts and figures***. The data consist of raw facts, such as customer names and addresses. The data is an element of a transaction. The data needs to be processed before it can be turned into something useful.
- ***The information is a collection of data (facts and figures) arranged in more meaningful manner, which helps in decision-making.***

Turning data into information is a process, or a set of logically related tasks performed to achieve a defined outcome. This process of defining relationships between various data requires knowledge. The knowledge is the body, or rules, guidelines, and procedures used to select, organise, and manipulate data to make it suitable for specific tasks. Consequently, information can be considered data made more useful through the application of knowledge. The collection of data, rules, procedures, and relationships that must be followed are contained in the knowledge base.

Data Processing Methods

The data must be processed in order to convert it into information. For this purpose, different operations may be performed on data. Therefore, data processing is defined as: *"a sequence of operations on data to convert it into useful information"*. The data processing can be accomplished through following methods:

1. **Manual Data Processing:** In ***manual data processing***, data is processed manually without using any machine, or tool to get required results. In manual data processing, all the calculations, logical operations, and data is transferred manually. This method of data processing is very slow and errors may occur in the output.
2. **Mechanical Data Processing:** In ***mechanical data processing method***, data is processed by using different devices like typewriters, mechanical printers, or other, mechanical devices. This method of data processing is faster and more accurate than manual data processing.
3. **Electronic Data Processing:** ***In electronic data processing*** a modern technique is applied to process data. The data is processed using computer; Data and set of instructions are given to the computer as input and the computer automatically processes the data according to the given set of instructions. This method of processing data is very fast and accurate.

Data Processing Activities

Regardless to the data processing method used, various functions and activities, which need to be performed for data processing can be grouped under five basic categories:

1. **Collection:** The data originates in the form of transaction or some observations. This data is then recorded in some usable form. The data may be initially recorded on paper source documents and then converted into a machine usable form for processing. Alternatively, they may be recorded directly into machine-readable form. The data collection is also termed as data capture.
2. **Conversion:** Once the data is collected, it is converted from its source documents to a form that is more suitable for processing. The data is first codified by assigning identification codes. A code comprises of numbers, letters, special characters, or a combination of these. After codification of data, it is verified to ensure the accuracy before processing starts. After verification, the data is transcribed from one data medium to another.
3. **Manipulation:** Once data is collected and converted, it is ready for the manipulation, which converts data into information. The manipulation consists activities like sorting, calculating, summarising and comparing.
4. **Managing the Output Results:** Once data has been captured and manipulated, one may store the output for later use. The storage is essential for any organised method of processing and re-using data. The storing activity involves storing data and information in organised manner in order to facilitate the retrieval activity. The stored output can be retrieved to find again the stored data, or information. The retrieval techniques depend on the data storage devices.
5. **Communication:** The communication is the process of sharing information. Unless the information is made available to the users who need it, it is worthless. Thus, communication involves the transfer of data and information produced by the data processing system to the prospective users. The reports and documents are prepared and delivered to the users.
6. **Reproduction:** In order to reproduce it requires to copy, or duplicate data or information. This reproduction activity may be done by hand, or by machine.

The data processing activities described above are common to all data processing systems from manual to electronic systems. These activities can be grouped in four functional categories, viz., data input, data processing, data output, and storage, constituting what is known as a **data processing cycle**.

Data Organisation

Having discussed the Data Processing Cycle it is important to understand how data is organised on a computer. The data can be arranged in a defined order as described below and shown in Figure 7.1.

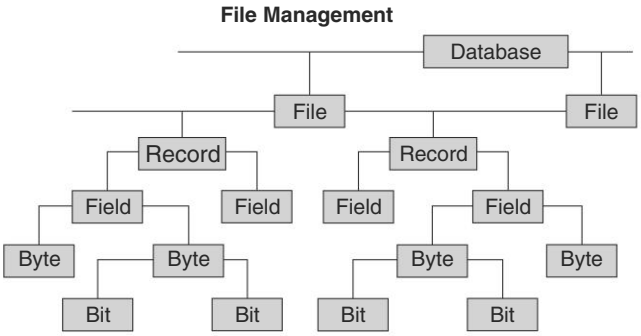


Figure 7.1 Hierarchy of Data as Stored in File Management System

1. **Data Item:** A data item is the smallest unit of information stored in computer file. It is a single element used to represent a fact such as an employee's name, item price, etc.
2. **Field:** The data items are physically arranged as fields in a computer file. Their length may be fixed, or variable.
3. **Record:** A record is a collection of related data items or fields. Each record normally corresponds to a specific unit of information. It can be seen how each related item is grouped together to form a record.
4. **File:** The collection of records is called a file. A file contains all the related records for an application.
5. **Database:** The collection of related files is called a database. A database contains all the related files for a particular application.

FILE MANAGEMENT SYSTEM

In the initial phase of computerisation, there were no databases. The computers that were available at that time were less powerful and more complex to handle. In order to manage any business applications on computers, one needs the data to be captured, stored, and processed. The data at that time was captured and stored in plain data files also called **flat files**. Though these data file processing and management system evolved over time, it always had many shortcomings. ***The File Management allowed a collection of individual files to be accessed by applications programs***. These files are also referred as Flat Files, as they simply consist of data with no data definition. An additional knowledge is required to interpret these files such as the file format properties. The modern database management systems used a more structured approach to file management (such as one defined by the Structured Query Language) and therefore have more complex storage arrangements. These flat files are of different types:

The flat files are data files that contain records with no structured relationships.

- **Comma-Separated Value (CSV):** Many applications use comma-separated value (CSV) flat files. This simple text format file records each record on one line. It delimits (separates)

field values with a comma and a hard return after the last field. For example, a data file consisting of name, roll number and gender of students will store the data as "Rahul, 12, Male" on one line and "Sonia,11, Female" on the next line.

- **Fixed Length:** The fixed-length flat files do not have delimiters separating data fields. Instead, they have a user-defined starting point and character length for each record. A developer may create his flat file with six characters for a student's name, starting at location zero (characters 0 to 6); two characters for roll number, starting at location six (characters seven and eight); and one character for gender, starting at location eight (the ninth and final character). An entry may be written as "Rahul 12M". One can note the space after "Rahul", which represents the sixth character in the record. If the developer uses a search program to find Rahul's age, he would search the flat file starting at location six and would check only fields in the search parameters. When searching thousands, or millions of records this saves time.
- **Tab Delimited:** The tab-delimited flat files function similarly to CSV flat files. However, instead of using a comma to separate values, the tab key identifies where one entry ends and another begins. This allows data entries to contain commas without the need of quotation marks and, if a developer needs to look at a raw data file, the information in it appears organised and he can quickly scan through it visually. The tab-delimited flat files also differ from fixed-length flat files by their sorting method. Some programs may see the tab delimiter as a space and not recognise, when entries change, so the developer must ensure his program differentiates between spaces and tabs to sort data correctly.

The file management system is still used in the environments, where computers are used but there is no DBMS. In such systems, data is stored and managed in flat files through application programs. The data definition required to understand the sequence, type and size of data is defined within the application software program. In case, one needs to modify the data files, or data access methods, one needs to modify the application program as all this is defined within that. The application developers always have the tendency to define separate data file for each of their programs, which lead to data duplication, data redundancy, and data inconsistency. For example, Billing Software and Sales Order System both requires customer data file along with some other data files for each of these two systems as shown in Figure 7.2. But the two systems requiring the same customer data file were created separately by two different teams and are also being managed separately by different application programs.

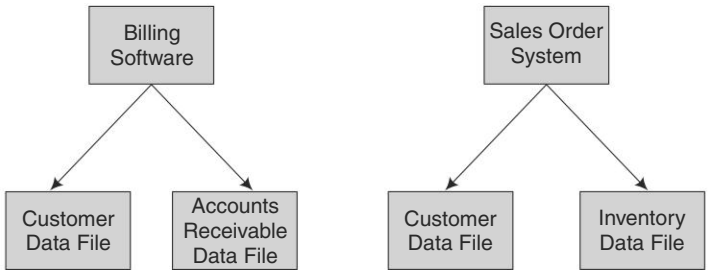


Figure 7.2 Application Softwares using same Data Files

The file processing system is the oldest form of data processing system. Although a computer file processing system has many advantages over the manual record keeping system, but it has some limitations also. Some of the disadvantages that are associated with the file management system are as follows:

1. **Data Redundancy:** The ***data redundancy*** means multiple copies of the same data. In flat file-based system, each application program has its own data files and the same data may exist in more than one file. The duplication of data creates many problems.
2. **Data Inconsistency:** The ***data inconsistency*** means that different files contain different information of a particular object, or person. Actually redundancy leads to inconsistency. When the same data is stored at multiple data files, the inconsistency occurs.
3. **Data Isolation:** The data is isolated in separate files and it is difficult to access the desired information from data files.
4. **Program Data Dependency:** The data stored in a file depends upon the application program through which the file was created. It means that the structure of the data file is defined in its application program. It is difficult to change the structure of data files or records.
5. **Difficult Program Maintenance:** Since the structure of data file is defined within the application programs, any modification in a data file (such as size of data field, its data type etc.) requires the modification of the application program also. In this case, one has to spend lot of time for modifying, testing, and debugging the program.
6. **Limited Data Sharing:** Since each application program uses its own data files, the flat file system provide the limited facility to sharing of data across applications.
7. **Data Insecurity:** This system does not provide proper security against illegal access to data. Anyone can easily change, or delete valuable data stored in the data file. It is the most critical problem of a file management system.

The usefulness of these stand-alone file management systems was restricted by some of these limitations. The individual systems were not responsive to changes in business conditions, or the dynamic and ever changing needs of the business managers. These difficulties—along with advances in technology made it possible to design, build, and operate large-scale collections of data in a computerised environment—provided an impetus for organisations to manage data in an integrated manner. Even after many limitations some of the best financial applications are dependent on these file management systems. The **best advantages** of this mode of data management is that it is faster to process than any other mode and it is relatively easy to design and implement.

FILE ORGANISATION

The file organisation refers to the relationship of the key of the record to the physical location of that record in the computer file. A file should be organiased in such a way that the records are always available for processing with no delay. This should be done in line with the activity and volatility of the information. The file organisation may be either physical file, or a logical file.

- A physical file is a physical unit, such as magnetic tape, or a disk.
- A logical file on the other hand is a complete set of records for a specific application or purpose. A logical file may occupy a part of physical file, or may extend over more than one physical file.

The objectives of computer based file organisation:

- Ease of file creation and maintenance
- Efficient means of storing and retrieving information.

Types of File Organisation

Organisation of a file depends on what kind of file it happens to be: a file in the simplest form can be a text file, files can also be created as binary, or executable types. Also, files are keyed with attributes, which help determine their use by the host operating system.

The selection of a particular method depends on:

- Type of application
- Method of processing
- Size of the file
- File inquiry capabilities
- File volatility
- The response time

The various file organisation methods are:

1. **Sequential Access Method:** A sequential file contains records organised in the order they were entered. The order of the records is fixed. The records are stored and sorted in physical, contiguous blocks within each block the records are in sequence. Here the records are arranged in the ascending, or descending order, or chronological order of a key field which may be numeric, or both. Since the records are ordered by a key field, there is no storage location identification. It is used in applications like payroll management where the file is to be processed in entirety, i.e. each record is processed. Here, to have an access to a particular record, each record must be examined until we get the desired record. The sequential files are normally created and stored on magnetic tape using batch processing method.

   Advantages:

   - Simple to understand
   - Easy to maintain and organise
   - Loading a record requires only the record key
   - Relatively inexpensive I/O media and devices can be used
   - Easy to reconstruct the files
   - The proportion of file records to be processed is high

Disadvantages:

- Entire file must be processed, to get specific information
- Very low activity rate stored
- Transactions must be stored and placed in sequence prior to processing
- Data redundancy is high, as same data can be stored at different places with different keys
- Impossible to handle random enquiries

2. **Direct, or Hashed Access Files Organisation:** With direct or hashed access a portion of disk space is reserved and a 'hashing' algorithm computes the record address. So there is additional space required for this kind of file in the store. The records are placed randomly through out the file. The records are accessed by addresses that specify their disc location. Also, this type of file organisation requires a disk storage rather than tape. It has an excellent search retrieval performance, but care must be taken to maintain the indexes. The files in his type are stored in direct access storage devices such as magnetic disk, using an identifying key.

   Advantages:

   - Records can be immediately accessed for updation
   - Several files can be simultaneously updated during transaction processing
   - Transaction need not be sorted
   - Existing records can be amended or modified
   - Very easy to handle random enquiries
   - Most suitable for interactive online applications

   Disadvantages:

   - Data may be accidentally erased, or over written unless special precautions are taken
   - Risk of loss of accuracy and breach of security. Special backup and reconstruction procedures must be established
   - Less efficient use of storage space
   - Expensive hardware and software are required
   - High complexity in programming
   - File updation is more difficult when compared to that of sequential method

3. **Indexed Sequential Access Organisation:** Here the records are stored sequentially on a direct access device i.e. magnetic disk and the data is accessible randomly and sequentially. It covers the positive aspects of both sequential and direct access files. In this the search key is compared with the index ones to find the highest index key preceding the search one, and a linear search is performed from the record the index key points onward, until the search key is matched, or until the record pointed by the next index entry is reached. The type of file organisation is suitable for both batch processing and online processing. Here, the records are organised in sequence for efficient processing of large batch jobs but an index is also used to speed up access to the records. The indexing permit access to selected records without searching the entire file.

Advantages:

- Permits efficient and economic use of sequential processing technique when the activity rate is high
- Permits quick access to records, in a relatively efficient way when this activity is a fraction of the work load

Disadvantages:

- Slow retrieval, when compared to other methods
- Does not use the storage space efficiently
- Hardware and software used are relatively expensive

4. **Inverted List:** In file organisation, this is a file that is indexed on many of the attributes of the data itself. The inverted list method has a single index for each key type. The records are not necessarily stored in a sequence. They are placed in the data storage area, but indexes are updated for the record keys and location. The inverted list files use more media space and the storage devices get full quickly with this type of organisation. The benefits are apparent immediately because searching is fast. However, updating is much slower. The content-based queries in text retrieval systems use inverted indexes as their preferred mechanism.

DATABASE MANAGEMENT SYSTEM

The Database

The need for integration and sharing of data across all organisation applications lead to creation of databases. The organisations adopted the database system approach for storing and managing data. ***A Database is a collection of related data organised in a structured manner***. A data in a database has some relationship with other data. A data in a database is always stored in a uniform manner and carry similar meaning across applications. ***A software package that is used to define, create, store, manage, and manipulate the data is called Database Management System (DBMS)***. *The* database system allows organisations to manage data independent of application software. The DBMS provides organising framework for managing various applications using same data sets. Rather for each application utilising independent data files, DBMS are designed to ensure that various software applications access a common database, as shown in Figure 7.3.

The Database is a structured data held in computer system.

A database can also be defined as a collection of related data stored in an efficient and compact manner. A database holds related data as well as description of that data. For this reason, a database is also defined as a self-describing collection of integrated records. The description of data is known as the data definition, or data dictionary, or metadata. For example, when a table of a database is designed, the data type, size, format, and other descriptions of fields are specified. The databases are used for variety of purposes in an organisation.

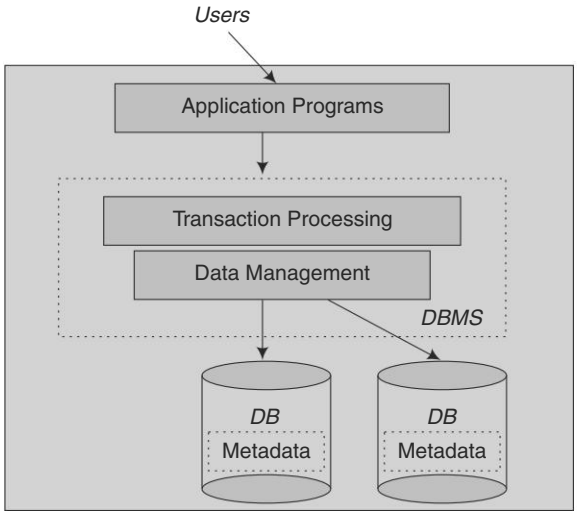


Figure 7.3 Database Management System

Types of Databases System: The databases may be of different types. These are:

1. **Centralised Databases:** A database that is completely located at a single computer called database server and all the users access it from the central database server, is called ***centralised database***. A centralised database provides an efficient way to access and update data. These databases are usually used in computer network environments. The centralised databases can be Personal computer databases, or Client/Server databases or Central computer databases.
2. **Distributed Databases:** A distributed database is a single logical database, which is spread physically across multiple computers called database servers over wide area network. Such databases are managed by the organisations having offices across locations. In distributed database system some of the database tables may be maintained at one location with a DBMS, while another group of database tables may be maintained at another computer with a DBMS. The distributed databases are further divided into two categories:
   - **Homogeneous Databases:** The ***homogeneous database*** means that the database technology is the same at each of the locations and the data at various locations are also compatible. The homogeneous system is comparatively easier to design and manage. In case of homogeneous database systems – the operating system used at each location must be same or compatible. The data structures used at each location must be same, or compatible; and the database application (or DBMS) used at each location must be same or compatible.
   - **Heterogeneous Databases:** The ***heterogeneous database systems*** means the database technology might be different at each location. In a heterogeneous system, different nodes may have different hardware & software and data structures at various

nodes or locations are also incompatible. The heterogeneous systems are usually used when individual sites use their own hardware and software. On heterogeneous system, translations are required to allow communication between different DBMS. The heterogeneous system is often not technically or economically feasible.

Evolution of DBMS

The databases have been in use since the early days of computers and have evolved from punch card based file systems to object-oriented models. The majority of older systems were more linked to the custom databases with an objective of creating faster application solution, unlike modern systems which can be applied to wide variety of different databases. Originally, the application of DBMS was found only in large organisations with high investment on computers needed to support large data sets. Today with growth in technology, both in hardware and software front, this scenario has changed, with more and more organisations managing all kind of applications on databases.

The brief history of Database Systems is given below:

- **1950s:** Limited use of data as the computer was used primarily for scientific and military applications.
- **1960s:** The uses of computer started in the busisess word in a limited manner for very specific applications by large organisations. The file based management systems were in high demand as application programs directly defined these data sets within the program.
- **1970s:** The database concept defined with hierarchical data models, which then got refined to Network models and then to the relational model. In all these type of database models, data is separated from the application program and kept in individual tables.
- **1980s:** The microcomputers were introduced and the need for microcomputer based databases solution felt. The database program such as Dbase, Paradox, FoxPro, MS Access were created. These microcomputer databases helped users to create and manage their own databases.
- **Mid-1980s:** The network concepts were introduced, so the need for data sharing became essential. In order to share data resources, concept of distributed databases and object oriented database emerged.
- **1990s:** The Internet and World Wide Web became a reality and databases of all kinds were available from a single type of client, i.e. the Web Browser. Concept of Data Warehousing, and Data Mining also emerged. The business applications like Business Intelligence, CRM, and SCM became a reality.

One of the most important parts of DBMS is data models, which defines the structure of the database. The four different types of data models that exist include: Hierarchical, Network, Relational, and Object oriented data models. In all the four different types of data models, the data is organised in a different manner within the database.

A data structure refers to the overall design for records in a database.

DBMS—A Concept

A Database Management System (DBMS) is defined as a software package that contains computer programs that can control the creation, maintenance, and also the use of any database. The DBMS is a software system that uses a standard method of cataloging, retrieving, and running queries on data. The DBMS manages incoming data, organises it, and provides ways for the data to be modified, or extracted by users or other programs. Typically, database management system is considered as a computerised record keeping system. However, *DBMS is a collection of programs, which are used to define, create and maintain databases.* Basically, DBMS is a general-purpose software package whose overall purpose is to create and maintain information and to make that information available on demand.

> The DBMS is software that controls the organization, storage, retrieval, security, and integrity of data in a database.

The DBMS supports both a logical and physical view of the data. ***The logical view of the database is how data is organised for presentation to users***. The end users need to be least concerned about the internal organisation of the data. Through a DBMS, end users only need to consider how various data items are logically related to one another; they need not be concerned about actual location of data. ***The physical view is about how data is structured, located, and stored within the computer system***. The data may be stored in a single location, or distributed among multiple locations, depending on the number of data items, the size of individual databases, speed of processing and accessing the data, and size of the organisation. One strength of a DBMS is that while there is only one physical view of the data, there can be any number of logical views. This allows users to view database information in a more business related manner rather than from a technical, processing viewpoint.

> The logical view refers to the way user views data, and the physical view to the way the data are physically stored and processed.

There are many functions for which DBMS software's are used, some of the main functions are:

- **Defining the Structure of Database:** It involves defining tables, fields and their data types, constraints for data to be stored in the database, and the relationships among tables.
- **Populating the Database:** It involves storing data into database.
- **Manipulating the Database:** It involves to retrieve specific data, update data, delete data, insert new data, and to generate reports.

Components of DBMS

The major components of any database management system are:

1. **DBMS Engine:** A DBMS engine is the part of the system that accepts and deals with logical requests that are received from a variety of other DBMS subsystems. It then works to convert them into physical equivalents and will then gain access to the database along with its data dictionary as they are on a storage device.

2. **Data Definition Language:** The data definition language (DDL) allows the users of the database to define structure of the database create databases and modify its structure. The **data dictionary** is like any language dictionary where the complete data elements that have been used within the database are described using meaning of the data, location of the data, and other characteristics of the data as to whether it is part of primary key, or foreign key, or candidate key, etc.
3. **Data Manipulation Language:** The data manipulation language (DML) allows the users to add, update, delete, and read the records from the database. It also allows extracting records using the structured query language. The DML are the primary interface between the user and the information in the database.
4. **Application Generation System:** An Application Generation system that contains all the facilities that could be used to help the user develop transaction intensive applications. This procedure will usually require the user to perform complex and detailed tasks to complete the transaction.
5. **Data Administration System:** A Data Administration system helps the user with managing the overall database environment. It helps in maintain the backup and recovery of lost data, managing the system's security, query optimisation, concurrency control, and change management.

Key Terms

- *Data*: The meaningful facts comprising of text, graphics, images, sound, and video segments.
- *Database*: An organised collection of logically related data.
- *Information*: The processed data that is useful in decision-making.
- *Metadata*: The data that describes data.
- *Entity*: It includes Person, Place, Thing, Event, Concept.
- *Attributes*: The data elements (facts), which elaborates about some entity. Also, sometimes called fields, or items, or column or domains.
- *Data values*: The instances of a particular attribute for a particular entity.
- *Key Field*: A field that uniquely identifies the record. An attribute, or set of attributes that uniquely identifies a particular entity is a key.
- *Records:* The set of values for all attributes of a particular entity also known *as* 'tuples', or 'rows' in relational DBMS.
- *File: The* collection of records also known as 'Relation', or 'Table' in relational DBMS.
- *Schema:* It is a description of the overall database structure, while a subschema holds the definition of part of the data described in the schema.
- *Relation:* A relation is a set of tuples, or a two-dimensional table of data. An attribute corresponds to a column in a relation. This is also referred as Entity.
- *Tuple*: A tuple corresponds to a row, or a record in a relation.
- *Data definition language (DDL):* It is the language used to describe the contents of the database.
- *Data manipulation language (DML):* It is the language used to form commands for input, edit, analysis, output, reformatting etc.

Advantages and Disadvantages of Database Management System

The DBMS has a number of advantages as compared to traditional computer file processing approach.

Advantages	*Disadvantages*
• Program-Data Independence	• Requirement of Database Manpower
• Minimal Data Redundancy	• Higher Installation & Management Cost
• Improved Data Consistency	• Higher Data Conversion Cost
• Improved Data Integration	• Higher Manpower Training Cost
• Improved Productivity of Data Sharing	• Database Failure
• Improved Data Accessibility & Responsiveness	
• Reduced Program Maintenance	
• Data Atomicity	
• Better Data Sharing	
• Improved Data Security & Recovery	
• Better User Interface	

Database Models

The concept of database was introduced by IBM in 1960s. Since then, a lot of research has been done in this field and various database models were developed. A brief description about the database models is given below:

Hierarchical Data Model

The **Hierarchical data model** is the oldest among other types of data models. It was created in 1960s and became more popular with the Information Management Systems (IMS) of IBM in 1970s. In hierarchical data model, the data is organised into a tree-like structure. A relationship exists when one record has a direct association with another. The second record is accessed through the first one. It always follows a parent/child relationship, which means each parent can have many children but each child can have only one parent. All attributes of a specific record are listed under an entity type.

The hierarchical data models are relatively simple to implement, understand, and use. As they follow the one-to-many parent child relationship, tend to be less flexible, and difficult to change. Adding of new data, or to answer ad hoc queries is difficult in these data models. Compared with other database models, hierarchical DBMS are simpler, faster, and more efficient. These type of data models are more suitable for high volume, transaction oriented applications. Owing to their rigid structure, they are most useful when data elements and their interrelationships can be explicitly defined in the beginning, and are not expected to change. The hierarchical data model is given in Figure 7.4.

Advantages and Disadvantages

- Data must possess a tree structure – good for geographical data
- Data access is easy using the key attribute, but difficult for other attributes

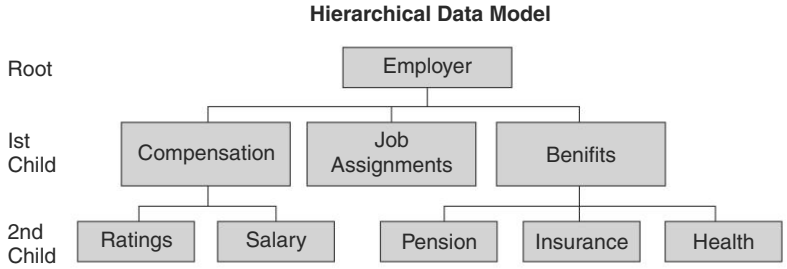


Figure 7.4 Hierarchical Data Model

- All records are called nodes
- Less flexible databases
- All access paths & relations must be defined in advance
- Adhoc queries are not possible
- Query process is time-consuming
- Processes day-to-day operations & structured queries much faster
- Efficient for a large size database
- Application Programming is time consuming & complicated
- Tree structure is inflexible
  - Cannot define new linkages between records once the tree is established
  - Cannot define linkages laterally, or diagonally in the tree, only vertically
  - The only geographical relationships, which can be coded easily are "is contained in" or "belongs to"
- The DBMS based on the hierarchical model (e.g. System 2000) have often been used to store spatial data, but have not been very successful as basis for GIS.

Network Data Model

The hierarchical data model allowed one-to-many relationship following typical parent child relationship, but some data were more naturally modelled with more than one parent per child. The Network data model permitted the modelling of many-to-many relationships in data. In 1971, the Conference on Data Systems Languages (CODASYL) formally defined the network model. The basic data modelling construct in the network model is the set construct. A set consists of an owner record type, a set name, and a member record type. A member record type can have that role in more than one set; hence the multi-parent concept is supported. An owner record type can also be a member, or owner in another set. The data model is a simple network, and link and intersection record types (called junction records) may exist, as well as sets between them. Thus, the complete network of relationships is represented by several pair wise

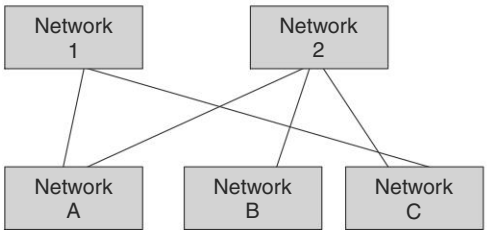


Figure 7.5 Network Data Model

sets; in each set some (one) record type is owner (at the tail of the network arrow) and one or more record types are members (at the head of the relationship arrow). Usually, a set defines a one-to-many relationship, although one-to-one is permitted. Some of the popular Network databases were TurboIMAGE and IDMS. Figure 7.5 below describes the Network Data Model.

Advantages and Disadvantages

- Objective of network model is to separate data structure from physical storage, eliminate unnecessary duplication of data with associated errors, and costs
- View records as sets
- Record can become members of more sets
- More flexible as compared to Hierarchical structure
- Uses concept of a data definition language, data manipulation language
  - Uses concept of m:n relationships means an owner record can have many member records and a member record can have several owners
- The network model has greater flexibility then the hierarchical model for handling complex spatial relationships
- Very difficult to construct & maintain
- Links between records of the same type are not allowed
- While a record can be owned by several records of different types, it cannot be owned by more than one record of the same type (patient can have only one doctor, only one ward)
- Example of a network database
  - A hospital database has three record types:
    - patient: name, date of admission, etc.
    - doctor: name, etc.
    - ward: number of beds, name of staff nurse, etc.
  - Need to link patients to doctor, also to ward
  - Doctor record can own many patient records
  - Patient record can be owned by both doctor and ward records

Relational Data Model

The Relational Data Model is easier, more flexible, and more versatile as compared to any other data models. The relational data modelling organises the data and relations between them in the form of tables. A table is a collection of records (rows) and each record in a table contains the same fields (column). The column describes the specific data element about those records, often called data fields. The invention of this database system has standardised the way the data is stored and processed. The concept of a relational database was derived from the principles of relational algebra. Example of relational database table is given below in Figure 7.6.

A relational database stores information across different tables and connects them with link.

Student No.	fname	lname	dob	qual	exp
IT101	JOY	CHUGH	17-Aug-81	BSc	2
IT102	JOY	JOHNSON	12-Feb-77	MBA	5
IT103	PETER	JAIN	15-Mar-82	BSc	2
IT104	NEHA	AGGARWAL	16-Feb-81	MA	2
IT105	GLORIA	ARORA	21-Nov-83	MSc	2
P101	SANDY	JAIN	24-May-80	BSc	1
P102	KAMAL	ARORA	02-Jun-79	BCOM	0
P103	JOY	HARDEY	03-Mar-80	BSc	5
P104	JOE	TROVOLTA	17-Oct-77	MSc	3

Figure 7.6 Relational Data Model

The relation is the primary unit of storage in a relational database, which is a two-dimensional table. A relational database can contain one, or more of these tables. Each table consists of a unique set of rows and columns. A single record is stored in a table as a row, also known as a **tuple**. The attributes of the data are defined in columns, or **fields**, in the table. The characteristics of the data, or the column, relates one record to another. Each column has a unique name and the content within it must be of the same type.

Advantages and Disadvantages

- The most flexible of the database models
- Provide both data and structural independence
- Relations between records can be created at any time
- No great programming efforts required
- Most widely used model
- Most RDBMS data manipulation languages require the user to know the contents of relations, but allow access from one relation to another through common attributes

Type of Relationships

The tables can be related to each other in a variety of ways. The functional dependencies are formed when an attribute of one table relates to attributes of other tables. Some examples of different types of relations are explained below and also in Figure 7.7.

1. **One-to-One:** The simplest relationship is ***the one-to-one relationship, in which one record in a table is related to another record in a separate table***, for example, one student can take up only one job, so the relationship between student and job table is one-to-one.

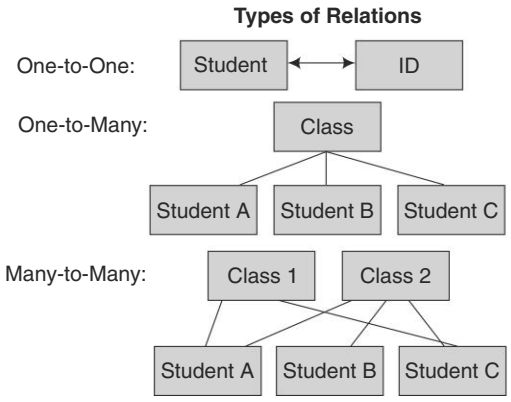


Figure 7.7 Different Type of Relations

2. **One-to-Many:** ***A one-to-many relationship is one in which one record in a table is related to multiple records in another table***. For example, one student can study multiple courses, so the relationship between the student and course table is one-to-many.
3. **Many-to-One:** ***A many-to-one relationship defines the reverse situation; more than one record in a single table relates to only one record in another table***.
4. **Many-to-Many:** Finally, in ***a many-to-many relationship, more than one record in a table relates to more than one record in another table***. Many-to-many relationship is difficult to manage; good database administrators normally resolve this to many-to-one and one-to-many.

Defining Key Attributes

The primary key is a key selected to uniquely identify all other attribute values in any given row. It cannot contain any null values.

A key in a table is one that distinguishes one row of data from another. The key may be a single attribute, or may consist of a group of attributes that uniquely identifies a record. Every table must contain a primary key, which differentiates records from one another. The primary keys can be an individual attribute, or a combination of attributes. The foreign keys relate tables in the database to one another. A foreign key in one table is a primary key in another. The foreign keys generally help in defining parent-to-child relationships between tables.

Characteristics of a Key

The foreign key is an attribute(s) in one table whose values must either match the primary key in another table or be null. It is a logical pointer.

- A key is an attribute that determines the values of other attributes within the entity.
- A key may consists of one or more attributes in order to define functional dependence.
- The attributes, which are part of key are called Key Attributes.
- A multi attribute key is called composite key.
- A key of a relation always have a unique identification.

The stored data is manipulated using a programming language called Structured Query Language (SQL). Many varieties of SQL exist. The SQL is based on set theory; relational operators such as and, or, not, in are used to perform operations on the data. The operations that can be used in a relational database include insert, select, update, and delete privileges.

Object/Relational Database Models

The object/relational database management systems (ORDBMSs) are an extension of the relational models, where it adds new object storage capabilities to the relational systems at the core of modern information systems. It integrates management of traditional fielded data, complex objects such as time-series, and geospatial data, and diverse binary media such as audio, video, images, and applets. By encapsulating methods with data structures, an ORDBMS server can execute complex analytical and data manipulation operations to search and transform multimedia and other complex objects.

The Object/Relational (OR) approach has inherited the robust transaction and performance management features of the relational models and the flexibility of its object oriented concepts. The structure of these database models is similar to relational table structure and follows the same Data Definition Languages (DDLs) and also allows the assimilation of object management possibilities.

Advantages and Disadvantages

- The main advantages of extending the relational data model come from *reuse* and *sharing*.
- The reuse comes from the ability to extend the DBMS server to perform standard functionality centrally, rather than have it coded in each application.
- The ORDBMSs approach has the obvious disadvantage of complexity and associated increased costs.
- There are proponents of the relational approach that believe the essential simplicity and purity of the relational model are lost with these types of extension.
- There are also those that believe that the Relational DBMSs is being extended for what will be a minority of applications that do not achieve optimal performance with current relational technology.

Object Models

The object DBMSs add database functionality to object programming languages. They bring much more than persistent storage of programming language objects. The object DBMSs extend the semantics of the object programming languages like Java, C++ to provide full featured database programming capability, while retaining native language compatibility. A major benefit of this approach is the unification of the application and database development into a seamless data model and language environment. As a result, applications require less code, use more natural data modelling, and code bases are easier to maintain. The object developers can write complete database applications with a modest amount of additional effort.

The object oriented database (OODB) paradigm is the combination of object-oriented programming language (OOPL) systems and persistent systems. The power of the OODB comes from the seamless treatment of both persistent data, as found in databases, and transient data, as found in executing programs. In contrast to a relational DBMS, where a complex data structure must be flattened out to fit into tables or joined together from those tables to form the in-memory structure, the object DBMSs have no performance overhead to store, or retrieve a web, or hierarchy of interrelated objects. This one-to-one mapping of object programming language objects to database objects has two benefits over other storage approaches: it provides higher performance management of objects, and it enables better management of the complex interrelationships between objects. This makes object DBMSs better suited to support applications such as financial portfolio risk analysis systems, telecommunications service applications, world wide web document structures, design and manufacturing systems, and hospital patient record systems, which have complex relationships between data.

DATABASE NORMALISATION

The data that is stored in tables are organised logically based on a particular purpose that minimises duplication, reduces data anomalies, and reinforces data integrity. The process by which data is organised logically is called normalisation. The normalisation simplifies the way data is defined and regulates its structure. The normalisation also simplifies the way data is defined in order to ensure data consistency and stability, to minimise data redundancy, and to ensure consistency, and avoid update and delete anomalies that result in ambiguous data, or inconsistent results. There are five forms in the normalisation process with each form meeting a more stringent condition.

The normalisation is the process of efficiently organising data in a database.

In order to understand the normalisation concept better, let us take the CD rental store example. A multi-city CD rental store issues audio/video CDs on rent to its customers and maintains the rental data in database in the following format:

Rental Database Table

TID	Date	CID	Name	Add	City	Pin	Phone	CD_ID	Copy	Title	Rent

The above table, which consists of attributes like Transaction ID (TID), Date of transaction (Date), Customer ID (CID), Name of the customer (Name), Address of the customer (ADD), Customer City (City), Pincode (Pin), Customer Phone (Phone), CD identification number (CD_ID), CD copy number (Copy), Title of CD (Title), and Rental (Rent). The same data table can be depicted as follows:

Rental (TID, Date, CID, Name, Add, City, Pin, Phone, CD-ID, Copy, Title, Rent).

First Normal Form (1NF)

If the rental store operator manages the database in the above manner, there will be plenty of problems with respect to data duplications. For example, what happens, if customer wants to rent out more than one CD? In order to overcome this problem, one needs to remove the repeating groups, by implementing first normal form. ***A relation is in first normal form (1NF) if it has no repeating groups***.

An entity type is in 1NF when it contains no repeating groups of data.

Before converting the relation to 1NF, make sure that the data is represented in a proper tabular format that qualifies the following properties:

- Entries in columns are single valued and are of the same kind.
- Each row is unique.
- Sequence of columns is insignificant.
- Sequence of rows is insignificant.
- Each column has a unique name.

The most common mistake made by database users against the first normal form (1NF) are the lack of a Primary Key (PK) and the use of 'repeating columns'. This is where multiple values of the same type are stored in multiple columns.

In order to resolve the above example to 1NF, we will split the table into two:

Customer Database Table

TID	Date	CID	Name	Add	City	Pin	Phone
PK							

CD Database Table

TID	CD_ID	Copy	Title	Rent
PK	PK			

The PK in the above table denotes the Primary Key. By doing so, each transaction can have many CDs and each CD can be rented on many transactions. All key attributes are defined. There are no repeating groups in the table and all attributes are dependent on the primary key may be partially.

Second Normal Form (2NF)

The 1NF splits the repeating groups, but it still has problems relating to replication and partial dependency. Where will one record the details of new CD, which has not be rented yet?

A relation is in second normal form (2NF) if it is in 1NF and no non-key attribute depends upon only a part of the primary key. The purpose is to make sure that each column is defined in the correct table using the more appropriate names and each attribute is part of correct table. In our example, as far as attributes of customer table is concerned all attributes are fully dependent on the primary key field TID, whereas in CD table there is concatenated key (TID+CD_ID). In this table, copy# depends fully on the key, but the title and rent is dependent only on CD_ID part of the key not on the TID.

An entity type is in 2NF when it is in 1NF and when all of its non-key attributes are fully dependent on its primary key.

CD Database Table

TID	CD_ID	Copy #	Title	Rent
PK	PK			

In order to resolve this, one needs to split the CD table into two parts as follows:

CD1 Database Table

TID	CD_ID	Copy#
PK	PK	

CD2 Database Table

CD_ID	Title	Rent
PK		

With this split, each non-key column depends on the whole key. The problem with 2NF is transitive dependency, which means there is no dependency between two non-key attributes.

Third Normal Form (3NF)

Even in 2NF, problems related to replication, hidden dependency and also same problem of non-rental of a CD remain. In order to solve these it is necessary to reduce second normal form entities to third normal form (3NF) by removing attributes that depend on other, non-key attributes.

An entity type is in 3NF when it is in 2NF and when all of its attributes are directly dependent on the primary key.

This means that we should not store any data that can either be derived from other columns, or belong to another table. If we look at the customer table, date, and CID fields are dependent on TID, but the remaining fields like Name, Address, City, Pin, and Phone are dependent on CID. So to resolve this problem, one needs to split the customer table.

Customer1 Database Table

TID	Date	CID
PK		

Customer2 Database Table

CID	Name	Add	City	Pin	Phone
PK					

Many database designers stop the normalisation process at 3NF. Indeed, these were the original normal forms, which are now extended with additional levels of normalisation. The additional levels of normalisation are explained briefly. In some cases, you may even need to de-normalise some for performance reasons.

Boyce/Codd Normal Form

One can reduce third normal form entities to Boyce/Codd normal form (BCNF) by ensuring that they are in third normal form for any feasible choice of candidate key as primary key. In short, Boyce/Codd normal form (BCNF) addresses dependencies between columns that are part of a Candidate Key. ***A relation is in Boyce-Codd normal form (BCNF) if every determinant is a candidate key.*** A determinant is any attribute, whose value determines other values within a row.

A relation is in Boyce-Codd Normal Form (BCNF) if every determinant is a candidate key.

Some of the normalisations performed above may depend on the choice of the Primary Key. The BCNF addresses those cases, where applying the normalisation rules to a Candidate Key other than the one chosen as the Primary Key would give a different result. In actuality, if we substitute any Candidate Key for Primary Key in 2NF and 3NF, 3NF would be equivalent with BCNF.

In a way, the BCNF is only necessary because the formal definition is focused on the Primary Key rather than an entity item abstraction. If one defines an entity item as an object, or information instance that correlates to a row, and considers the normalisation rules to refer to entity items, this normal form would not be required.

The BCNF covers very specific situation, where 3NF misses inter-dependencies between non-key attributes. Typically, any relation that is in 3NF is also in BCNF. However, a 3NF relation may not be in BCNF if (a) there are multiple candidate keys; (b) the key is a composite key; and (3) there are common attributes between the keys.

Fourth Normal Form (4NF)

One can reduce Boyce/Codd normal form entities to fourth normal form (4NF) by removing any independently multivalued components of the primary key to two new parent entities. Then, one should retain the original (now child) entity only if it contains other, non-key attributes. Where BCNF deals with dependents of dependents, 4NF deals with multiple, independent dependents of the Primary Key. An entity is in 4NF when:

- It is in 3NF.
- Has no multiple sets of multi-valued dependencies.
- Many-to-Many relationships are resolved independently.

Fifth Normal Form (5NF)

Reduce fourth normal form entities to fifth normal form (5NF) by removing pair-wise cyclic dependencies that are appearing within composite primary keys with three, or more component attributes to three, or more parent entities. This addresses problems that arise from representing associations between multiple entities with interdependencies. Making it 5NF consists of adding parent tables, one for each meaningful combination that has children in the original table. A table with such information is 5NF if the information cannot be represented in multiple smaller entities alone.

ENTITY RELATIONSHIP MODELS

The Entity Relationship (E-R) Modelling is a set of diagrams that are used to interpret, specify, and document logical data requirements for database processing systems. ***The E-R Models are Conceptual Models of the database***. They cannot be directly implemented in a database. They are independent of hardware, software, and databases, but are very powerful

The entity-relationship model (or ER model) is a data modeling technique that graphically represents the logical relationships of entities (or objects) in order to create a database.

tools for data modelling. Many variations of E-R Modelling are used in practice—main differences are in notation and in symbols used to represent the constructs. The E-R models help in depicting the relationships between different entities. The entity is same as the table, which has some attributes and one of the attribute is a key attribute, or identifier. The relationship is an association between two entities, for example A CUSTOMER *places* an ORDER; An EMPLOYEE *takes* an ORDER; A STUDENT *enrols for* a COURSE. In all the above examples CUSTOMER, ORDER, EMPLOYEE, STUDENT and COURSE are entities participating in relationships.

Some of the characteristics of relationships are:

- The relationships are typically given names, like CUSTOMER places ORDER. Here places is the name given to a relationship between entities CUSTOMER and ORDER.
- A relationship can include one or more entities.
- The *degree* of a relationship is the number of Entities that participate in the relationship.
- The relationships of degree 2 are called *binary relationships*. Most relationships in databases are binary.
- The degree of Relationships can be one, two or three and are called unary, binary, and ternary relationships respectively. (Refer Figure 7.8)

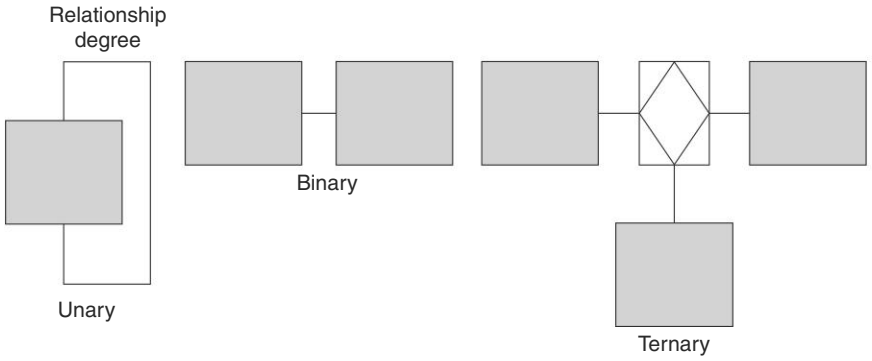


Figure 7.8 Degrees of Relationships

- The relationship **Cardinality** refers to the number of entity instances involved in the relationship. For example:
  - *one* CUSTOMER may place *many* ORDERS (so one-to-many cardinality between CUSTOMER and ORDERS)
  - *many* STUDENTS may register for *many* CLASSES (so many-to-many cardinality)
  - *one* EMPLOYEE receives *one* SALARY (one-to-one cardinality)
- The common type of cardinalities used are:

1:N	'One-to-Many'
N:M	'Many-to-Many'
1:1	'One-to-One'

E-R Diagrams

The most common way to represent the E-R models is by using a diagram. There are a wide variety of notations for E-R diagrams. Most of the different notations are concerned about how relationships are specified and how attributes are shown. In almost all variations, entities are depicted as rectangles with either pointed, or rounded corners. The entity name appears inside. The Relationships can be displayed as diamonds, or can be simply line segments between two entities. For Relationships, one must include: Relationship name, degree, cardinality, optionally (minimal cardinality). For example, in Figure 7.9, it shows the E-R diagram between Students and Curriculum entities. It is read as—One, or many Student is enrolled in Curriculum and Curriculum is being studied by many students or may not be.

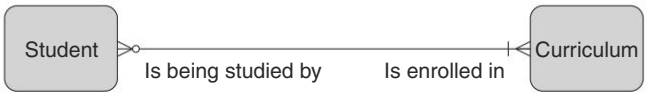
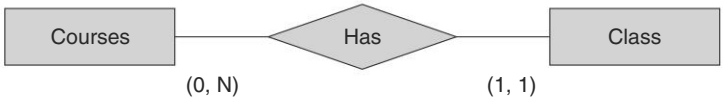


Figure 7.9 E-R Diagram

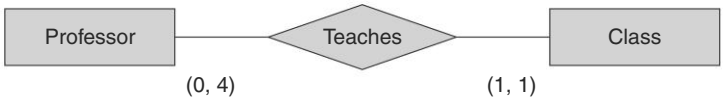
Some more examples of E-R Diagrams using other type of notations are:

1. Each department offers several courses and course is being offered by one and only one department.

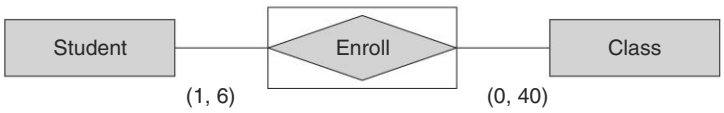
2. Course may have number of classes and the class must have atleast one course.



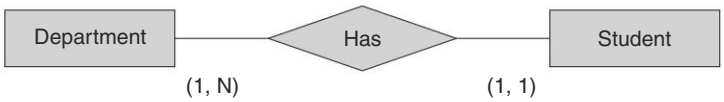
3. Each professor may teach maximum 4 classes, or may do not teach and the class must be taught by atleast one professor.



4. A student may enroll in several classes, but takes each class only once during the enrollment period. Each student can take max. 6 classes and each class may have max. 40 students.



5. Each department has atleast one, or several students and each student belongs to one single department.



CREATING AND MANAGING DATABASES USING MICROSOFT ACCESS

Once the conceptual model of the database is ready, convert it to Relational Model which includes *Relations, Tuples, and Attributes.* The Relational Model is then converted into databases using one of the RDBMS softwares like ORACLE, DB2, or ACCESS. As defined earlier, Relation is a two-dimensional table, or simply a table of the database. The Tuple is an entity instance, or simply a Row in a table. In this chapter, we will discuss how to create and manage Microsoft® ACCESS 2007 databases.

The Microsoft Access is a relational database management system. It is an application software that is used to create and manage computer-based databases on desktop computers and/or on networks. The Microsoft Access can be used to create simple and powerful information system solutions for small and medium size organisations.

Starting Microsoft Access

In order to start Microsoft Access, one should open the Windows **Start** menu and choose **Programs;** Select **Microsoft Office** then **Microsoft Office Access 2007**.

On entering Access one is presented with a Getting Started with Microsoft Access screen as shown below, apart from the menus, toolbar, templates, and recent databases. One can either create a new database, or open an existing one.

When Microsoft Access opens, it displays an interface, which is divided in various sections. The top section displays a long bar also called the title bar. The title bar starts on the left side with the Office Button  . If the mouse is positioned on it, a tool tip would appear. When clicked, the Office Button displays a menu that allows performing the routine Windows operations like creating a new database, opening an existing database, saving an object, printing an object, etc. The Quick Access toolbar  is displayed on the right side of the Office Button. By default the Quick Access toolbar displays Save, Undo, and Redo options, which can be customised by clicking on the customised button on the right side of the Quick Access Toolbar.

The main area of the Microsoft Access interface is divided into three sections. The left side displays Templates categories. The middle part again is divided into two—the top part allows the user to create a database and the bottom part displays some information from Microsoft. The right side displays list of Open Recent Database. The bottom section of the Microsoft Access interface displays a status bar.

Navigation Pane and Access Objects

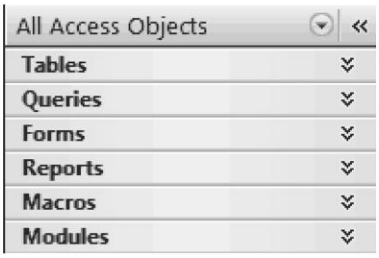
Once the Access database is opened, the left section is occupied by a rectangular object called the **Navigation Pane**. The Navigation Pane is the central point of a database. It allows reviewing the objects that are part of a database. One also uses it to change the way the objects are displayed, whether the objects should appear in categories, and the type of categories. By default, the Navigation Pane appears as a rectangular box with a title on top. The top section of the Navigation Pane displays an All Tables label.

One can:

- Click the double right-arrows  to open it. The arrows change to double left-arrows  .
- Click the double left-arrows  to close it. The arrows change to double right-arrows  .

Access Objects

One can create different kinds of objects in Access to manage its database more effectively. In order to view or hide the objects on the Navigation pane:



- One can click the double down-arrows to view objects. The double down-arrows change to double up-arrows.
- One can click the double up-arrows to hide objects. The double up-arrows change to double down-arrows.

The Navigation pane stores the objects in database: tables, queries, forms, reports, macros, and modules. The objects always display with an icon to the right. The icon tells you the object type: table, query, form, report, macro, and module.

Objects	
Tables	In Access, data is stored in tables. A table is a set of columns and rows, with each column referred to as a field. Each value in a field represents a single type of data. Each row of a table is referred to as a record. One can add/edit/delete/filter data using tables object.
Queries	One use queries to retrieve specific data from the database. It allows extracting part, or full data from one or more tables within a database.
Forms	Forms are a user-friendly layout to display and enter data from and within database tables. It gives the ability to choose the format and arrangement of fields. One can use a form to enter, edit, and display data.
Reports	The reports organize, or summarise the data in a more presentable format so that one can print it or view it onscreen.
Macros	The macros give the ability to automate tasks. One can use a macro to add functionality to a form, report, or control.
Modules	Like macros, modules give the ability to automate tasks and add functionality to a form, report, or control. The macros are created by choosing from a list of macro actions, whereas modules are written in Visual Basic for Applications.

One can double-click an object to open the object and right-click on object to view a menu of options. The objects that are open appear on tabs. One can right-click a tab to view a menu of options one can perform, such as save the object, close the object, or change the view.

Change Views  **:** A view is a way of looking at an object. For example, in Access, data is stored in tables. Two of the possible ways you can view a table are Datasheet view and Design View. One can see the data contained in a table in Datasheet view. One can also see the design of a table in Design view.

To close a database:

1. One should click the Microsoft Office button. A menu appears.
2. One should click Close Database. Access closes the database.

To exit Access:

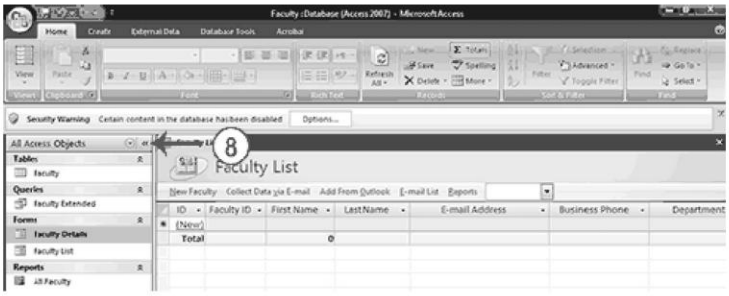
1. One should click the Microsoft Office button. A menu appears.
2. One should click Exit Access. It helps to exit Access.

Creating Databases

There are many methods exist for creating databases; one can create a blank database, or use a template provided by Microsoft. The templates are organised by categories. In order to access a sample by category, one can select the category from the left section of the window.

To use a template to create a database:

1. One should start Access. The Getting Started with Microsoft Office Access screen appears.
2. One should click Local Templates. Icons representing local templates appear in the center of the window.
3. One should click the icon for the template that one wants to use.
4. One should click the Browse button. The File New Database window appears.
5. One should locate the folder in which one wants to store the database.
6. One should click OK.
7. One should click Create. Access creates and opens the database.



8. One should open the Navigation pane. Then access displays the tables, queries, forms, reports, and other objects related to the database one selected.

How to Open an existing database?

1. One should click the Office button. A menu appears.
2. One should click Open.
3. One should locate the folder in which the database is stored.
4. One should select the database and click Open.
5. One should access opens the database.

Create a Blank Database

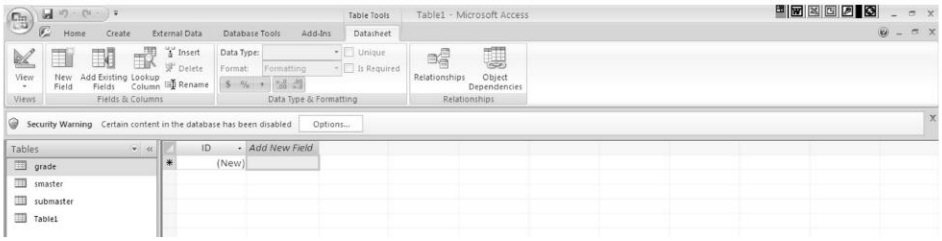
A blank database is a database with nothing in it. One needs to create all the tables, forms, reports, queries, and so on. If one cannot find a template that suits, then create a blank database. Follow the steps given below:

To create a blank database:

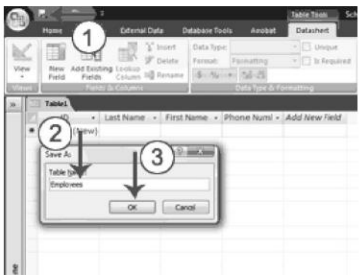
1. One should start Access.
2. One should click Blank Database.
3. One should type the name for the database in the File Name field. Then access will automatically append .accdb to the name.
4. One should click the Browse button. The File New Database window appears.
5. One should locate the folder where the database is to be stored.
6. One should click OK.
7. One should click the Create button. Then the access creates the database and opens a datasheet with the Table Tools available to the performer.

Creating Tables

Every database has one or more tables. If the database is created using templates, Access would provide some basic tables as per the template selected. If one has created a database without using templates, then one needs to create a table by selecting the Create Menu. One can create the tables either in a datasheet mode as shown in the following screen shot or using the design view. If one starts a table in Datasheet View, the Microsoft Access creates and gives the default column. Once a table displays in Datasheet View, one can start entering data into its cells and each column would automatically get the field names as field1, field2, and so on. One can always change these names. In order to change filed names, just double click the column header, or right click a column and click **Rename Column.**



After one creates a table, one must name and save it, as follows:



1. One should click the Save button on the Quick Access toolbar. The Save As dialog box appears.
2. One should type the name for the table.
3. Then click OK. Access names the table and save it within the database.

Creating Tables in Design View

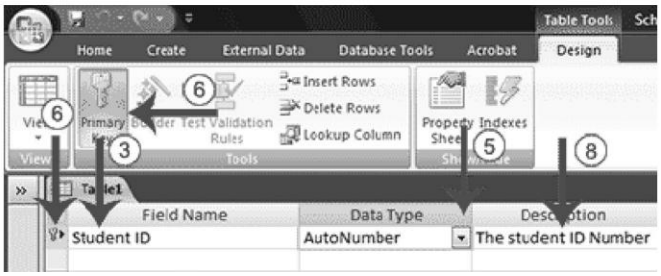
In order to create tables in Design view requires more understanding of data properties and many other database characteristics. In order to activate the design view click on the view button on the extreme left of the screen. The Table design view allows the user to type in the field name, data type, description, and various field properties for each of the fields. The field name can be 64 characters long name including space. Each field can be of one of the following data types:

Data Type	*Use*
Text	Alphanumeric data. Text data type allows storing any valid character up to 255 characters characters long. One can make queries on Text fields
Memo	Long text. Use for long pieces of text, such as notes and long descriptions. Can store to 64,000 characters. One cannot make any queries on these fields. These types of fields are useful for storing support data.
Number	Numeric data including decimals. Use for numbers one wants to use in mathematical calculations.
Date/Time	Use for dates and times as per the valid calendar from 100 to 9,999 years.
Currency	Use for currency and same as Numbers. All currency data is prefixed with currency signs (if required) and provides accuracy up to 15 decimal digits.
AutoNumber	Unique sequential numbers, or random numbers automatically inserted when one creates a record. Use to create a primary key. It cannot be modified by the user.
Yes/No	Logical data. One can use when only one of two values is valid. Yes/No, True/False, etc.
Hyperlink	Used to create hyperlinks within the database tables. For example, one can create a website field and give active web address using hyperlink.
Attachment	One can attach images, spreadsheet files, documents, charts, and other types of supported files to the records in the database tables. One can also view and edit attached files. The attachment fields provide more flexibility than OLE Object fields.
OLE Object	Use to attach an OLE object such as a Word document, Excel spreadsheet, or PowerPoint presentation. One cannot run any query on these types of fields. The size of these objects is restricted to 1 GB.
Lookup Wizard	Creates a field that allows the user to choose a value from another table, or from a list of values by using a list box or combo box.

The access provides several ways to view the objects in the database. One can use Design view to create, or modify an Access table. One can use the View button on the Home tab, or the Table Design button on the Create tab to change to Design view. Using Design view is the preferred method for creating a table because it provides with the most options and enables to precisely define the table.

In order to use Design view to create a new table:

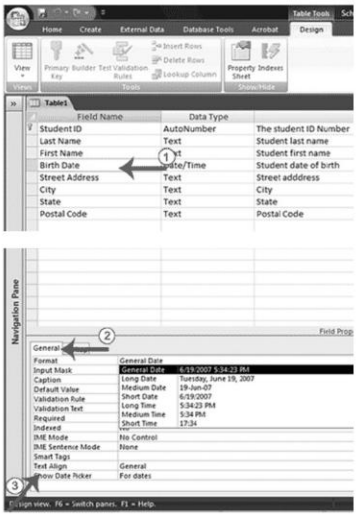
1. One should activate the Create tab first.
2. Then one should click Table Design in the Tables group. And access changes to Design view and the Table Tools become available.



3. One should type the first field name in the Field Name field.
4. One should press the Tab key.
5. One should select the Data Type from the drop-down list.
6. One should click Primary Key if the field that was created is a primary key. A small key appears next to the field name.
7. One should press the Tab key.
8. One should type a description. The description is optional.
9. One should press the Tab key. The access moves to the Field Name field.
10. One should repeat steps 3 through 10 until one have created all the fields.

To set field properties:

1. One should click the field for which the field properties are to be set.
2. One should activate the General tab in the Field Properties area.
3. Then set the properties that needs to be set.
4. Then repeat steps 1 through 3 until one has set all the properties for all fields.



One can use Design view to create or modify a table. After the task is complete, one must save the table by clicking the Save button on the Quick Access toolbar.

Opening a Table

The most regular operations that one will perform on a table is to open the existing table. In order to open a table, first locate it in the Navigation Pane and just double-click the table. The table will be displayed in Datasheet View.

Closing a Table

After using a table, one can close it by clicking the close button ✕ on the right side of the tabs.

Renaming a Table

After creating a table, sometimes one needs to save it by different name. In order to rename a table, in the Navigation Pane, one should right click the name of the table and then again click Rename.

Deleting a Table

If one needs to delete a table from the database, from the Navigation Pane, he should right click the table and then click Delete. It is important to know that the deleted table does not go to the Recycle Bin, so one cannot recover it. One should make sure before deleting the table.

Managing Data in Access

In order to understand how to manage data in Access, let us use a 'Grading' database. The Grading database consists of data about imaginary set of students, which is divided into three

tables. The first table is a 'students' table that has description about the student's name, date of birth, qualification and experience. The second table is a 'Subject' table that has details about different subjects and the third table is 'Grades' table having grades scored by different students in different subjects. The structures of three tables are given below:

1. **Student Table**

(a)	Sno	text	5	Student Number a required field
(b)	Fname	text	15	Student First Name
(c)	Lname	text	15	Student Last Name
(d)	Dob	date		Student Date of Birth
(e)	Qual	text	5	Student Qualification
(f)	Exp	number integer		Student Experience

2. **Subject Table**

(a)	Scode	text	5	Subject Code a required field
(b)	Sname	text	30	Subject Name
(c)	Type	yes/no		Compulsory (Yes) or Elective

3. **Grade Table**

(a)	Sno	text	5	Student Number a required field
(b)	Scode	text	5	Subject Code a required field
(c)	Grade	text	1	Grade with default value of F

Setting up a Primary Key

Whenever a database is designed using new tables, each table must have a **Primary Key.** A *primary key* is a field or combination of fields that uniquely identify each record in a table. A *foreign key* is a value in one table that must match the primary key in another table. The primary keys and foreign keys are used to join tables together to improve database efficiency. If a table does not contain a primary key, then Access will ask to set up an ID field. In the above database, the students table will have SNO field as its primary key. In order to do this:

1. One should load the Students table under the Design View
2. One should select SNO field
3. One should right click to select the Primary Key.

In the same manner, one should create the Scode as a Primary Key in Subject Table. Since in Grades table neither SNO nor Scode is unique, so one should select both the fields as concatenated Primary Key.

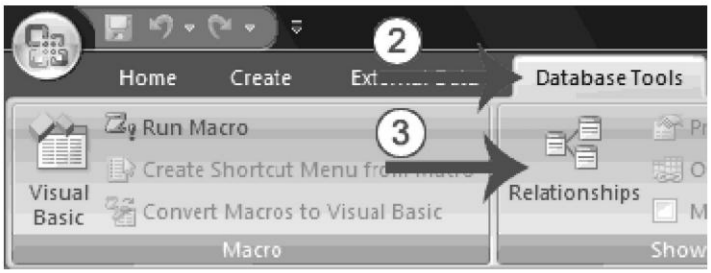
Relationships

In databases if there are two, or more tables, it is important to define relationship between them. A good database is one in which each table is related to at least one another table in the database. A **Relationship**  is a method, which tells Access how the information in the tables relates to each other. There are two valid types of relationships: one-to-one and one-to-many. In a one-to-one relationship, for every occurrence of a value in table A, there can only be one matching

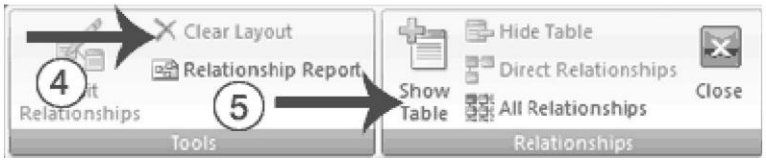
occurrence of that value in table B, and for every occurrence of a value in table B, there can only be one matching occurrence of that value in table A. The one-to-one relationships are rare because if there is a one-to-one relationship, the data is usually stored in a single table. However, a one-to-one relationship can occur when one wants to store the information in a separate table for security reasons, when tables have a large number of fields, or for other reasons. In a one-to-many relationship, for every occurrence of a value in table A, there can be zero or more matching occurrences in table B, and for every one occurrence in table B, there can only be one matching occurrence in table A. When tables have a one-to-many relationship, the table with the one value is called the *primary* table and the table with the many values is called the *related* table.

To create relationships:

1. One should close all the open database tables
2. One should select the Database Tools Tab.
3. Then click on **Relationships** button under database tools menu, which will load an empty *Relationships Window.*



4. If anything appears in the relationships window, one should click the Clear Layout button in the Tools group. If one is prompted, it requires to click Yes.
5. One should click the Show Table button in the Relationships group. The Show Table dialog box appears.

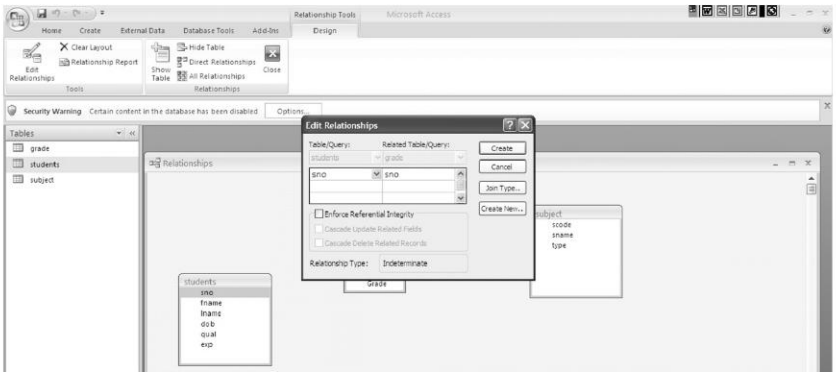


6. *One should double click* on the Students, Subject, and Grades tables to add them to *Relationships Window*.
7. One should press **<Esc>,** or click on the window's **Close** button to **Close** the *Show Table* window.
8. One can use *drag and drop* to create a join line linking the SNO field of Students Table to the SNO field of the Grades Table.

9. An *Edit Relationships* window appears—it requires click on **Create button** to confirm the type of join.
10. Similarly, one should create a join between Scode of Subject table and Scode of Grade Table.

Joining Tables

As described earlier, if there are two, or more tables, it is important to join them using relationship. The tables are joined using the **Relationship** tool of Access, as described in the previous section. It will show the following screen:



It will display the Edit relationship window, in which one can modify the *Join Type.* Join type will allow either selecting only records where the join field is equal, or to include all records from one of the tables and can *Enforce Referential Integrity*. The *referential integrity* ensures that the validity of the relationship between two tables remains intact. It prohibits changes to the primary table that would invalidate an entry in the related table. As per our database example, Referential Integrity will ensure that a student's number in Grades Table must be in the Student table. Once the *Referential Integrity* is activated, one can *Cascade Update/Delete Related Records*. These cascades are very useful in automatically changing data in a linked table. For example, if the student leaves the course, its details are deleted from the Students table; Delete Cascade will automatically delete the same student details from the Grades table and also from all other linked tables.

Once relationships have been set up, various additional features automatically emerge. For example, if one sets up a form for one of the new tables then a sub-form giving a list of appropriate students is added. An additional benefit of relationships is that the links are automatically shown whenever one uses more than one table in a query. By setting appropriate join properties, one can also get the unmatched records. The Microsoft Access supports three types of Joins:

- Displays only those records of joined tables, where the join fields of the joined tables are equal (Equi-Join)
- Displays all records of the parent table (students master) and only those records of child table (grades) where the joined fields are equal.

- Displays all records of the child table (grades) and only those records of parent table (students master), where the joined fields are equal.

MANAGING DATABASE RECORDS

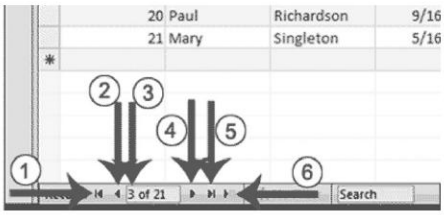
Once the database tables are created, one would always like to make changes in the existing data set by adding new records, or deleting existing records or update the existing records. In order to add a new record to the currently open database table, use the **New Record** button on the status bar. The new records are always added at the end of the existing data table. As soon as one starts typing, Access creates a new empty record (marked with an asterisk), while the current record indicator changes from an arrow to a pencil. In order to add one record in student table:

1. Load the student table.
2. Click on the **New Record** button on the status bar.
3. Start typing the data into various fields (or columns) of the table. As per the table structure, SNO field is a required field, so do not leave it blank.

In order to edit records, just select the record that one wants to edit and move the cursor to appropriate column and start editing.

In case one wants to delete the current record, click on the **Delete Record** button available on the menu ribbon, or select the record that one wants to delete and right click to select the delete button. Deleting records from a database means deleting it permanently. It takes confirmation before the deletion. One cannot use the Undo to recover the deleted record.

To use the Navigation bar to move around a table:



1	Go to First Record
2	Go to Previous Record
3	The Current Record
4	Go to Next Record
5	Go to Last Record
6	Create a New (Blank) Record

Sorting Records

By sorting, one can arrange a column, or a set of columns in alphabetical, numerical, or date order. One can sort in ascending order, or descending order. One can also sort within a sort. When

sorting within a sort, one can perform the innermost sort first. For example, if one is sorting by state and then city, it requires to sort the city first and then sort by state.

To add a sort:

1. One should click the column label for the column you want to sort.
2. One should activate the Home Tab.
3. One should click the Ascending , or Descending button in the Sort & Filter group. Access sorts the column in ascending or descending order.

To remove a sort:

1. One should activate the Home tab.
2. One should click the Clear All Sorts button in the Sort & Filter group. The Access clears all of the sorts.

Selecting Records

Before one can perform an operation on a column or row, one must select it. In order to select a column, click the column head. In order to select several columns, one can click a column head and then drag. In order to select a row, then click the blank area to the left of the row. In order to select several rows, one can click the blank area to the left of a row and then drag. In order to select the entire table, click the Select All button in the upper-left corner of the table.

The Databases offer the facility of extracting complete, or part of records according to some pre-defined criteria. For example, in students table, one can extract all students with commerce qualification. The Access allows selection of records using one of the two methods; *Select using a Filter* and *Select using a Query*.

Select using Filters

The simple selections can be made directly on the table itself, using a filter. In order to select students with BCOM qualification, one should move the cursor on the qualification column. Then select the BCOM under qualification column and one should further click **Filter by Selection** from the icon ribbon. It will give one four options to select from to refine the filter options. One should select one of the four options and get the filtered result. In order to remove the filtered output, one should click on the **Toggle Filter** button. This way one can filter any dataset of the active table. Having made the required selection, one might want to delete the filtered records, or just want to print.

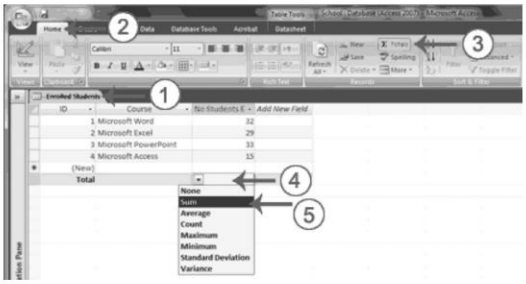
One can also use the Advanced Filters, which are quite similar to database query. One can also save the advance filter as a query and refine the query.

Computing Totals

The compute function in Access helps one to compute the sum, average, count, minimum, maximum, standard deviation, or variance of a number field; the count, average, maximum, or minimum of a date field; or the count of a text field.

To compute totals:

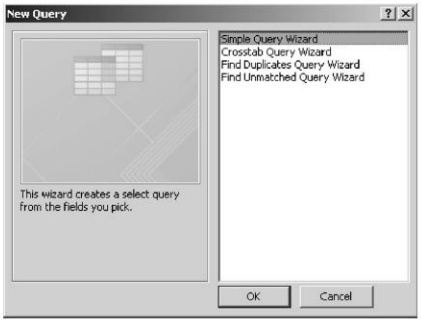
1. One should open the table or query for which compute totals needs to be performed.
2. One should activate the Home tab.
3. One should click the Totals button in the Records group. A Total line appears at the bottom of the table or query.
4. One should click on the Total line under the column one wants to total. A drop-down appears on the left side of the field.
5. One should click the drop-down button to select the function one wants to perform. The Access performs the calculation and displays the results in the proper column on the Totals row.



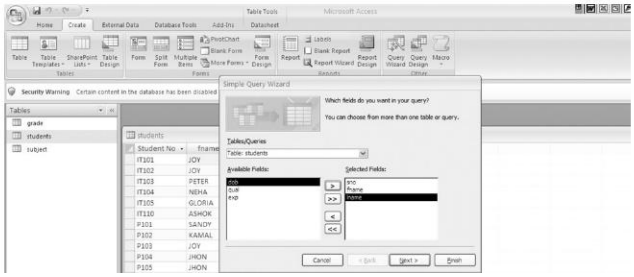
Database Query

A query is the result of getting, or isolating a list of values from a table, or another query. The querying is the technique of examining data to create a dependent list. One can perform querying on a table, a form, or a query. The Microsoft Access provides various means of performing such an operation visually. As an alternative, Microsoft Access supports SQL that allows you to query a database using standard database language SQL.

One of the simplest ways to create a query is by using the Query Wizard. It presents a list of tables and queries that one can select from the current database. In order to use the Query Wizard, click on the Create Menu tab and click Query Wizard  . This would display the New Query dialog box.



On the New Query dialog box, one can click Simple Query Wizard and click OK. From the first page of the Simple Query Wizard, the user can choose the table, or an already created query. After selecting the table, or query, the second page of the wizard would present the fields from the selected table, or a query, as shown below:

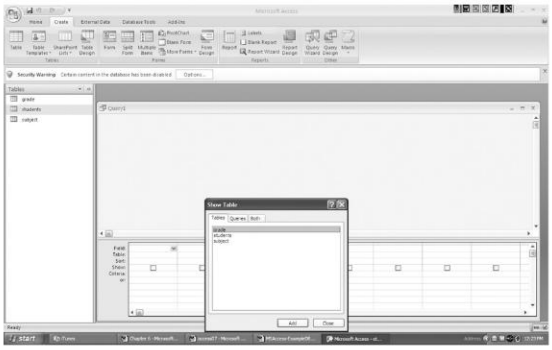


One should select the set of fields on which one wants to create a query and click the next button. This will help in creating a simple query.

Alternatively, query in Access can be designed using the design view. One can design a query using the Design View:

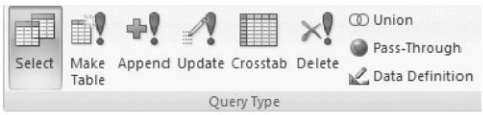
- In order to display a query in Design View, from the Navigation Pane, one can right click a query and click Design View.
- In order to start designing a new query, in the other section of the Create tab of the Ribbon, click Query Design.

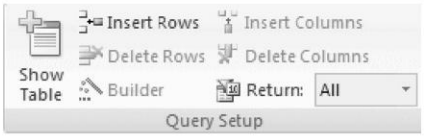
Or alternatively, one should follow the following steps:

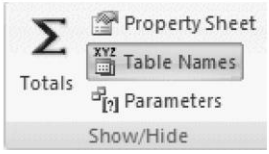


1. One should activate the Create tab.
2. One should click the Query Design button in the Other group. The Show Table dialog box appears, as shown below.
3. One should activate the Tables tab if one wants one's query to be based on a table otherwise activate the queries or both tab.
4. One should select the table, or query on which one wants to base one's query.
5. One should click Add. The table appears in the window.
6. One should click Close. Access changes to Query Design view.

One can now select the tables or queries on which one wants to create a query. When a query is displayed in Design View, the Design tab of the Ribbon displays the buttons used for a query:







Display All Records and All Fields

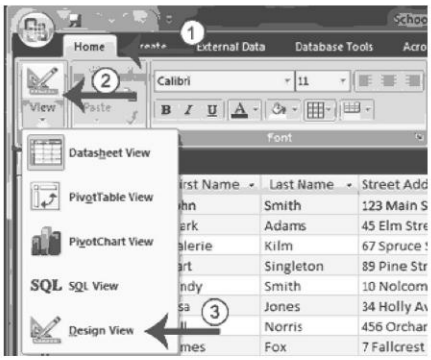
In Query Design view, each table has an option that allows one to display all of the fields and all of the records in a table. This option appears on the field line on the drop-down menu as the table name followed by a period and an asterisk (*tablename**) So to all the records and all the fields:

1. One should open a table, or query in Query Design view.
2. One should click the drop-down in the first field on the Field row and then select the *tablename.** option. The table name appears on the table line.
3. One should click the Run button . Access retrieves all of the fields and records for the table and displays them in Datasheet view.

Change from Datasheet View to Query Design View

After executing the query, one can easily change back to Query Design view and make modifications to one's query, or create a new query. In order to change to Query Design view:

1. One should activate the Home Tab.
2. One should click the drop-down below View in the Views group. A menu appears.
3. One should click Design View. Access changes to Query Design view. One can modify the query.
4. One can also click the Design button in the lower-right corner of the Access window to change to Design view.

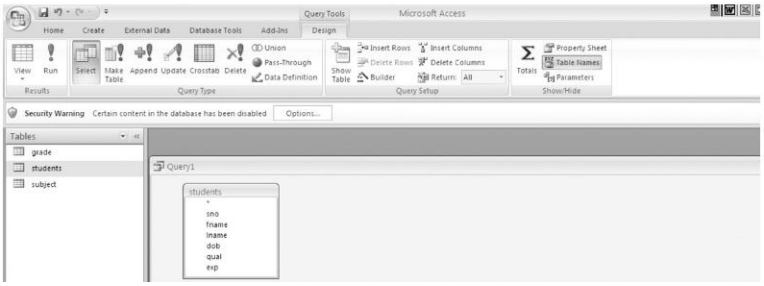


Selecting Columns

In order to create the fields for a query, one use the table(s) or, query(ies) displayed in the upper section of the window. Once the tables/queries are selected, one can select the fields that are relevant for the query in the following manner:

- In order to select one field from the list, just click it.
- In order to select many fields on the same range, one can click one of them, press and hold Shift. Then click one field on the other end of the desired range.
- In order to select fields at random, then click one of the desired fields, press and hold Ctrl and then click each one of the desired fields.
- In order to select all fields, one can click the * line on the list of fields.

Once one has made the selection on the list in the top part of the query window, one can drag it and drop it in the bottom section of the query window. Once the selection fields are complete, one will get the following screen:



In order to execute a query:

- If the query is currently closed, from the Navigation Pane:
  - One should just double click it
  - One should just right click it and then click Open
- If the query is already open and it is in Design View on the Ribbon, one should click the Run button  .
  - One can click the View button  or can click the arrow of the View button and click Datasheet View

Some operations require selecting a column from the bottom section of the query window:

- In order to select a field in the lower section of the view, one should click the tiny bar of the column header, it will select the whole column.
- In order to select a range of columns, click the column header of one at one end, press and hold Shift, then click the column header at the other end.

Removing Column

A query is made of number of columns. Sometimes, one needs to modify the query definition by changing the columns. If one does not need a column in a query, one can either delete it or replace it, with another column:

- In order to delete a column:
  - Once it is selected, one should press Delete
  - Then Right click the column header and click Cut
- In order to delete a group of columns, then one should select them and press Delete

Replacing Column

In order to replace a column, click the arrow on the combo box that displays its name and select a different field from the list.

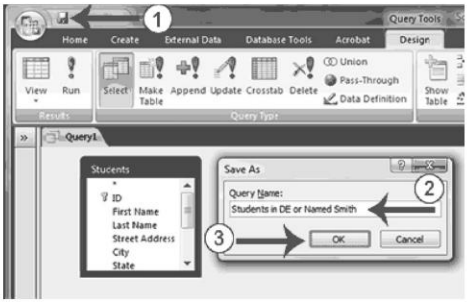
Moving Column

The columns on a query are positioned in a sequential manner as they are added to it. If one wants to change the order of columns, one can move them and rearrange them in any sequence of choice. Before moving a column or, a group of columns, one must first select it. Then:

- In order to move a field, click its column header once. Click it again and hold the mouse down, and drag in the direction of choice.
- In order to move a group of columns, first select the group and then proceed as if it were one column.

Save a Query

After one creates a query, one can save it. One can also rerun a saved query at any time. If one changes the data on which the saved query is based, one will see the changes when you rerun the query. In order to save a query:



1. One should click the Save button on the Quick Access toolbar. Access saves the query unless one is saving for the first time. If one is saving for the first time, the Save As dialog box appears.
2. One should type the name one wants to give to own query.
3. One should click OK. Access saves the query. One can now access the query by using the Navigation pane.

One can also save by right-clicking a query's tab and then selecting Save from the menu that appears.

Modify a Query

Once created, a query can be modified. Simply open the query in Query Design view and make the changes. One can add columns, change the sort order, change the criteria, and make other changes. In Query Design view, the Query Setup group offers several options that can assist in query modification. One can use the Insert Rows button to insert a row in the criteria area. Then click anywhere in the row before which one wants to insert a new row and then click the Insert Rows button.

One can use the Insert Columns button to insert a column. One can click anywhere in the column before which one wants to insert a column and then click the Insert Column button .

One can use the Delete Rows button to delete a row in the criteria area. One can click anywhere in the row one wants to delete and then click the Delete Row button.

One can use the Delete Columns button to delete a column. Then click anywhere in the column one wants to delete and then click the Delete Column button .

Printing Query Output

One can print the record of a query by right clicking the query from the Navigation Pane and then click Print.

Use a Query to Make a Table

One can use a query to create a table. This is useful when one want to create a new table that includes the fields and data from an existing table. In order to create a table:

1. One should open the table or query on which one wants to base one's new table on in Query Design view.
2. One should enter the criteria on which one wants to base one's new table.
3. One should click the Make Table button. The Make Table dialog box appears.
4. One should type the name one wants to give one's new table.
5. One should click OK.

6. One should click Run.
7. One should click Yes.
8. One should close the query. (Right-click the query's tab and then click Close.)
9. One should double-click the new table's name in the Navigation pane to view the new table.

Parameter Queries

If one is interested in creating a user defined query based on different criteria values for the same field, one needs to create a Parameter Query. With Parameter query one can change the criteria each time, the query is executed. The design of this type of query is very similar to any other query except that instead of setting a fixed criteria Access ask for the information at run time. One can type the criteria message in square brackets [ ] in the criteria field, to create the Parameter query. For example, to create a qualification based Parameter query, under the qualification column, type in [Indicate Qualification?] under the criteria field. The Square brackets tell Access that this is a question, to be displayed at run time.

If one wants to make one's user prompt more flexible, one should use one of the following formats.

Like "*" & [*Prompt*] & "*"	Returns all records that contain the value one enters. Example: If one enters **ad,** Access returns all records that include the sequence *ad* anywhere in the field.
Like "*" & [*Prompt*]	Returns all records that end with the value one enters. Example: If one enters **S,** Access returns all records that end with *S*.
Like "*" [*Prompt*] & "*"	Returns all records that begin with the value one enters. Example: If one enters **S,** Access returns all records that begin with *S*.
> [Prompt] **Note:** One can also use < (less than) ,<= (less than, or equal to) >=, (greater than, or equal to), or <> (not equal)	Find all records with a value greater than the value one enters. Example: If one enters 5, Access returns all records that are greater than *5*.

Expression Query

One can also create expression based queries. In expression based queries one can perform any calculation on any fields of participating tables. For example, to find the experience of students in months, one needs to multiply the experience field with 12 as the data entered is in years. In order to do this, one can multiply the experience field with 12 in the field column. When the query is executed, instead of the experience column heading it will show EXP1 (expression 1). If one needs to change this, go back to the query design and just type over the EXP1 with the desired text.

While creating queries, one can also sort the query output on any of the participating fields, by just selecting sort (Ascending or Descending) option. One can sort on more than one field, which acts as a sort within a sort.

Action Queries

In Access, apart from simple select queries that allow the user to select data from database tables, there are action queries. The action queries are used to update the data within database tables. There are four type of action queries supported by Access, which perform the following tasks:

- Make Table Query: Copy records into a new table
- Delete Query: Delete records from a table
- Append Query: Append records to an existing table
- Update Query: Update the values in one or more, fields in a table

Over and above the select and action queries there is a *Crosstab* query. The Crosstab query is used to summarise the data in one, or more tables.

Make-Table Queries

The Make Table query as the name suggests allows to create a new table from the existing table(s). The best application of this kind of query is when one needs to move a part of data from the main table to another table based on certain criteria. For example, if one needs to move the commerce students with four years or more, experience to another table, one will use the Make Table query. First one needs to create a select query which identifies the students with BCOM qualification and Experience >= 4, and then shift into an action query by selecting the Make Table query button on the Query Menu. It will ask for a new table name and say OK.

Delete Queries

The Delete query allows deleting records from the database tables on the basis of select criteria. One needs to first create a select query and then select Delete query button from the Query Menu. For example, if one needs to delete records of all those students, who have no experience, first create a select query with Experience <=0 as criteria and then execute Delete query. It will delete all those records that satisfy the criteria from the Database table. Once deleted, it is difficult to recover back.

Append Queries

The Append query allows to add records to a selected table on the basis of select query. If one wants to add the details of all MBA students to one of the existing OldStudents table, then write a select query on Students table to select MBA students on Qualification field and execute the Append query and select OldStudents table. This will add all the MBA students from the students table to OldStudents table.

Update Queries

The Update queries are often used in business applications, where data is changing with transaction, for example inventory getting consumed, or replenished. In order to create an update query, one needs to create a select query with appropriate expression and execute an update query. Before

updating the records in a table, Access always give a warning message, as one cannot undo the update query result.

Crosstab Queries

The Crosstab queries are used to summarise data in tables. As an example, let us count number of students with different qualifications.

1. At the *Database Window*, one should click on **Queries** in the *Objects* list
2. One should click on **[New]** and choose the **Crosstab Query Wizard**—press **<Enter>** for **[OK]**
3. Base one's query on the **Students** table one should click on **[Next >]**
4. One should move **Qual** from the *Available* to the *Selected Fields* by clicking on **[>]** to set up the *row heading*—click on **[Next >]**
5. One should click on Qual to set up the *column heading*—click on **[Next >]**
6. One should summarise each row using **Count** from the list of *Functions*—click on **[Next >]**
7. One should press **<Enter>** to **[Finish]** the query, accepting the default query name
8. One should close the query by clicking on the window's **[Close]** button

FORMS

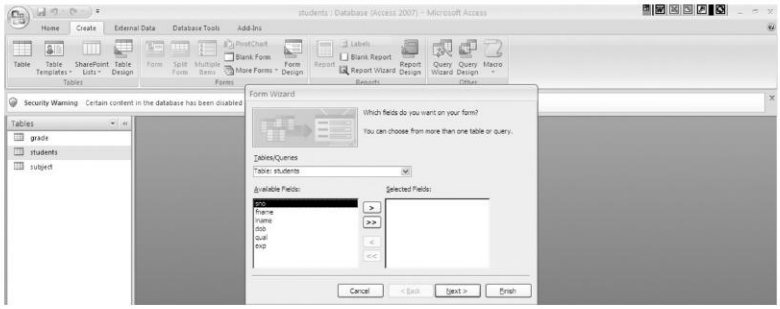
The Database form is the user friendly object that a user uses to interact with a database. The Access forms are much like paper forms: one can use them to enter, edit, or display data. They are based on tables or queries. When using a form, one can choose the format, the arrangement, and which fields one wants to display. The Access can automatically create several types of forms like simple form, split form, and multiple items form.

A split form is a form in which the same data is displayed in two views simultaneously. One part of the form displays in Form view (stacked fields), while the other part displays in Datasheet view. The two views are synchronised, so as one selects a field in one view, it is automatically selected in the other view. One can add, change, or, delete the data in either view. Using a split form gives one the benefits of two types of forms in a single form.

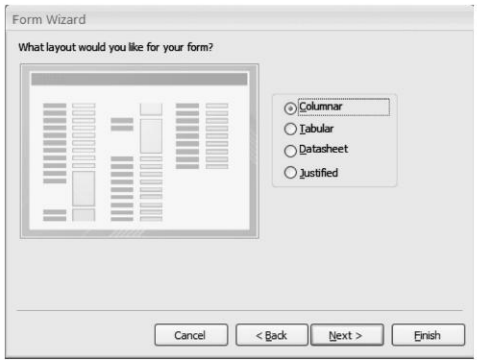
One can use the Multiple Items button on the Forms tab to create a form that displays multiple records, one record per row.

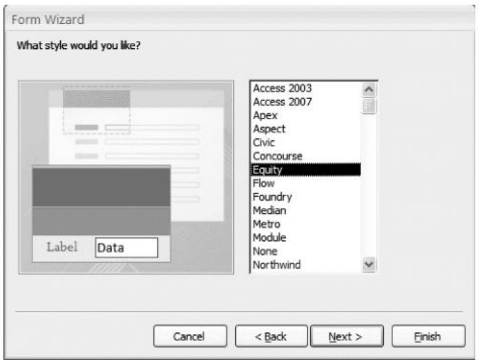
Creating Forms

There are various ways in which one can create a form. In order to automatically generate a form, in the Navigation Pane, select the table. On the ribbon, one needs to click Create. In the Forms section one needs to click Form. One can also create a form using a wizard. In order to launch the Form Wizard, on the Ribbon, one needs to click Create. In the Forms section, then click More Forms, and click Form Wizard. On the first page, one needs to select the table or query that holds the desired fields:



After selecting the table or query, available field list is displayed from which one can select the fields for the form. Once the next button is clicked, form wizard will display the following screen:





The user can select the desired layout for the form and click the next button to display the different available styles.

On the last page of the form wizard it will ask the user to type in the form name.

Data Entry on Form

One can enter data either using table object or forms. The users who are familiar with forms prefer to use forms for data entry as they provide an easy and user friendly display of information than tables. The data entry on a form is performed using various types of Windows controls. On text boxes, the user enters data by typing it. On a combo box, depending on how the object was configured by the database developer, the user may have to only select an item from the list. In some other cases, the user may be allowed to enter new data.

After entering or changing data on a control, to move from one field to the next, the easiest way is to press Tab key. On most occasions, the user can also press Enter. The Enter key may not move the focus from a text box that allows multiple lines of text. If the user is simply reviewing data without performing data entry, the keyboard's arrow keys can also be used to move between fields.

Form Layout

The Microsoft Access supports multiple form layouts like **Columnar**, **Datasheet**, **Tabular**, and **Justified**. A columnar form is used to display data of one record at a time. A tabular form displays its data in a series of cells with continuous sets of records. A datasheet form looks and behaves like a table, displaying all possible records at the same time instead of one record at a time. A justified form provides a consistent look with borders added to labels.

Form Sections

A form can display one to three different sections when in Design View. In order to add the sections, one can:

- Right click the middle of the form and click **Form Header/Footer**
- On the ribbon, one can click Arrange and, in the Show/Hide section, click the **Form Header/Footer** button

A form can also be equipped with two other sections. To get them, one can:

- Right click the middle of the form and click **Page Header/Footer**
- In the Show/Hide section of the Arrange tab of the ribbon, one can click the **Page Header/Footer** button

A form is equipped with special horizontal lines used to visually separate sections of a form. In order to equip a form with dividing lines, one needs to add a header and a footer section.

The Background Colour

By default, for all forms that one creates, the body of the form is always painted with a white colour. If one does not enjoy white forms, one can set the background to a colour of ones choice. Unlike the picture, the form does not control its background colour. This aspect is left to each section to manage.

Before specifying the colour of a form, one needs to first click or, select the intended section. In order to change the background colour of a section:

- On the ribbon, click Home and, in the Font section, select a colour from the **Fill/Back Colour** button
- Right click a section, position the mouse on Fill/Back Colour and click the desired colour
- On the ribbon, click Design and, in the Font section, select a colour from the **Fill/Back Colour** button
- Access the Properties window of the section. In the Format or the All tab, click the **Back Colour** field. If one clicks the arrow of the property, one can select a familiar colour from the list. Otherwise, one can click the browse button. This would display a list of colours similar to that of the **Font/Fore Colour** window.

Unlike the **Fill/Back Colour** (and the Font Colour) of the Font sections of the Home and the Design categories of the ribbon, when one right click a section of a form and position the mouse

on **Fill/Back Colour**, the colours that display do not show their tool tip, which would indicate their names.

Special Effects

The Microsoft Access provides some special visual effects used to raise, or sink, etc. a section of a form, or report, a label, or a field. These effects can be controlled by using the **Special Effect** field in the Properties window.

Modify a Form

After one creates a form, it opens in Layout view, where you can modify it.

To change the size of a field:

1. One should click a side of the field and drag to change the width of the field.
2. One should click the top, or bottom of a field and drag to change the height of a field.

To move a datasheet:

1. One should click the datasheet to select it.
2. One should click and drag the four-sided arrow in the upper-right corner to move the datasheet.

To resize a datasheet:

1. One should click the datasheet to select it.
2. One should click a side of the datasheet and drag to change the width.
3. One should click the top, or bottom of the datasheet and drag to change the height.

To apply an AutoFormat:

The AutoFormat option on the Format tab enables one to apply formats quickly, such as background colors, field colors, field label colors, and fonts.

1. One should activate the Format tab.
2. One should click AutoFormat. The AutoFormat menu appears.
3. One should click the format you want to apply.

To change a form title:

When one creates a form, by default, Access uses the form name as the title. One can change the title.

1. One should activate the Format tab.
2. One should click the Title button.
3. One should type the new title.

To add the date and time:

One can easily add the date and time to one's form.

1. One should activate the Format tab.
2. One should click the Date and Time button. The Date and Time dialog box appears. Select the date and time format one wants. The date and time appear on one's form.

REPORTS

One can always make sophisticated queries, but one cannot present the output of those queries in a presentable format. The Database Report object allows the user to present the output of a table or query in a presentable format. Although one can print tables or forms, reports are customised to be printer friendly. They can perform and display calculations with headers and footers. The Microsoft Access provides wizards to quickly create reports. The Microsoft Access can also help the user to quickly create a report using one of the pre-designed layouts within Report Wizards. The Report Wizard is available from the Reports section of the Create category of the ribbon.

The data on fields for forms and reports fall in three main categories: fields that directly originate from a table or a query; fields created as a combination of existing fields; and fields independent of any other fields. The techniques used to create these fields are different but a field created using one technique can be changed into another category as necessary.

If one wants to use a field that is already part of a table, or a query, before, or when creating a report, one must specify the list that holds the fields. There are various ways in which one can do this:

- If one has already started a report in Design View without selecting a table, then on the Properties window for the form, click the arrow of the **Record Source** field and select the table from the list.
- If one wants to use only a selected list of fields from a table, one needs to start the report in Design View without selecting an object. Then, on the Properties window, one can click the Record Source field and then click its ellipsis button. This will allow using the Query Builder to create a query that is a list of the needed fields. After creating the query, close it. Its Field List would display only the previously selected fields.

In order to add a field to a report, one can either click a control from the Ribbon and click the report, or drag a field from the Field List to the report.

To create reports in a simple manner one can:

1. Open the Navigation pane.
2. Click the table, or query on which one wants to base your report.
3. Activate the Create tab.
4. Click the Report button in the Reports group. Access creates one's report and displays one's report in Layout view.

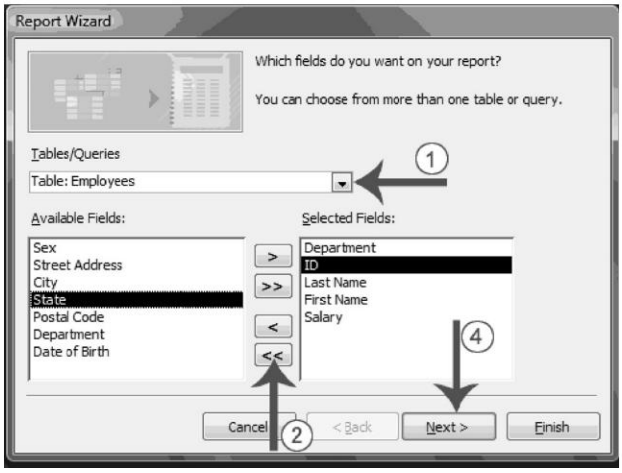
Use the Report Wizard

One can also use the Report Wizard to create a report. The Report Wizard provides one with more flexibility then one gets by using the Report button. One can choose the tables and fields, group the data, sort the data, summarise the data, choose a layout and orientation, apply a style, and title one's report. One should follow the steps shown here to create a report by using the Report Wizard:

To create a report by using the Report Wizard one can: Open the Report Wizard

1. Activate the Create tab.
2. Click Report Wizard in the Reports group. The Report Wizard appears.

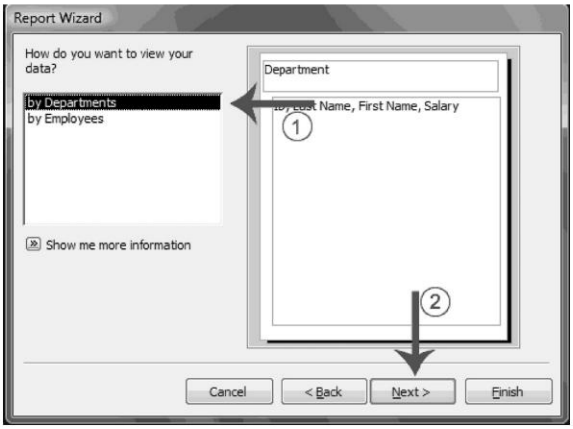
3. Select tables, queries and fields
4. When using the Report Wizard, one can use fields from multiple tables and/or queries if the tables/queries have a relationship.



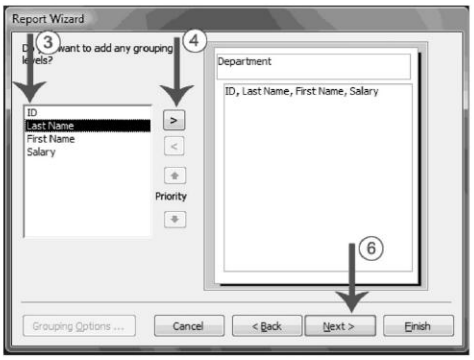
1. Click the drop-down next to the Table/Queries field and then click the table from which one wants to select fields.
2. Click a field and then click the single-right arrow to select a single field, click the double-right arrows to select all fields, click a field and then click the single-left arrow to deselect a single field, or click the double-left arrow to deselect all fields.
3. Repeat steps 1 and 2 for each table from which one wants to select fields.
4. Click Next. The Report Wizard moves to the next page.

Group

When using the Report Wizard, one can group data. Grouping puts all of the values in a field into a group based on the field's value.



1. One should click to select the field by which one wants to group your data. One may not see this page of the wizard if one is selecting data from a single table.
2. One should click Next. The Report Wizard moves to the next page.
3. Click a field one wants to group by.
4. Click the right-arrow to select a field; click a field and then click the left arrow to deselect a field. Use the up- and down-arrows to change the order of the groupings. If one is only using one table, this may be one's first opportunity to select a field to group by.
5. Repeat steps 3 and 4 for each field one wants to group by.
6. Click Next. The Report Wizard moves to the next page.

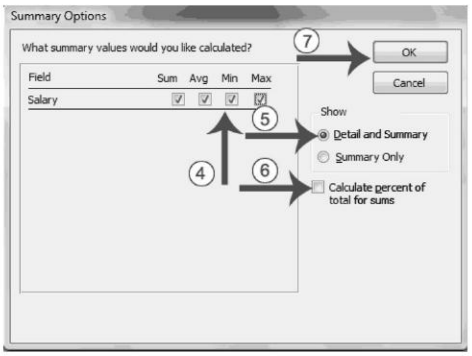


Sort and Summarize

By using the Report Wizard, one can create up to four levels of sort. The Access sorts the first level, and then sorts the second level within that sort, and so on. If one have grouped one's data, one can summarise it by displaying the sum, average, and minimum or, maximum value for each numeric field. One can choose to have your report display just the summary data, or each detail line and the summary data. There is also an option that allows one to display the percent the sum of each group is of the grand total. All of the fields in your report may not fit on a single page. One can Access automatically adjust the size of the font so that every field fits. one can:

1. Click the drop-down and then select the field one wants to sort by.
2. Click the button to choose ascending, or descending order. Clicking the button toggles between Ascending and Descending. One can sort up to four levels.
3. Click the Summary Options button. The Summary Options window appears.

4. Click to select the summary data one wants.
5. Click to select whether one wants detail and summary data or if one wants summary data only.
6. Click if one wants to calculate the percent to the total for sums.
7. Click OK. The Summary Options window closes.
8. Click Next. The Report Wizard moves to the next page.

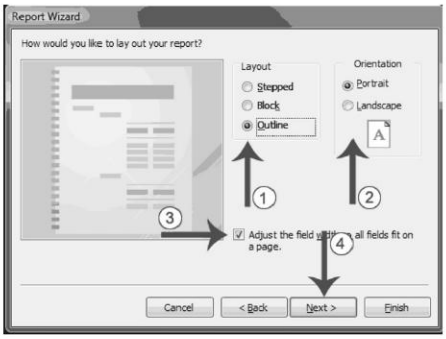


Layout and Orientation

One can choose the layout and orientation of one's report. The layout determines, where each field appears on the page. The Access provides three options to choose from: Stepped, Block, and Outline. When one choose an option, the left side of the window displays a graphic of the layout.

The orientation determines whether Access creates the report in portrait, or landscape. If one prints in Portrait, the shortest edge of the paper becomes the top of the page. Portrait is the default option. If one prints Landscape, the longest edge of the paper becomes the top of the page. One can:

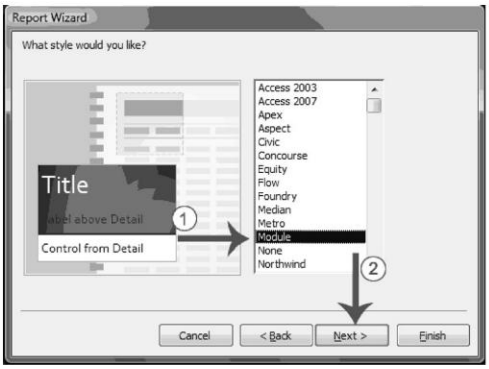
1. Click to select a layout.
2. Click to select a page orientation.
3. Choose the Adjust The Field Width So All Fields Fit On A Page option if one wants all fields to fit on a single page.
4. Click Next. The Report Wizard moves to the next page.



Style

A style is a set of formats consisting of such things as background colors, fonts, font colors, and font sizes. The Access supplies predesigned styles that format titles, labels, and more. When one chooses a style, the left side of the window displays a preview. One can:

1. Click to select a style.
2. Click Next. The Report Wizard moves to the next page.



Create a Title

On the final page of the Report Wizard, one can title one's report. The title appears at the top of the report and on the Navigation pane. One can:

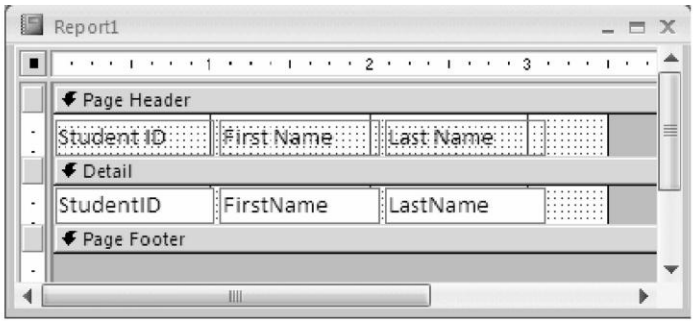
1. Type the title one wants to give the report.
2. Click Finish. Access creates, saves, and opens one's report in Layout view.

Managing Reports in Design View

One of the ways to display a report is called the Design View. As explained earlier, one can display a report in Design View:

- From the Navigation Pane, right click it and click Design View.
- If the report is already opened, in the Views section of the ribbon, one can click the arrow button under View and click Design View.
- If the report is already opened, one can right click its tab or its title bar and click Design View.

As done for a form, in the Design View of a report, one can add, position, format, configure, and manipulate the necessary controls. The Design View is equipped with one, or more sections. The primary sections are the Page Header, the Detail, and the Page Footer.



The Print Preview

In order to have an idea of what a report would look like on a printed piece of paper, one can display it in what is referred to as Print Preview. In order to do this:

- If report is created using the Report Wizard, it would automatically display in Print Preview
- In the Navigation Pane, one can right click a report and click Print Preview
- If the report is already opened, one can right click its tab, or its title bar and click Print Preview

When a report appears in Print Preview, the Ribbon is made of only one tab. In order to appear realistic, a report in print preview appears as a piece of paper with margins. Its body is filled with the data that would be printed. Here is an example:

The right side and the bottom right side display a scroll bar each. Like a form in Form View, the Print Preview of a report may be equipped with navigation buttons. The functionality of these navigation buttons is as described for a table.

After using the Print Preview, to close it, in the Close Preview section of the ribbon, one can click the Close Print Preview button  . This would display the report in the view it previously had.

The Layout View

The Layout View of a report appears as a drawing board. It shows its title bar and its system buttons. In its body, it displays three dotted lines that represent the top section and the margins. Like a Design View, one can use the Layout View to add and manipulate controls on a report. Unlike the Design View, when a report is in Layout View, the ribbon does not have a Design tab. Instead, it is equipped with a Format tab that has a Controls section; but that section is not similar to the section of the Design View. In order to use the controls of a data source, one can drag them from the Field List.

Modify a Report

After one creates a report, one can modify it. You can add groups or sorts, add fields, change labels, and perform many other tasks. One can view a report in Report view, Layout view, Design view, and Print preview. One can also modify a report in Layout view or, Design view. In Layout view, one can see your data, and the report one sees closely resembles how one's report will look when one prints it. One can make most, but not all changes to one's report in Layout view. The Design view displays the structure of one's report. In this view one cannot see the underlying data, but one can perform some tasks in the Design view that you cannot perform in Layout view.

To change to Layout view one can:

1. Open one's report.
2. Activate the Home Tab.
3. Click the View button. A menu appears.
4. Click Layout View. Access changes to Layout view.

To add a field one can:

1. Open the report in Layout view.
2. Activate the Format tab.
3. Click the Add Existing Fields button in the Controls group. The Field List pane appears.
4. Click Show All Tables if the field one wants to add does not appear.
5. Click the field one wants to add and drag it onto one's report. A thick line appears on the report. Access places the field before the line. If one wants the field to appear in the detail area, be sure to drag it to the detail area.

To delete a field one can:

1. Open one's report in Layout view.

2. Click the field one wants to delete.
3. Press the Delete key. The Access deletes the field.

To move a column one can:

1. Open one's report in Layout view.
2. Click the column label.
3. Drag the column to the new location. The Access moves the column to the new location.

To change a title one can:

1. Open one's report in Layout view.
2. Double-click in the Title Field.
3. Click and drag to select the current title.
4. Type a new title.
5. Click anywhere outside the Title field. The Access changes the title.

To change a field label one can:

1. Open one's report in Layout view.
2. Double-click the field label.
3. Click and drag to select the label name.
4. Type the new label name.
5. Click anywhere outside the label. The Access changes the field label.

To change the paper size one can:

1. Open one's report in Layout view.
2. Activate the Page Setup tab.
3. Click the Size button in the Page Layout group. A menu appears.
4. Click the size of the paper you are going to print on.

To change paper orientation one can:

1. Open one's report in Layout view.
2. Activate the Page Setup tab.
3. Click Portrait, or Landscape to choose the orientation one wants to use. The Access changes the page orientation.

To change margins one can:

1. Open one's report in Layout view.
2. Activate the Page Setup tab.
3. Click the Margins button in the Page Layout group. A menu appears.
4. Click the margin size one wants. Access changes the page margin.

To add page numbers one can:

1. Open one's report in Layout view.
2. Activate the Format tab.

3. Click the Insert Page Number button in the Controls group. The Page Numbers dialog box appears.
4. Click a radio button to choose a format.
5. Click a radio button to choose a position.
6. Click the drop-down in the Alignment field and then choose an alignment.
7. Deselect Show Number On First Page if one does not want the page number to appear on the first page.
8. Click OK. The Access places the page number in one's report.

To add current date or time one can:

1. Open one's report in Layout view.
2. Activate the Format tab.
3. Click the Date and Time button in the Controls group. The Date and Time dialog box appears.
4. Deselect the Include Date box if one does not wish to include the date.
5. Click to select a format if one is including the date.
6. Deselect the Include Time box if one does not wish to include the time.
7. Click to select a format if one is including the time.
8. Click OK. The Access places the date and/or time in one's report.

Apply an Auto Format

One can use the AutoFormat option on the Format tab to apply formats such as background colors, fonts, and font sizes quickly. One can:

1. Activate the Format tab.
2. Click AutoFormat. The AutoFormat menu appears.
3. Click the format one wants to apply.

After one modify one's report, one must save it if one wants to keep the changes. In order to save, click the Save button on the Quick Access toolbar or, right-click the report's tab and then click Save.

The Page Header and Footer

A database report can be equipped with a Page Header that represents the top part, a detail section that represents the body of the report, and a Page Footer section that represents the bottom part. If one creates a report using either the Blank Report or the Report, Design options of the Reports section of the Ribbon, the report would be equipped with a Page Header and a Page Footer section.

If the report does not have these sections, one can always add them later by:

- Right click the report and click **Page Header/Footer**
- On the ribbon, click Arrange. In the Show/Hide section, click **Page Header/Footer** 

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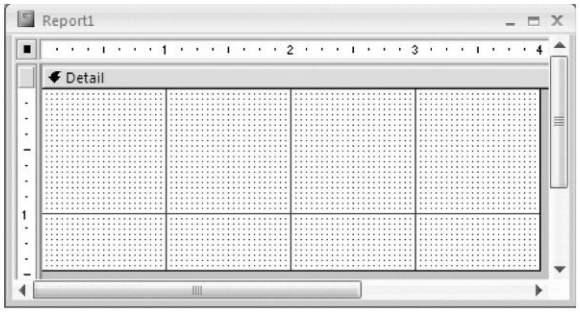
One can use these same techniques to remove the sections. As mentioned earlier, the Page Header represents the top section of the printed paper. Therefore, when designing a report, one can put in the Page Header the object that needs to be displayed on each top part of the printed paper. For example, one can put the common title or, the page number in that section.

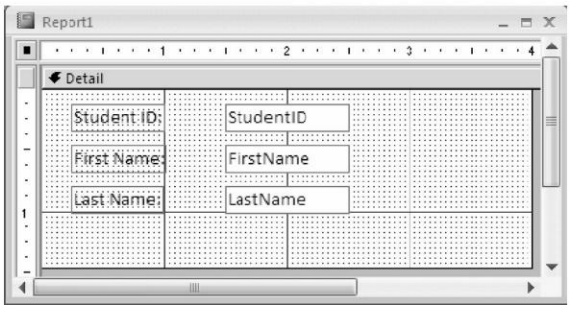
Since the Page Footer represents the bottom part of each printed page, one can put on it the object(s) that would be displayed at the bottom of each page. For example, one can use it to display the date the report is being printed.

The Detail Section

Like a form, to show the sections of a report, it must be opened in Design View. Like a form, the most fundamental part of a report is the Detail section. The detail section holds the most controls of a report. In fact, a report can have only that section. If one creates a report using one of the options from the Reports section of the Create tab of the ribbon, the report would come equipped with various sections. In order to have only the Detail section, one can right click the report and click the option of those sections to remove them. One may end up with only the Detail section:

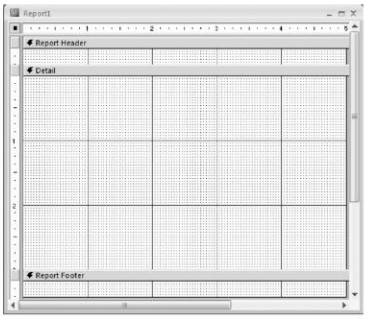


One can then equip it with the desired controls. Here is an example:



The Report Header and Footer

As mentioned already, the report is the primary object used to print the data of a database. One might have created a database that represents many objects sold in a store, or one could have



created a database for a list of people such as the students of a high school. In these cases, one may want to create a report that shows the list. In order to print a realistic book, magazine, or brochure, one would want to have a front cover and a back page. In order to support the cover and the back page, the report can be equipped with two other sections: The Report Header and the Report Footer sections.

If one creates a report using either the Report, or the Report Wizard options of the Reports section of the Ribbon, the report would be equipped with a Report Header and a Report Footer section. If one has a report that does not have these sections, one can add them later by:

- Right click the report and click **Report Header/Footer**
- On the ribbon, click Arrange. In the Show/Hide section, click **Report Header/Footer**

One can use these same options to remove the Report Header and the Report Footer sections. As seen in the above screen shot, one can have a report that has a Report Header and a Report Footer section without the Page Header and the Page Footer sections. If the report has Page Header and the Page Footer sections but does not want to show them on a printed paper, one can completely reduce their heights.

Display Only

By default, after adding a section to a report, the section would show in Design View and its contents would appear in the other views. If one wants to hide the section in either the Design View, or the other view, one can do so by the **Display When** enumerated property. In order to apply it, display the report in Design View and access the Properties window of the section on which one wants to control this characteristic.

The **Display When** property has following options:

- **Always:** This is the default value of the property. It indicates that the section will display in Design View and its contents would appear in all views.
- **Print Only:** The section will appear in Design View and Print Preview only, not in Report View or Layout View.

SUMMARY

- The data processing operations which includes, handling, merging, sorting, and computing are performed upon data in accordance with strictly defined procedures, such as recording and summarising the financial transactions of a business. The various methods of data processing are manual, mechanical and electronic.
- All good decisions are dependent on sound management of information that is derived from good data. The data is more efficiently managed using databases. The database is a collection

of interrelated records organised in a structured manner. In the initial phase of computerisation, there were no databases. The data at that time was captured and stored in plain data files called 'Flat files'. These data files were managed using File Management Systems, which is a collection of individual files that were accessed by application programs.

- The flat files were always dependent in application programs as the definition or, the structure of the data is described within these programs. The common problems that were associated with File Management system are data duplication, application program dependence, isolated data, data redundancy, and data sharing across programs.
- The file organisation refers to the relationship of the key of the record to the physical location of that record in the computer file. A file should be organised in such a way that the records are always available for processing with no delay. The various file organisation methods include: sequential, direct-access, index-sequential, and inverted.
- The need for integration and sharing of data across all organisation applications lead to creation of databases. The organisations adopted the database system approach for storing and managing data. A software package that is used to define, create, store, manage, and manipulate the data in database is called Database Management System (DBMS). The database system tried to overcome all the problems associated with File Management System and allowed organisations to manage data independent of application software.
- The major components of DBMS are DBMS Engine, Data Definition Language, Data Manipulation Language, Application Generation System, and Data Administration System
- One of the most important parts of DBMS is data models, which defines the structure of the database. The four different types of data models that exists include: Hierarchical, Network, Relational, and Object oriented data models. In all the four different types of data models, the data is organised in a different manner within the database.
- In Hierarchical data model, the data is organised into a tree-like structure. A relationship exists when one record has a direct association with another. The Network data model is an extension of Hierarchical data models and allowed the many-to-many relationships. The Relational data model is easier, more flexible, and more versatile as compared to any other data models. The Relational data modelling organises the data and relations between them in the form of tables. A table is a collection of records (rows) and each record in a table contains the same fields (column). The column describes the specific data element about those records, often called data fields. The object DBMSs add database functionality to object programming languages. They bring much more than persistent storage of programming language objects. The Object DBMSs extend the semantics of the object programming languages to provide full featured database programming capability, while retaining native language compatibility.
- The normalisation simplifies the way data is defined in order to ensure data consistency and stability, to minimise data redundancy, and to ensure consistency, and avoid update, and delete anomalies that result in ambiguous data, or inconsistent results. There are five forms in the normalisation process with each form meeting a more stringent condition. Sometime, one needs to de-normalise depending on the need of the application.
- The Entity-Relationship (E-R) modeling is a set of diagrams that are used to interpret, specify and document logical data requirements for database processing systems. The E-R models are *Conceptual Models* of the database. They cannot be directly implemented in a database. They are independent of hardware, software, and databases, but are very powerful tools for data modelling. There are many variations of E-R modelling, which are used in practice—main differences are in notation, symbols used to represent the constructs. The E-R models help in depicting the relationships between different entities.

- Once the conceptual model of the database is ready, convert it to Relational Model which includes *Relations, Tuples and Attributes.* The Relational Model is then converted into databases using one of the RDBMS. The Microsoft Access is a relational database management system. It is an application software that is used to create and manage computer based databases on desktop computers and/or on networks. The Microsoft Access can be used to create simple and powerful information system solutions for small and medium size organisations.
- There are many methods exist for creating databases; the fastest and easiest in using one of the templates. To create a database using one of the templates, just select from the list of given samples. The templates are organised in categories. In order to access a sample by category, one can select the category from the left section of the window. After selecting a template, in the right section, one needs to give the database name of the new database, though by default, Microsoft Access suggests some name. It also suggests the folder. Once the name of the database and its location is specified, one can click Create button.
- One can create different kinds of objects in Access to manage its database more effectively. The commonly used objects that can be created and managed include Tables, Queries, Forms, and Reports. The Table allows creating database table, definitions, creating data within tables and allowing user to add/edit/delete/filter data within tables. The queries allow extracting part, or full data from one, or more related tables. It also allows the user to do simple computation on the data. The forms are user-friendly layouts to display data on the screen allowing the user to enter data in a table. The reports are more readable and a presentable layout of the output based on the table or queries.
- Every database has one or more tables. If the database is created using templates, Access would provide some basic tables as per the template selected. If one has created a database without using templates, then one needs to create a table by selecting the Create Menu. One can also create tables using Design View. The table design view allows the user to type in the field name, data type, description, and various field properties for each of the fields. The filed name can be 64 characters long name including space.
- If there are two, or more tables, it is important to join them using relationship. A good database is one in which each table is joined, or related to at least one another table in the database. The tables are joined using the Relationship tool of Access. The two tables are related using the primary key of the parent table with a non-key of the child table. The Primary Keys help Access to uniquely identify each individual record in a table and hence work more efficiently.
- The databases offer the facility of extracting complete or part of records according to some pre-defined criteria. The Access allows selection of records using one of the two methods; *Select using a Filter* and *Select using a Query.* A query is the result of getting, or isolating a list of values from a table or another query. The querying is the technique of examining data to create a dependent list. One can perform querying on a table, a form, or a query. The Microsoft Access provides various means of performing such an operation visually. In Access, one can create a simple select query, or action queries, or a crosstab query.
- The database form is the user-friendly object that a user uses to interact with a database. Forms are used to facilitate data input and allow the user to set up their own data entry screen. The forms can also be used for queries. The forms can be created using the form wizard, or design view. The forms can be created using a table, query, or both.
- One can always make sophisticated queries, but one cannot present the output of those queries in a presentable format. The Database Report object allows the user to present the output of a table, or query in a presentable format. Although one can print tables, or forms, reports are customised to be printer friendly. They can perform and display calculations with header and footers. The Microsoft Access provides wizards to quickly create reports. The Microsoft Access can help the user to quickly create a report using one of the pre-designed layouts within Report Wizards.

KEY TERMS

Append Query
Attribute
Binary Relationships
Boyce Codd Normal Form (BCNF)
Centralised Database
Crosstab Query
Database
Database Management System (DBMS)
Database Queries
Database Tables
Data Definition Language
Data Dictionary
Data Duplication
Data Integrity
Data Manipulation Language
Data Processing
Data Redundancy
Data Inconsistency
Deletion Query
Direct Access File Organisation
Distributed Database
Entity
Entity-Relationship Diagram (E-R)
Expression Query
Field
Fifth Normal Form (5NF)
File Management System
First Normal Form (1NF)
File Organisation
Flat Files
Foreign Key
Forms
Fourth Normal Form (4NF)
Hierarchical Data Models
Index-sequential Access Method
Inverted List
Metadata
Network Data Models
Normalisation
Object-Relational Database
Object Oriented Databases
Parameter Query
Primary Key
Records
Relational Data Models
Relationship
Reports
Second Normal Form (2NF)
Sequential File Organisation
Schema
Ternary Relationships
Third Normal Form (3NF)
Tuple
Unary Relationships
Update Query

SELF-STUDY QUESTIONS

1. _____ refers to the process of performing specific operations on a set of data or a database.
   (a) Data Base (b) File Management System
   (c) Data Processing (d) Microsoft Access
2. Which one of the following activities is not part of Data Processing?
   (a) Manipulation (b) Collection (c) Communication (d) Printing
3. _____ means that different files contain different information of a particular object, or person.
   (a) Data Redundancy (b) Data Inconsistency
   (c) Data Isolation (d) Data Sharing
4. A _____ is a collection of related data organised in a structured manner.
   (a) Data Base (b) File Management System
   (c) Data Processing (d) Microsoft Access

5. A database that is completely located at a single computer called database server and all the users access it from the central database server, is called _____.
   (a) Centralised Database (b) Distributed Database
   (c) Homogeneous Database (d) Heterogeneous Database
6. Which one of the following is not one of the components of a DBMS?
   (a) DDL (b) DML (c) Data Dictionary (d) Tuple
7. _____ Database Model follow the one-to-many parent-child relationship.
8. The Relational Data Modeling organises the data and relations between them in the form of _____.
   (a) Table (b) Database (c) Attributes (d) Primary Key
9. _____ helps in uniquely indentifying all the attributes in any given row.
10. An entity type is in _____ when it is in 1NF and all of its non-key attributes are fully dependant on its primary key.
    (a) 1NF (b) 2NF (c) 3NF (d) BCNF

REVIEW QUESTIONS

1. Describe why organisations need databases.
2. How databases are more reliable than file management systems?
3. List the different types of database models that exists.
4. How logical models are different from physical models?
5. Describe why one needs to normalise the data before creating databases.
6. List different forms of Normalisation.
7. What are action queries in Access? How are they different from select queries?
8. What is Referential Integrity? Why one needs to activate that?
9. How entering data in Forms is different from entering data in Tables?
10. Why one needs to create Reports?

QUESTIONS FOR DISCUSSION

1. Explain with an example, how database helps in managing the business information solution.
2. Identify the key database technology for organisations to implement in the era of Digital Economy.
3. It is always beneficial for flat organisational structured organisations to implement databases using Flat file management systems. Comment.
4. Majority of organisations worldwide have only TPS and MIS as part of their Information Systems. Do these organisations really need databases, and if so, why?

APPLICATION EXERCISES

1. Identify the examples of integrated databases that some of the leading Indian companies have adopted.

2. Search the Computer Journals and/or Internet to find information about:
   (a) Indian Organisations using Relational Database Structure
   (b) Indian Organisations using Internet Database Structures
   (c) Indian Organisations using Multimedia Databases
3. Use the students database available online (http://www.mhhe.com/behl2e) to answer following queries using Access:
   (a) List the MBA graduates
   (b) Students with first name as "JOY"
   (c) Students with first name as "JOY" or "JOE"
   (d) Name of IT students
   (e) Name of BSc, or BCOM graduates
   (f) Students having more than 3 years of experience
   (g) List all the compulsory subjects
   (h) List all electives
   (i) Students who have scored "B" grade in OB1
   (j) List the students, who have opted for database course
   (k) List the grades of all compulsory subjects sorted by students first name
   (l) List the electives taken by different students
   (m) List the name of students who have taken database, or project management courses
   (n) List the date of birth of students who have scored D in any subject
   (o) List the qualification of those students, who have scored D in electives

GROUP PROJECTS

1. Identify an organisation. Study the Database Systems Solution that is being used by that organisation, the structure being followed, level of management that accesses the database. Identify the types of database table being used; type of database structure; and user interfaces that have been developed to meet the needs of various levels of management.
2. Select a placement process of your college, or university. Observe the process for couple of days and list the key attributes that are required to manage the placement activity. Construct the entity-relationship diagram and create tables using Access. Create appropriate forms and reports.

Caselets

1. Sales Database at ABC Pvt Ltd.

ABC Pvt. Limited is a small retailer in a colony of Delhi. The owner of the company wants to manage its sales process using database tool. A group of students have been hired by him to develop the database system. You are required to design and develop a simple, yet useful database. Your work will focus on the user interface aspect of the system. The final product will be a visually attractive database that a small business could use to keep track of clients and their accounts. In order to do this, you will create tables that contain employee, customer, and order information. You will make a query incorporating information from the three tables that will enable the user to eliminate excess data entry. Finally, you will create a form as well as a report based on that query.

The following is a list of the items, which you must complete for this assignment. It is suggested that you implement the features in the order listed; in some cases, you must implement them in this order.

(a) Create the following tables: Employee Information, Customer Information, Order Information. Each table must incorporate five fields.

Examples of fields the Employee and Customer Information tables should include are:

- Identification Number
- First Name
- Last Name

Examples of fields that the Order Information table should include are:

- Order Number (Hint: You should specify the Data Type as AutoNumber)
- Date
- Product
- Quantity
- Comments

You will need to create at least 10 records in the Employee and Customer Information tables and at least 15 records in the Order Information table. At least two customers should place two orders each.

(b) Construct a query incorporating fields from each of the three tables. Hint: You must create relationships between the tables. In addition, make sure you incorporate at least one field to enter comments.

(c) Make a form which utilises the query. The form can be created using the wizard. However, once the form is created, you must rearrange the fields to make the design more aesthetically pleasing.

(d) Develop a report which also utilises your query. The report can be created using the wizard. However, after it is created, rearrange the information and the design style (colour scheme, fonts, etc.) so that they look similar to as they were on the form. Make sure that your report is sorted by order date.

2. College Database

Design a small database for your college. At the minimum, data needs to be kept on students (personal information), all courses offered at some time by the college (catalogue), courses offered during a semester (schedule of classes), and class lists for faculty (student information and grade fields). Decide on how many tables you will need (you need at least three for the data described), which fields should be in the tables, and how to best link them together (which fields you will use as primary keys or links). The tables MUST be linked. An example of fields in the student table might be Student_ID, First_Name, Last_Name, Address, City, State, Zip, Phone, etc., where Student_ID is your primary linking field.

Enter some sample data. There should be data on at least 10 students and 15 courses offered overall and 10 courses offered in the current semester.

Create a report or query that gives data on only one student. You need to be able to go into the report or query wizard, type in a name or ID# and extract out classes and grades.

Run the following queries using the above created tables. Label each query with its proper number.

1. All students from Delhi.
2. All students from Mumbai and Bangalore.
3. All students with GPA less than, or equal to 2.5.
4. All students with course list.
5. All students with course and faculty list.
6. All faculty teaching specific courses.
7. A list of all students in order by last name and first name.
8. A list of all students in order by GPA.
9. A list of all students in order by city and date of birth.
10. A list of all students in order of Student_Id and born in October (if no one is from October pick another month).

Answers to Self-Study Questions

1. (c)	2. (d)	3. (b)	4. (a)
5. (a)	6. (d)	7. Hierarchical Data Model	
8. (a)	9. Primary Key	10. (b)	

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Chapter 8

SPSS—A Statistical Decision Tool

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What is SPSS?
- How to manage and manipulate data in SPSS?
- How to use data effectively to support decision reporting?
- How to restructure and format SPSS datasheets?
- How to create reports using various decision and graphical tools?
- How to analyse data to support decision-making?

INTRODUCTION

Most of the decision-making is statistics based and SPSS is a tools that provides a statistical and data management for analysts and researchers. With SPSS one can generate decision-making information quickly using powerful statistics, understand it and effectively present the results with high-quality tabular and graphical output, and share these results with others using a variety of reporting methods. The SPSS is software for managing data and calculating a wide variety of statistics. This chapter is intended to cover the use of SPSS as a decision-making tool.

The decision-making approaches in businesses have been changing fast over the past decade. The experience and intuition are no longer acceptable option in the highly competitive market environment. Most of the managers have realised the need of analytical approach, which are data-driven and facts-based decision-making. The amount of information available to managers and researchers has exploded in recent years, and it will continue to do so in the future. Most of this information is collected and stored in data warehouses, and it is available for analysis at various levels within the organisation to support decision-making. In order to support effective

decision-making process, it is necessary for the decision makers to analyse the available data using decision tools like Excel, SPSS etc.

Originally SPSS is an acronym of Statistical Package for the Social Science but now it stands for Statistical Product and the Service Solutions enables the user to get a quick look at the data, formulate hypotheses for additional testing, and then carry out statistical and analytic procedures to help clarify relationships between variables, create clusters, identify trends, and make predictions. It is one of the most popular statistical packages, which can perform highly complex, data manipulation and analysis with simple instructions. It is powerful decision tool for:

- Quickly access and analysis of massive datasets
- Easily preparation and management of data for analysis
- Analysing data with a comprehensive range of statistical procedures
- Easily building charts with sophisticated reporting capabilities
- Discover of new insights in the data with tables, graphs, mapping capabilities, cubes, and pivoting technology
- Quickly building dialog boxes or let advanced users create customised dialog boxes that make organisation's analyses easier and more efficient
- Streamline the process of creating surveys using familiar, intuitive interfaces and incorporate sophisticated logic to increase completion rates and ensure high-quality data
- Optimising and automating high-volume decisions and produce improved outcomes in specific business situations
- Collecting information about results, and using that information to refine predictive models and future recommended actions
- Making advanced modeling techniques more broadly available in order to predict what is likely to happen, based on patterns found in historical data.

Achieve Breakthrough Results

The leading-edge organisations already use the tools and techniques of SPSS Decision Management to remove the blind spots that had kept them from making the right decisions. By providing precise, contextual analytics, and insight at the point of impact, SPSS Decision Management has enabled these organisations to achieve "next generation" efficiencies:

- A European retail bank shortened loan approval time from six working days to less than three minutes. This cut the cost per loan approved from €240 to €32 – and increased employee productivity by 833 percent.
- A U.S.-based insurer was able to fast-track low-risk claims, achieving a 20 percent cost savings while doubling the rate of detected claims fraud.
- Another major insurer reduced payouts by €2.5 million while improving the satisfaction level – and loyalty – of the vast majority of its customers.

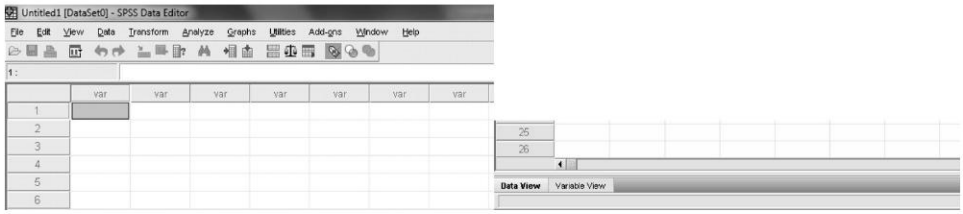
Because SPSS Decision Management can be configured to integrate with an organization's existing processes and systems, it can be used to address a wide range of challenges, including:

- Increasing the targeting – and effectiveness - of cross-sell or up-sell campaigns
- Reducing customer defection or churn
- Minimising the impact of fraud by focusing the work of investigators on the most suspicious cases
- Improving the efficiency of law enforcement by providing more precise guidance to officers or agents in the field
- Helping educators more clearly identify and meet student needs and manage their institutions more effectively

GETTING STARTED

In order to load preinstalled SPSS, one can click the Start button and select the SPSS from the All Programs, the **Data Editor window** will be loaded which will looks like the following screen shot.

Start → All Programs → SPSS Inc → SPSS



Data Editor Window

The SPSS Data Editor window resembles an Excel spreadsheet, except the columns are not labeled as *A*, *B*, *C*, *D* and so on. The extension of the saved file in Data Editor Window will be "sav." Data can either be typed directly into this window, or one can open an existing data file into the window. The existing files can be of various types such as an SPSS data file (*.sav), an ASCII text file (*.txt, *.csv, or *.dat), and Excel file (*.xls).

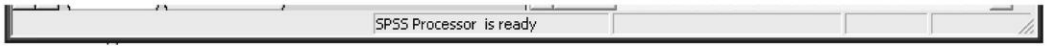
Though it is possible to change the layout of the *Data Editor* window to some extent, but by default one may see the following features:

- **Menu bar:** The *menu bar* contains menus with all the features needed to manage data and other files, to perform a wide range of statistical analysis, and to produce graphs. It also provides editing, control over fonts and other aspects of the appearance and customization of SPSS windows. Most menu items are not active (greyed) and cannot be selected until there is some data in the Data Editor. The Help menu contains lots of useful information about using SPSS including what all the menus and windows are for.

- **Tool bar:** The *tool bar* provides instant access to many useful features. On the left-hand side a standard set of tools is always available. The tools on the right are those appropriate

to the active window. In order to find out what a tool does, use the mouse to place the cursor over the tool button *without clicking*. The tool description will then appear at the left-hand end of the *status bar.* One of the most useful tools is **Dialog recall**  . This allows one to repeat an earlier operation by reopening the appropriate dialog box in its previous state.

- **Status Bar:** At the bottom of the *Data Editor* window, there is a grey *status bar* which provides a range of useful information about the current status. If SPSS is idle it will contain the information **SPSS Processor is ready**. The first space on the status bar is known as the information area. It provides a phrase and sometimes a pop up label to describe whatever the mouse is pointing to.



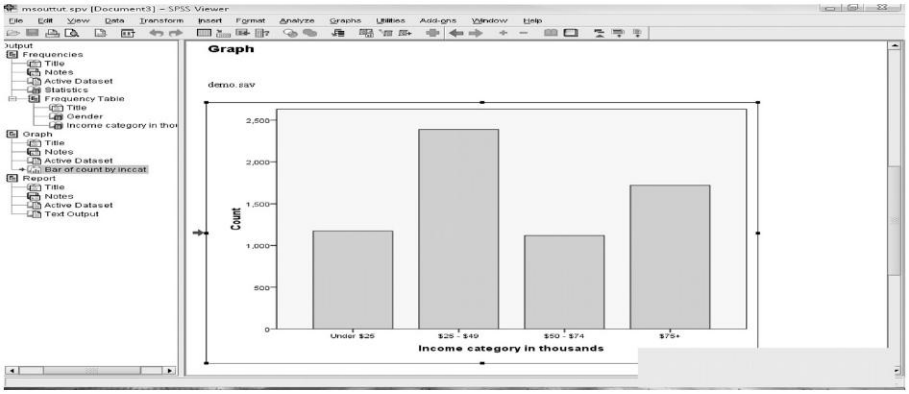
The contents of both the tool bar and the menus will change depending on what type of SPSS window one is looking at. The toolbars can be changed or new ones can be created in the **Show Toolbars** dialog box, opened by choosing **View** → **Toolbars.** The menus can be customised using the Menu Editor opened by choosing **Utilities** → **Menu Editor**. The Data can either be typed directly into the Data Editor's **Data View,** or an existing data file can be read in. The Data Editor looks like a spreadsheet, but has a much more rigid data structure.

The SPSS Windows and Files

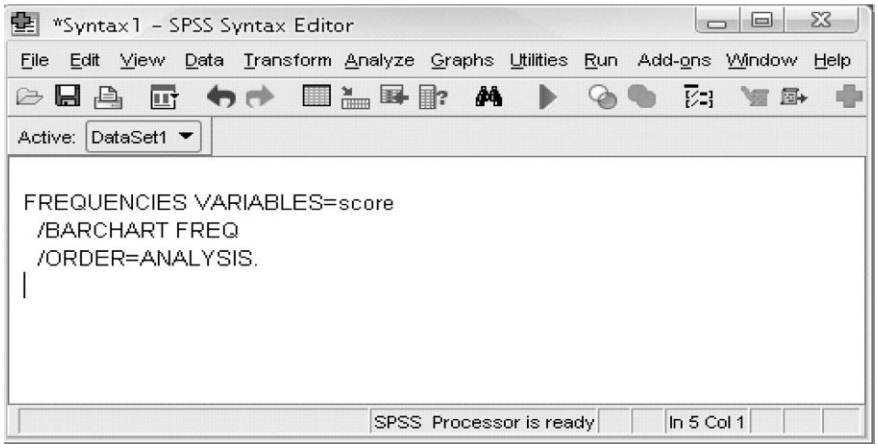
The SPSS has four main windows, plus a menu bar at the top. These windows allows the user to (1) work on data, (2) get the statistical output, (3) see the programming commands that was written and (4) provides the opportunity to write full-blown programs . Each window corresponds to a separate type of SPSS file.

1. **Data Editor (.sav files):** The Data Editor allows the user to see and manipulate the data. One can open at least one Data Editor. When one opens an SPSS data file, what one gets is a working copy of the data. The changes that are made on to the data are not permanent until one saves them using **File→Save** or **Save As**. The data files are saved with a file type of ".sav." The data definitions, the data and analysis on data is all possible using data editor window.
2. **Output Viewer:** It displays output and errors. The extension of the saved file will be "spv." This is a very powerful tool for manipulating and modifying SPSS output. The output Viewer window contains two panes. The output tables, graphs, etc., are displayed in the right-hand pane, while the left-hand pane, displays the outline of the individual pieces of

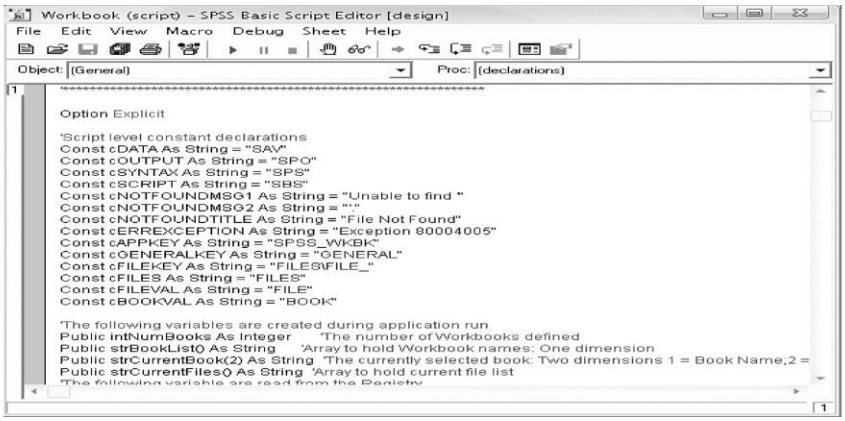
output and are represented by icons grouped together in a tree-like structure. The groups are labeled with the name of the SPSS operation, which produced them. The outline pane is used for navigating through the output, and provides a convenient means of selecting, deleting, and managing it. The double-clicking on the icon for a single piece of output either shows, or hides it. The double-clicking on one of the yellow icons representing grouped output collapses, or expands the corresponding 'branch'. A collapsed branch is flagged with a plus sign '+' in a box, and an expanded one by a minus '–'. In either pane, one can select an object by clicking on it.



3. **Syntax Editor:** The text editor for syntax composition. The extension of the saved file will be "sps." If one likes to work with the SPSS programming language directly, one will also open a Syntax Editor. The Syntax Editor allows to write, edit, and run commands in the SPSS programming language. If one is also using the menus and dialog boxes, the **Paste** button automatically writes the syntax for the command that one has specified into the active Syntax Editor. These files are saved as plain text and almost any text editor can open them.



4. **Script Window:** It provides the opportunity to write full-blown programs, in a BASIC-like language. The text editor for syntax composition. The extension of the saved file will be "sbs."



MANAGING DATA

The main use of the Data Editor is to manage data that needs to be analysed. It is used to define and redefine the data characteristics by changing the type of the data adding labels, creating new variable etc. The Data Editor has two views of the data set: a Data View and a Variable View, selected by clicking on the appropriate tab in the lower left corner of the window.

1. **Data View:** In the Data View, the data are laid out in the standard format for statistical analysis. Each row represents a unit of observation, also referred to as a 'record', or in SPSS as a 'case.' The case (observation) number in the leftmost column is assigned automatically and is not saved as data. Each column represents a variable. All of the data in a column must be of the same 'type,' either numeric, or string.

   Each data cell holds a data value. If data are missing, they are displayed as a period ("."), or as a blank (" "). The data values may be displayed as either the actual value or as a 'formatted' value. For example, a data value about a person's income might be 15000, while its formatted value might be shown as "$15,000." The formats can also take the form of value labels, for instance, data recorded as 1's and 2's might be labeled as 'Male' and 'Female.' While formatting makes it easier to interpret results, it is important to remember that the data values are what SPSS actually processes. In particular, when one set up a command that requires to specify one, or more data values, one may use values and not formatted values.

   One can switch the Data View between formatted and unformatted data by clicking on the **Value Labels** button on the Toolbar. One can also see the actual values for a given variable by clicking on it and then looking at the bar just above the data. The box to the left indicates the observation number and variable selected. The data values can be edited or

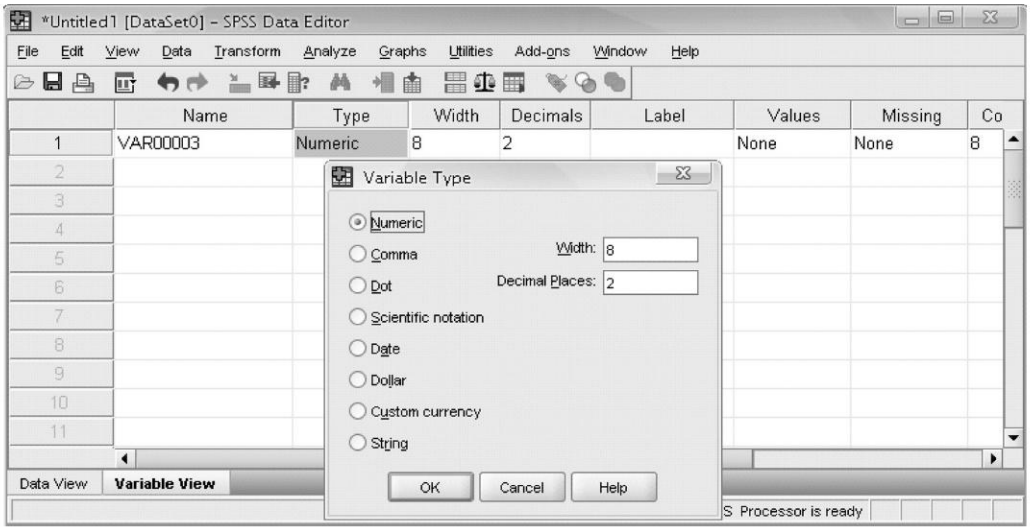
added by typing them directly into the Data View. In order to enter data, type in the actual data value.

2. **Variable View:** In the Variable View one can see and edit the information that defines each variable (also called 'meta-data') in the data set: each column of the Data View is described by a row of the Variable View. One can have various types of variables such as numeric, string, currency and date etc. These are defined below:
   - **Numeric:** A numeric variable that accepts only numbers. The values are displayed in standard numeric format.
   - **Comma:** A numeric variable whose values are displayed with commas delimiting every three places, and with the period as a decimal delimiter.
   - **Dot:** A numeric variable whose values are displayed with periods delimiting every three places, and with the comma as a decimal delimiter.
   - **Scientific notation:** A numeric variable whose values are displayed with an embedded E and a signed power-of-ten exponent.
   - **Date:** A numeric variable whose values are displayed in one of several calendar date, or clock-time formats. Select a format from the list. One can enter dates with slashes, hyphens, periods, commas, or blank spaces as delimiters. The century range for 2-digit year values is determined by the Options settings.
   - **Dollar:** A numeric variable whose values are displayed in dollar currency format.
   - **Custom currency:** A numeric variable whose values are displayed in one of the custom currency formats that one has defined in the Currency tab of the Options dialog box. The defined custom currency characters cannot be used in data entry but are displayed in the Data Editor.
   - **String:** The values of a string variable are not numeric, and hence not used in calculations. They can contain any characters up to the defined length. The uppercase and lowercase letters are considered distinct. It is also known as an alphanumeric variable.

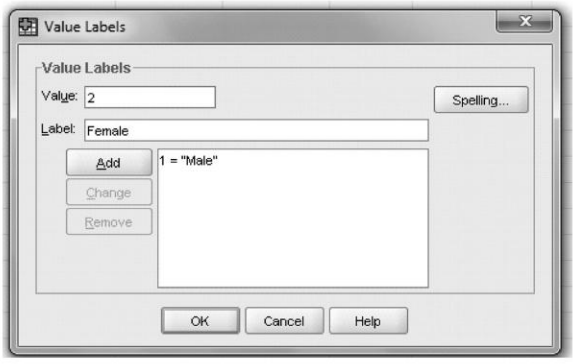
Defining or Redefining Variables

In order to define the variables and its characteristics select the Variable View tab, or alternatively select **View** → **Variables** from the menu bar. The variable definitions are displayed with the following headings:

- **Name:** The first character of the variable name must be alphabetic
- The variable names must be unique, and can have upto 64 characters.
- The spaces are NOT allowed and can have any letter, number or @, #, _ or $.
- **Type:** One can click on the 'type' box and select the variable type from the list as explained earlier.
- **Width:** The width allows to determine the number of characters SPSS will allow within the variable.



- **Decimals:** The number of decimals and it has to be less than or equal to 16.
- **Label:** It is a description of the variable without the restrictions of the variable name. The SPSS uses the variable label while analysis and also in the output. One can write characters with spaces up to 256 characters.
- **Values:** A powerful utility to define codes and categories.
  - One can click the cell in the values column as shown below.
  - For each of the value one can define the label, which can be up to 60 characters.
  - After defining the values click add and then click OK.
  - One can activate and deactivate the value labels in data view by using the value label button on the toolbar.



- **Missing:** The SPSS has two types of missing value; user defined missing values and system missing values.
  - System missing values are empty cells where no value has been entered, indicated by dots in the Data Editor for numeric variables.
  - User defined missing values are ordinary values defined as missing using the Missing attribute in **Variable View**.
  - These missing value cases, or records are processed and shown separately in the output view.

  - The SPSS ignore these missing value cases when it calculates statistics. For instance, in survey data it is common practice that some of the respondents do not answer some of the questions. In order to handle these unanswered questions in a statistically correct manner, it is advisable to use the missing data.
- **Columns:** The Columns attribute in **Variable View** contains the column width for the variable in the **Data View**. Typing in a new value can easily change it. This is done either using the Columns attribute, or by resising the column using the double-headed arrow and dragging the column width in data view.
- **Align:** The data can be aligned to the left, right, or centre in the Data Editor. In the same way text is aligned in a word processor. By default, SPSS aligns data with a numeric format to the right and string or text formats to the left.
- **Measure:** The measure attribute takes one of three values in SPSS.
  - The **scale** is for variable values measured on a continuous scale, such as height, weight etc. the scale variables have a ruler icon.
  - The **ordinal** is for variables whose values represent categories with some inherent order between them, such as social class, attitudinal scales (e.g. agree, neutral, disagree). The ordinal variables have a bar chart icon.
  - The **nominal** is for categorical variables with values, which are not sequentially ordered, they are just names.
  - By default, new numeric variables are set to **Scale** and variables with text (or string) values are set to **Nominal**. The examples include region, race, and gender values just represent group names. The icon is three separate 'blobs'. Sometimes a variable has only a few values so it might be interpreted as Ordinal by SPSS but often that has to be set by the user.

Saving Data

When one completes the analyses, it is important to save all the work. This may include the SPSS data file, the output file, and the text commands that one may have written into the Syntax window.

The SPSS data file contains the actual data, variable and value labels, and missing values that appear in the SPSS Data Editor window. The output viewer will have all the outputs from various procedures one has executed. These results can be saved to a file with an extension, ".SPO".

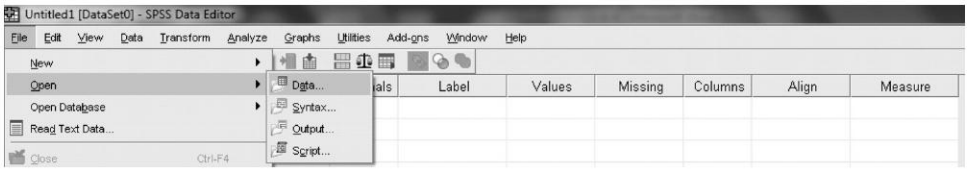
In order to save the any type of file in SPSS, simply click 'file' and click 'save as.' One can save the file in different forms by clicking "Save as type."

File → **Save...** (or **File** → **Save As...**) from the Main Menu.

Opening Existing Data File

In order to open an existing data file Bank.sav (this file is available at http://www.mhhe.com/behl2e under Cahpter 8), which consists of Bank employee's demographic data, one can:

1. Select FILE → OPEN → Data from the menu bar.



2. Select the Bank.sav file from the folder, where the file is saved and click Open.
3. It will load the data in the Data View. This file has 474 cases, or records.

Data Editing

This section contains a mixture of useful editing features in the SPSS Data editor. It is easy to add extra rows (cases) to the bottom of the Data view and columns (variables) after the last of the existing variables just by typing in the next blank row or column. There are a couple of useful buttons on the tool bar that allow you to choose, where variables and cases are inserted.

Insert variable: The **Insert Variable** button can be used to insert a blank column in the Data Editor. The new variable will be inserted after the last variable, unless a variable is selected at the time, in which case the new variable will be inserted just before it. Alternatively, choosing **Data → Insert Variable** from the menus will have the same effect. Swapping to the Variable View and typing in the variable name will also create a new variable.

Insert Case: The **Insert Case** button can be used to insert a new case in the Data Editor. The new case will be inserted after the last case unless a case/row is selected, when the new case will be inserted as a blank row before it. Or choosing **Data → Insert Case** from the menus will have the same effect.

Copy and Paste in Data View: The clicking on the variable name at the head of a column or the row number at the beginning of a case in the **Data View** will select all the values for that variable or case respectively. Once selected, it can be deleted using **Edit → Clear** from the menus, or with the **[Delete]** key. Any selected column, or row contents can be cut, or copied and then pasted into another using the menus **Edit → Cut**, **Edit → Copy** and **Edit → Paste**.

If copied data is pasted into an area of a different shape then SPSS will interpret the action. For example, copying and pasting a whole variable/column into several selected columns will produce duplicates of the copied variable, replacing any data already in the selected variables. The pasting a single copied value into a block of selected cells will replace all of the selected cells with that value. It is also very easy to duplicate a variable and its values by copying and pasting the variable using the context sensitive menus.

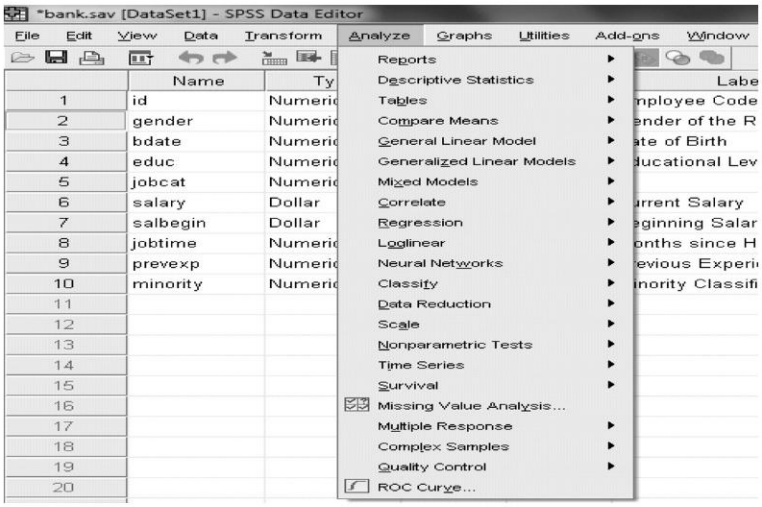
Copy and Paste in Variable View: A variable can also be selected as a row in the **Variable View**, in which case using Copy and Paste from the context-sensitive menu will create new variables with the same attributes as the original variable, but without the data. The right-click on a variable to use Copy and Paste. This will open a **Paste Variables** dialog box to define the

number and names of the new variables you create. It uses the name of the variable copied as the root of the new series of variables. One could change the name by typing something else in the **New Variable Names** box. One can change the length of the variable series by typing a number in the **Number of New Variables** box. And if one select just a single attribute within a variable it can be copied and pasted into another variable without affecting the unselected attributes.

If one had defined variable and value labels for attitude before it is copied it then these labels and any other attributes would have carried across to the new series.

ANALYSING DATA

The Analyse menu contains the statistical analyses available in SPSS. This is the most important menu option of SPSS. An arrow beside a menu item indicates that it has a sub menu. One should notice all the items in the Analyse menu have submenus. The list of menu items shown here is a fairly standard SPSS installation. One can move the mouse over each arrow to see a list of the procedures available in each sub menu. Other items may appear on this menu depending on what modules are installed and whether the menus have been customised.



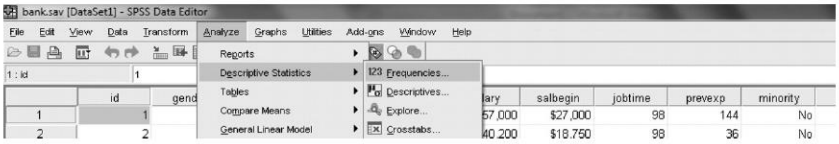
Frequency Tables

Once the data has been captured correctly, one can analyse it using the **Analyse** option in the main menu. The frequency distribution is one of the simplest procedures for summarising the data on a selected variable to look at the number of cases associated with each value of a variable. In SPSS, the Frequencies procedure generates summary tables of frequencies of each value for a variable. It can also be used to calculate summary statistics and charts for each variable individually.

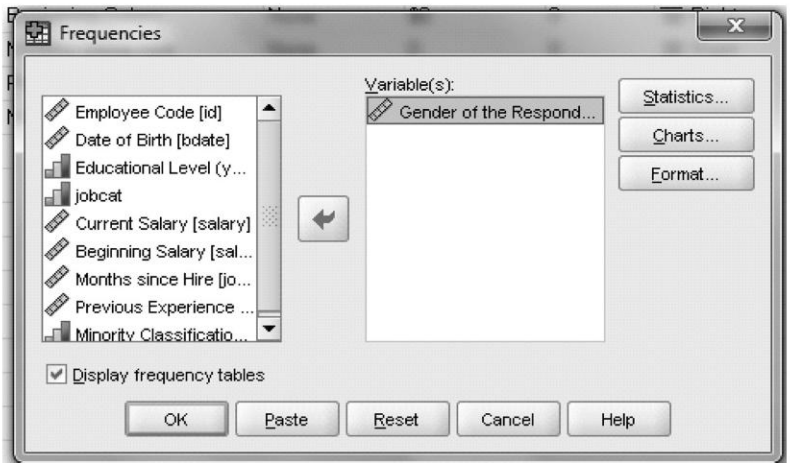
Frequency Distribution is defined as a representation, either in a graphical The or tabular format, which displays the number of observations within a given interval. The intervals must be mutually exclusive and exhaustive.

Using the data in "Bank.sav" file, let's perform the frequency distribution on Gender variable. In order to perform frequency distribution:

1. Click **ANALYZE → DESCRIPTIVE STATISTICS → FREQUENCIES** in the main menu.



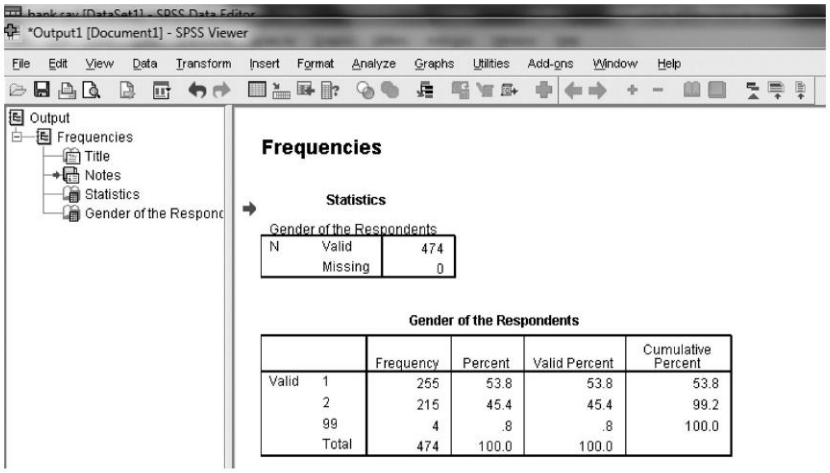
2. In the frequency dialog box that opens, select the GENDER variable by highlight the GENDER variable from the left-hand box and move to the variable name to the right-hand box, and click OK.



The Output Viewer

As soon as one clicks **OK, the SPSS Output Viewer** usually comes to the front as soon as a statistical procedure is run. It splits vertically into two panes. Above the split window, the menus have changed and different buttons are active on the tool bar to reflect the fact they are for use with different sort of window. The two 'panes' of the viewer each have separate scroll bars which means one can scroll down the results, or one can scroll through the outline, or click on an icon to jump to that bit of the results.

The left side of the output window is the **viewer outline**, consisting of small icons representing the different parts of the SPSS output. The right hand side contains the output itself. In the above screen shot one can see the start of frequencies output with the summary statistics table for the variable **Gender of the Respondents**. The N Valid is the number of cases with valid values, i.e.



474 cases, where gender has been recorded. The N Missing is the number of cases where there is no valid gender value. More summary statistics could be added to this table using the **Statistics…** button.

American Airlines deployed SPSS to replace its mainframe based analytics system, increasing productivity of its customer research team and improving decision making while reducing ongoing costs. Adding SPSS to the customer research department has enabled its analysts to dramatically increase their output and respond faster to research requests. The key benefits include:

- Better decision making. The analyst team can now take on more ad hoc requests from internal clients and deliver the results of those requests much faster than before.
- New hires avoided. Dramatically improving the productivity of its analysts has enabled the team to grow without the need to add new analysts — and the ease of use of SPSS accelerates the ramp-up time for new analysts.
- Increased research flexibility. The business analysts can use SPSS for Windows to test different research designs and explore data in complex ways quickly without the need for manual coding.

The second table gives the frequency distribution. If one tries to interpret the output in the second table, one may conclude that 255 cases are there in the data file with Gender having a value of 1 and 215 cases with value 2, 4 cases with value 99. The total of all the three is equal to total number of cases in the data file which is 474. The output table also gives the distribution in percentage terms and also the cumulative percent. Since there were no missing cases in the Gender variable so the percent and the valid percent figures are same in the output table.

But one of the obvious problems with this output is that it does not clearly indicate the frequency distribution among Male and Female Bank employees. Another problem, the third category of Gender (99) belongs to what? Category 1 and 2 is also not defined clearly in the data file. So, every time one has to refer to the coding sheet to interpret this frequency table. Once the codes are known the interpretation of the output is easy. If 1 means Male, 2 means Female, and 99 means missing values than the above output might be statistically wrong!!

In order to overcome this problem, one needs to add the coding scheme about each variable in the variable view of the data file. The benefit of adding this information is that it is always available with the data and the output becomes more readable and meaningful. In order to add such codes one needs to defining variable labels, value labels, and missing values in the variable view of the data file.

Frequencies: Charts

The **Charts...** button on the **Frequencies** dialog box opens the **Frequencies: Charts** dialog box, where one can choose to produce graphical equivalents of the frequency tables. There are three types of chart available. The Barcharts and PieCharts are best for variables with few distinct values, i.e. categorical (nominal or ordinal) variables. The Histograms are best for variables with lots of values measured on a scale, i.e. quantitative variables.

Defining Value Labels and Missing Values

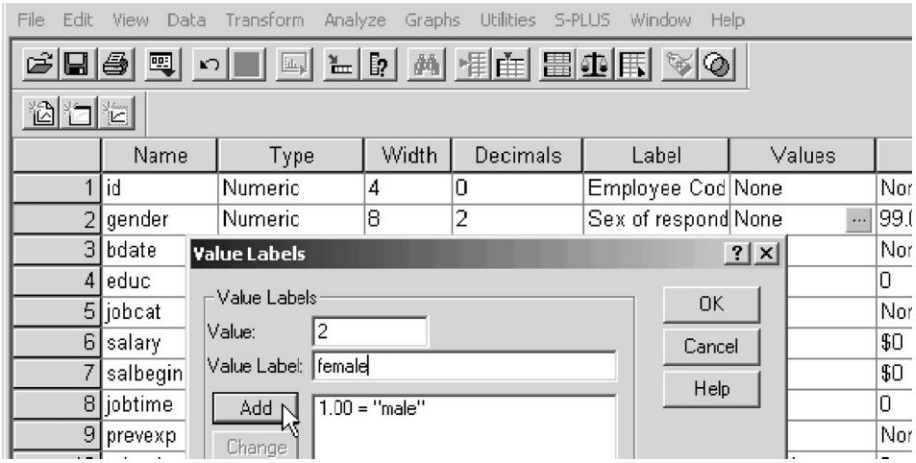
1. Variable and Value Labels

As explained earlier a good data set will include variable and value labels that provide a complete description of both the variable and the meaning of each value within a variable. It is necessary to define value labels for nominal and ordinal data, whereas value labels are not required for continuous data.

- **Variable Label:** It is a description of the variable without the restrictions of the variable name. The SPSS uses the variable label while analysis and also in the output. One can write characters with spaces up to 256 characters. In our example, for Gender variable one can define the variable label as "Gender of the respondents", which will be printed in all outputs wherever one uses this variable.
- **Values:** A powerful utility to define codes and categories. These value labels are printed in all analytical procedures and reports. For each of the value one can define the label which can be up to 60 characters.

In order to create both variable and value labels for GENDER, one can follow the following steps:

1. Double-click on the column heading for GENDER. This will make the column bold, and will open the "Variable View". One can also go directly to the variable view by clicking on the variable view tab on the bottom left corner.
2. Click in the field under 'Label' for gender variable and type in a description of this variable (e.g., Gender of the Respondents). This is a 'variable label', which will be shown in field list for all analysis windows and also in the output reports.
3. Click in the field under Values for gender and click on the button on the right of this field. This will open a dialog box.
4. Type in value 1 and value label 'Male' click Add button.
5. Type in value 2 and value label 'Female' click OK button.
6. If one needs to define the value labels for another variable, it requires selecting that variable and repeating the process. One needs to know the variable and value labels (or the coding scheme) for each of the variables.



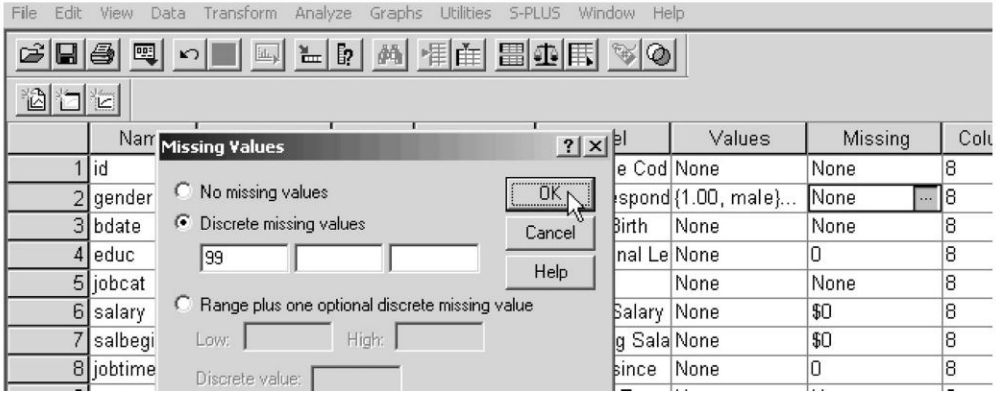
2. Missing Values

The SPSS has two types of missing values that are automatically excluded from statistics procedures: system-missing values and user-missing values. Any variable for which a valid value cannot be read from raw data or computed is assigned the system-missing value. Thus, generally, there is no reason to "set blanks to zero".

The user missing values are values that one tells SPSS to treat as missing for particular variables. These values are values (other than blanks) that one coded into the data to indicate non-acceptable responses.

In the Bank.sav data file, some of the cases in the GENDER variable has a value of "99", which indicates missing data from the respondent. This means that there are some of respondents who have not shared their Gender while filling in their responses. By using the Missing values, one can exclude these cases from any further statistical processing. In order to define missing values one can:

1. Click in the "Missing" field for gender variable in the variable view and click on the button on the right of this field to open missing values dialog box.



2. Select the Radio button beside "Discrete Missing Values" and enter the missing value "99" for GENDER. Note that one can define up to three discrete user-defined missing values. Alternatively, one can also define a range of discrete missing values plus one.
3. Select "OK" when done.

After adding variable labels, value labels, and missing values, one should rerun Frequencies for GENDER in order to check how the processing and the output changes. The output of the Frequency on Gender variable now should look like this:

Frequencies

Statistics

Gender of the Respondents

N	Valid	470
	Missing	4

Gender of the Respondents

		Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Valid	Male	255	53.8	54.3	54.3
	Female	215	45.4	45.7	100.0
	Total	470	99.2	100.0	
Missing	99	4	.8		
Total		474	100.0		

From the first table of the frequency output it is clear that there are 470 valid cases and 4 cases are missing with respect to Gender variable. This means that frequency percentages need to be calculated from 470 instead of 474.

The heading of the second output table is self explanatory as it displays the variable label instead of the abbreviated variable. The table also clearly defines the frequency of Male and Female respondents. Since there are 4 missing cases in Gender variable, it is recommended to read the valid percent column rather than the percent column, as the percent column calculates the percentages out of 474 which is incorrect. There are 54.3 percent Male respondents and 45.7 Female respondents in the data.

Generating Summary Statistics

The summary statistics can be computed using SPSS on some of the variable especially those are continuous variables. The SPSS summary statistics includes Mean, Standard Deviation, Minimum, Maximum, Variance, and Kurtosis distribution etc. For example, in the Bank.sav data file, if one is interested in calculating the mean, median, or standard deviation of a particular variable, one can either use the statistics option within the Frequency analysis, or using the Descriptives options the Descriptive Statistics.

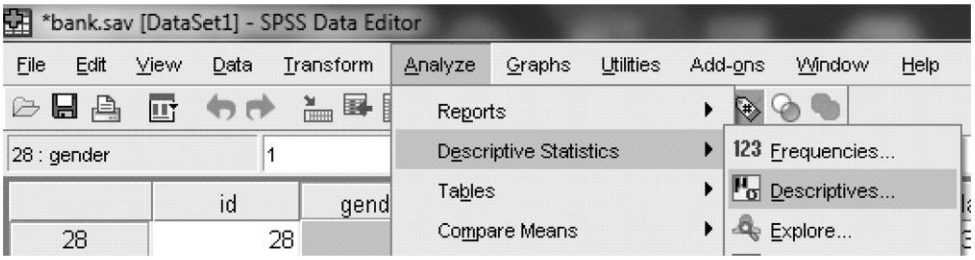
If Frequency distribution makes sense for a particular variable, than use the **Statistics** option within the **Frequency Distribution** Menu. For example, the variable SALARY in the Bank.sav data file has too many values for a frequency table to have any meaning, but if one is interested in

finding the average Salary of employees and also the highest and lowest values, one can calculate the summary statistics from the **Descriptives** option under the **Descriptive Statistics** under Analyze menu.

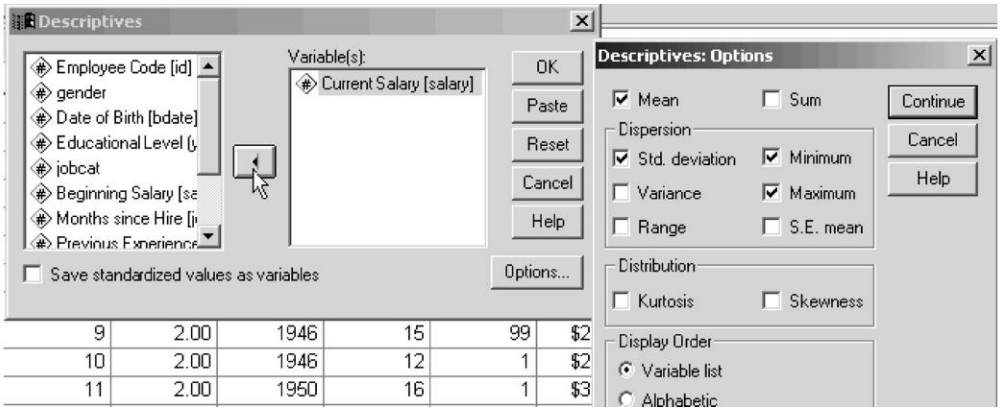
In **FREQUENCIES**, one can get summary statistics such as MEAN, Standard Deviation, SUM, just as one gets in **DESCRIPTIVES**, however, in addition, one gets a frequency table. Also, one can get some summary statistics that are **not** available in the **DESCRIPTIVES** command, for example, the mode and median. Use the **FREQUENCIES** command for categorical data and also when one needs the mode and median. One can use the **DESCRIPTIVES** command for continuous and interval variables, or when one doesn't need frequency counts, the mode, or median.

The SPSS can generate such information through the Descriptives procedure:

1. From the menu, select **ANALYZE** → **DESCRIPTIVE STATISTICS** → **DESCRIPTIVES.**



2. Select the SALARY variable from the left-hand box and move it to the right-hand box. Click "Options" bottom in the dialog box. This will open the **Options** dialog box.



3. In the **Options** dialog box, check the boxes beside the summary tools like the mean, minimum, maximum and standard deviation.
4. Click on "Continue" and then "OK" when done. The descriptive statistics will be calculated and the output will be displayed in the output viewer, which is as follows:

Descriptives

Descriptive Statistics

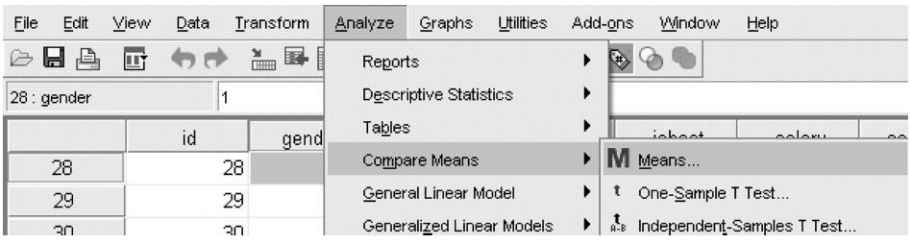
	N	Minimum	Maximum	Mean	Std. Deviation
Current Salary	474	$15,750	$135,000	$34,419.57	$17,075.66
Valid N(listwise)	474				

5. The output is simple to understand. The minimum salary of 474 respondents is $15750, maximum salary is $135000, the Mean salary is $34419.57 and the standard deviation is $17075.66

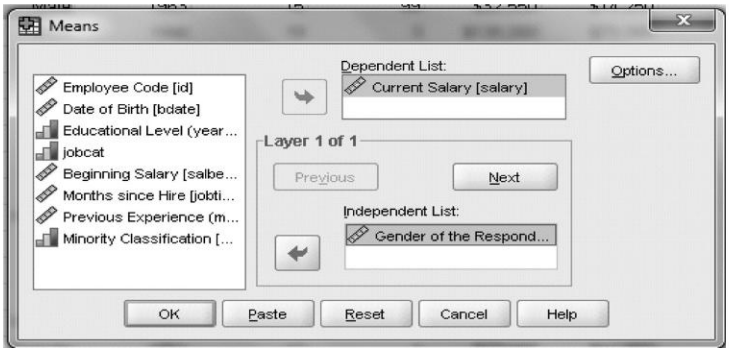
Comparing Means

While the Descriptive statistics procedures gives the general picture of the SALARY variable, what if one is interested in finding the difference in salaries between males and female employees. The SPSS can be used to compare the means for various groups using the Means procedure. The Compare Means submenu on the Analyse menu provides techniques for displaying descriptive statistics and testing whether differences are significant between two means for both independent and paired samples. One needs to follow the following steps:

1. From the menu bar, select **ANALYSE → COMPARE MEANS → MEANS.**



2. Select the SALARY variable from the left-hand side of variable list and click the top arrow to make this the Dependent variable. Dependent variable is one whose distribution one wants to test.



3. Select the GENDER variable from the left-hand variable list and click the bottom arrow to make this the Independent variable. The independent variable is one which will help in explaining the distribution of the dependent variable.
4. Click on "OK" to close this dialog box and the output will be displayed in the output viewer. The output from this procedure is as follows:

Case Processing Summary

	Cases Included		*Excluded*		*Total*	
	N	*Percent*	*N*	*Percent*	*N*	*Percent*
Current Salary * Gender of the Respondents	470	99.2%	4	.8%	474	100.0%

Report

Current Salary

Gender of the Respondents	*Mean*	*N*	*Std. Deviation*
Male	$41,342.67	255	$19,541.932
Female	$26,045.56	215	$7,572.996
Total	$34,345.05	470	$17,064.303

It is evident from the above output of compare Mean procedure that 99.2 percent of the data participated in the analysis. Also there is clear difference in the average salaries between Male and Female employees. The average salary of Male employees is $41,342.67 as compared to Female employees who draw only $ 26045.56. The possible explanations for this difference might be because of education, previous job experience, age, length of tenure with the bank, and other factors, but these needs to be tested.

Let's evaluate the plausibility of education as an explanation of the difference in salaries between Male and Female employees. Before one tries to do any comparison, it is better to understand the data that was collected in the data file and how it is tabulated.

If one looks at the education (EDUC) variable in the data editor, one will find that the current variable indicates the number of years of education completed by the respondent. In order to use this variable for further analysis, it is advisable to reorganise the data in three broader categories as:

Table 8.1 Recoding Rule Table

Category	*Rule*	*Meaning*
1	Less than 12 years of education	Did not complete Senior School
2	12 years and above but less than 16 years of education	At least Senior School
3	16 years and above years of education	At least Graduate

CHANGING DATA

The SPSS Data Editor window can be used to create new variables, enter new data values or change existing values one at a time. However, systematic changes of large amounts of data or complex changes are better done using a variety of procedures available in the **Transform** menu.

1. **Recode:** This procedures including Recode and Automatic Recode are used to change, convert, or regroup values in a variable. The results can either replace the original values, or be put into a new variable leaving the original variable unchanged.
2. **Count:** This is used to count a particular value, or list of values over a series of variables.
3. **Compute:** This is used to perform calculations on existing variables to create new variables, or modify existing ones.

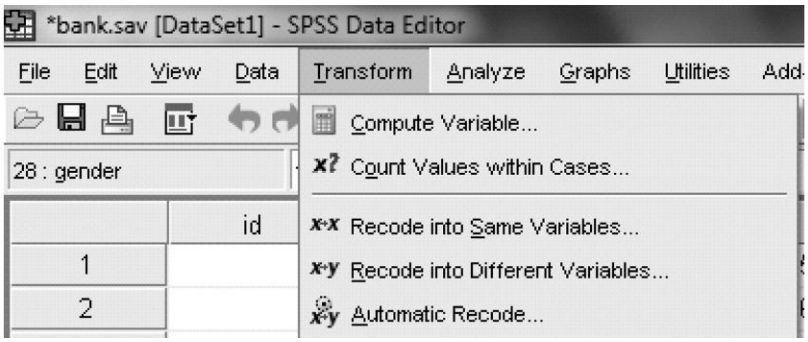
1. Recoding Variables

The reorganisation of data as per the defined categories can be done in SPSS by Recoding Variables. The Variables can be Recoded in either of two ways.

Into New Variable	It creates a new variable with new values based on the existing original values of the variable.
Into Same Variable	It overwrites the original values of the variable with the new values that one has specified as per the categorisation.

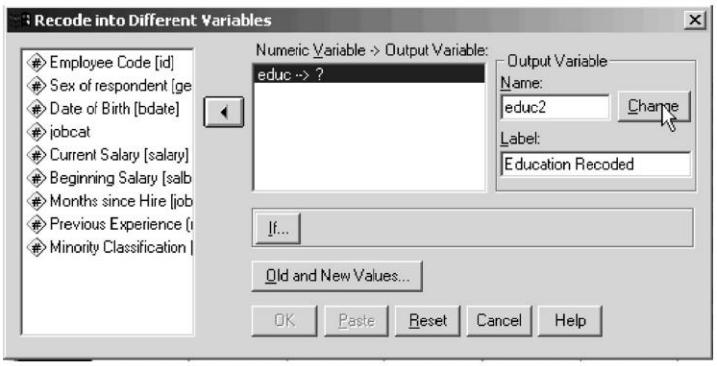
It is not recommended to create recoded variable into the same variable, unless there is a compelling reason to do so. It is always better to Recode into a New Variable. This also helps in retaining the original values for the variable which can be used later for another categorisation scheme on the same original variable. In order to recode the education variable (EDUC) one needs to follow the following steps:

1. From the main menu, select **TRANSFORM → RECODE INTO DIFFERENT VARIABLE.**

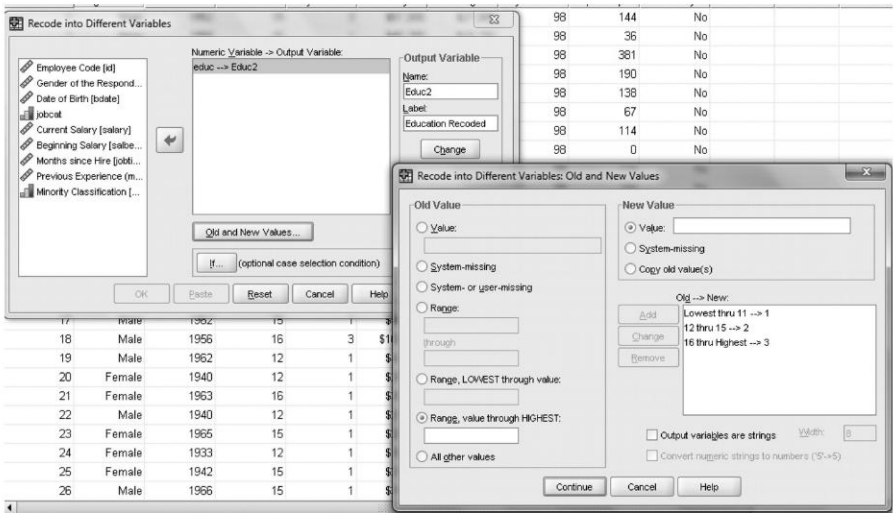


2. Select the variable Education Level (EDUC) from the left-hand side box to bring the variable over to the middle white box.

3. Type a new Name and Label for the new Output Variable and click "Change".



4. Click on "Old and New Values" to open another dialog box, which allows the user to select and apply the pre-defined regroupings or re-categorisations for the selected variable (Education Levels).
5. Under "Old Value", first select the radio button "Range, Lowest through value", specify the range of values of the old variable that constitute a value of the new variable. As per our example, type 11.
6. Then under "New Value", specify the corresponding value of the new variable, and click "Add". As per our example, type 1. Note that this recoding is added to a list under "Old -> New".
7. Keep repeating steps 5 and 6 as necessary. Repeat the steps as per the screen shot below to complete the recoding as per the example.
8. Click "Continue" when done.
9. Click OK at the first dialog box of Recode.



A new variable with the new variable name (EDUC2) will be created at the end of the variable list. The new variable will be having data values of 1, 2 and 3 as per the recoding rule. But what is 1, 2 and 3 means. In order to define the correct meaning to these data values, one needs to create variable, and value labels for the new variable (EDUC2) in the same way it was done for the Gender variable using the recoding rule table described earlier.

Once the variable and value labels are defined generate a frequency table to check that the new variable has been defined correctly. While calculating the frequencies, one can also generate the charts. In order to create frequency charts select the chart option within the Frequencies option. The Frequency table and the corresponding Bar chart for the new variable may look as follows:

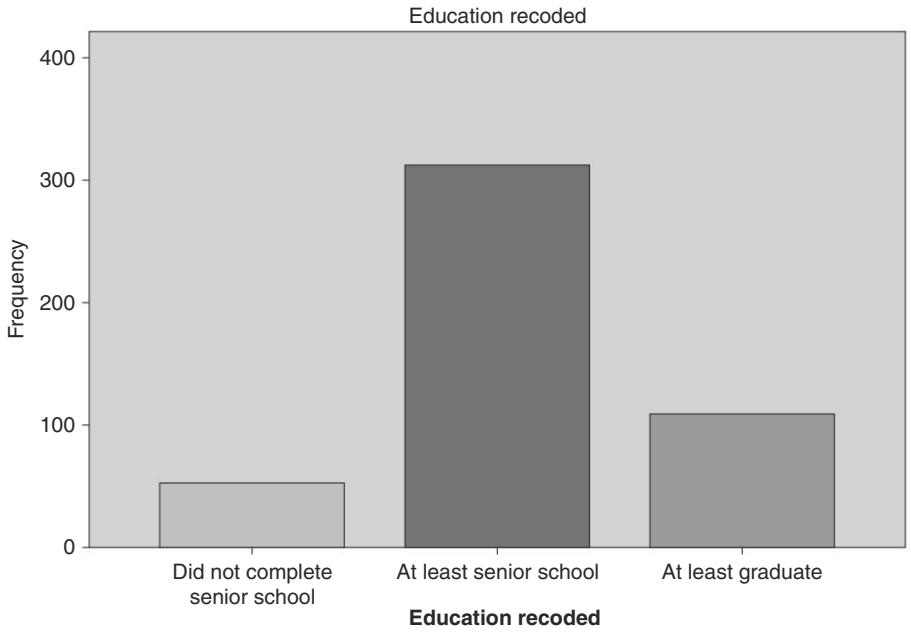
Frequencies

Statistics Education Recoded		
N	Valid	474
	Missing	0

Education Recoded

		Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Valid	Did Not Complete Senior School	53	11.2	11.2	11.2
	At Least Senior School	312	65.8	65.8	77.0
	At Least Graduate	109	23.0	23.0	100.0
	Total	474	100.0	100.0	

It is evident from the output that 65.8 percent of the respondents have completed at least senior school and 23 percent are graduates and only 11.2 percent have not completed senior school.



2. Automatic Recode

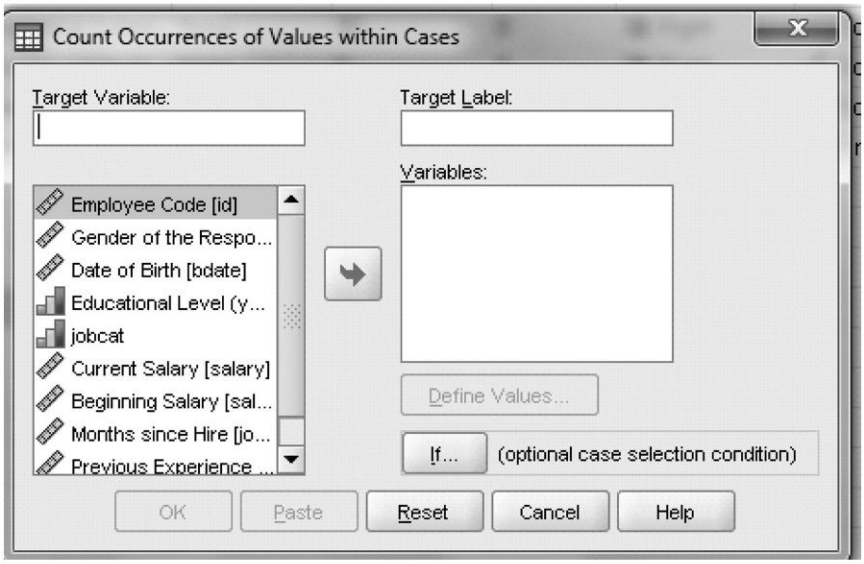
Transform → Automatic Recode... is a function to clear up data into sequentially numbered codes. It can help either to reorganise widely ranging numeric codes into a series of consecutive ones or to convert codes from a string, or text variable into a new numeric variable. The string variables longer than 8 characters cannot be used in most SPSS statistical procedures so it is best to convert the string data into numeric codes. For example, if the **gender** variable in the bank.sav data set has string values, 1 character in length than one can use the Automatic Recode to convert that into new Gender variable having Numeric codes.

The Automatic Recode dialog box is very easy and quite similar to Recode dialog box. One needs to just select the variable one wish to recode from the list on the left, put it in the **Variable → New Name box**. Then type in the name of the new variable in the box beside the New Name button and click the button to complete the mapping.

3. Count

Transform → Count simply counts the number of times a particular type of value occurs across a series of variables for each case.

The **Count Occurrences of Values within Cases** dialog box, requires a new variable name where the results of the count will go. The series of variables to be counted go into the **Variables:** box. Finally, the values to be counted are defined using the **Define Values…** button.

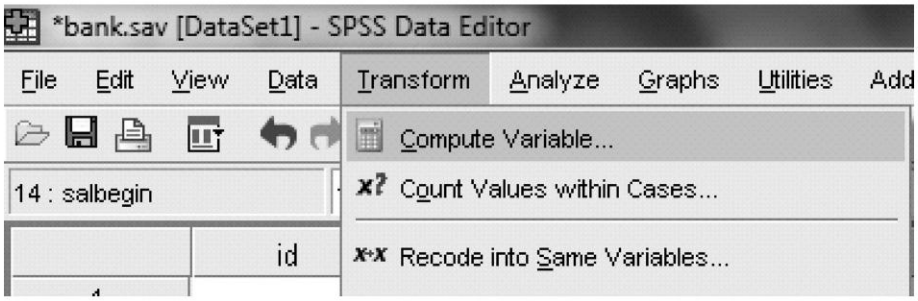


4. Computing a New Variable

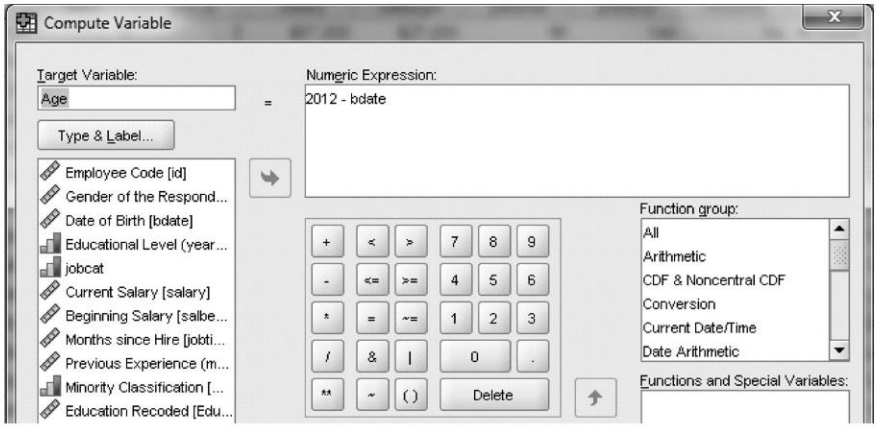
The SPSS also allows creating a new variable based on existing variables. These variables are called derived or computed variables. **Transform → Compute** can perform all sorts of calculations, changing existing variables or creating new ones. For example, in the bank data file, there is a

variable for date of birth of employees, but no variable which tells the Age of employees. One can derive the Age of employees from the date of birth variable using COMPUTE procedure of SPSS. One needs to follow the following steps to compute a new variable, AGE:

1. From the main menu, select **TRANSFORM → COMPUTE VARIABLES.**



2. Type the name of the new variable that one wants to create in the box under the "Target Variable" heading.
3. Create the mathematical expression that represents the new variable, either by typing that expression into the box under "Numeric Expression", or by using the keypad.
4. Click on "OK" when done.



A new variable by the name "Age" will be added at the end of the variable list and will have data values calculated as per the given expression.

Working with Dates

The dates in SPSS can be used in ordinary calculations although there are special time/date functions that may prove useful. They can also be displayed in a variety of formats that do not change the underlying date value—just the way they are displayed. This can be open using **Transform → Date and Time Wizard.**

There are a series of xdate functions, which can be used to extract various parts of the date. Here's a list of some of the **xdate** functions available.

XDATE.DATE(datevalue) - date portion.

XDATE.HOUR(datevalue) - hour of the day (an integer between 0 & 23).

XDATE.JDAY(datevalue) - day of the year (an integer between 1 & 366).

XDATE.MDAY(datevalue) - day of the month (an integer between 1 & 31).

XDATE.MINUTE(datevalue) - minute of the hour (an integer between 0 & 59).

XDATE.MONTH(datevalue) - month (an integer between 1 & 12).

XDATE.QUARTER(datevalue) - quarter of the year (an integer between 1 & 4).

XDATE.SECOND(datevalue) - second (a number between 0 & 60).

XDATE.TDAY(timevalue) - number of whole days (as an integer).

XDATE.TIME(datevalue) - time of day .

XDATE.WEEK(datevalue) - week number (an integer between 1 & 53).

XDATE.WKDAY(datevalue)- weekday (an integer between 1, Sunday, & 7, Saturday).

XDATE.YEAR(datevalue) - the year .

These functions can be used with **Transform → Compute** so a new variable can be generated. One can use any arithmetic function on dates.

SELECTING AND SORTING DATA

The Data Menu

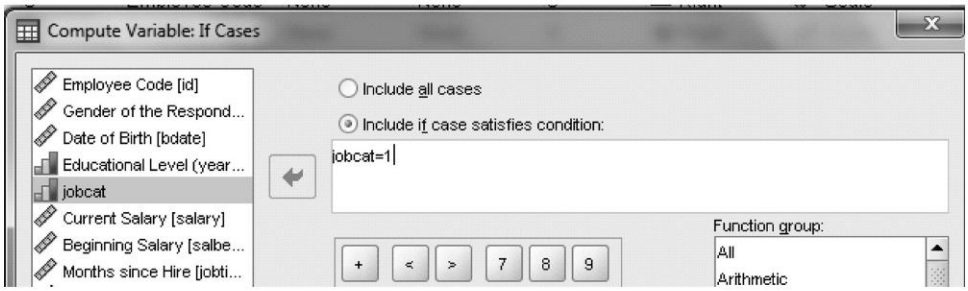
The data Menu allows to manage data files in terms of sorting, splitting, or weighted for purposes of analysis. All of these procedures are used to reorganise the data, or change the way SPSS deals with it.

1. **Logical expressions** are the building blocks for many selective procedures.
2. **Select Cases** is used to choose a subset of the data for analysis.
3. **Sort Cases** is used to reorder data in the data editor.
4. **Split File** is used to produce independent analysis for subsets of the data file.
5. **Weight Cases** is used to give different weights to the data. This is used to adjust for sampling error, reduce the influence, or exclude cases, or even reconstitute a table as data for further analysis.

1. Logical Expression

There are powerful selection tools in SPSS. One of the most powerful tools is to select subsets from the data using a Logical Expression. The simplest form of logical expression states that one quantity has a certain relationship to another. The logical expression can return a value of either *true* if the values match the relationship, *false* if the values do not fit in to that relationship. These true/false values are not saved as such but are used in various commands like selection of cases, or computation of new variables. One can use all the Relational and Logical Operators. The logical expression can be entered by clicking the **IF...** button in a transformation dialog box of Compute or Recode Procedures.

The figure shown below shows the **If** Cases dialog box for **Compute** procedure. Using the **bank.sav** data set, the logical expression **jobcat=1** means the calculation will be done just for cases where this is true, i.e. with a jobcat value of 1. For the remaining cases (False cases), the computed variable will have a system missing value (show a blank).

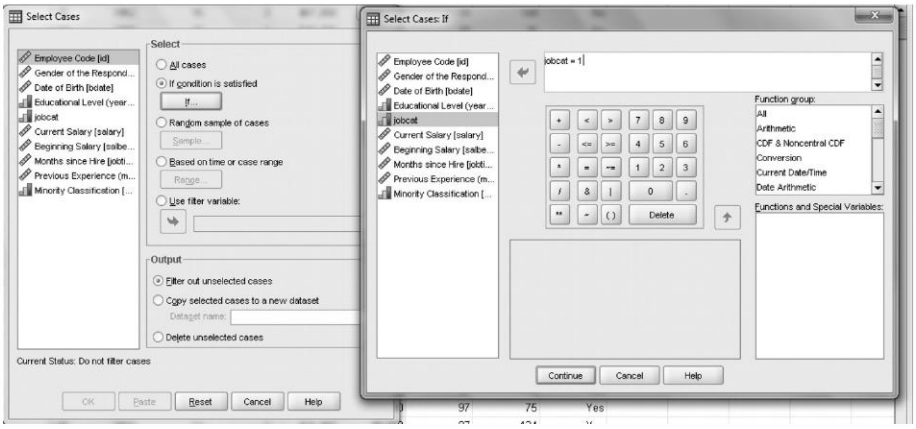


2. Select Cases

Use **Data → Select Cases** to select a subset of the data in the Data Editor. There are a variety of different ways of selecting cases:

- To use a logical expression, i.e. if the expression is true select that case.
- To draw a random sample from the all or part of the data set.
- To select a range of cases (say the first hundred).
- To select cases in a time frame.
- To use a filter variable where only cases with value 1 will be selected.

The first method is most commonly used method and is another example of the **IF** button, using a logical expression to select a sub group.



Once a selection has been made, the unselected cases can either be Filtered, or Deleted from the data editor or the selected cases can be **copied** to a new dataset. The SPSS creates a variable

called **filter_$** using the **Filtered** option. A case will take the value 1 for this variable if the logical expression is true and 0 if it is false and the case unselected. If the value labels are switched on, 1 is labelled 'Selected' and 0 is 'Unselected'. It inserts a diagonal line for unselected cases.

If one executes the Frequency or any other procedure on the filtered dataset, it will show only 227 valid cases. This means that 247 cases are unselected.

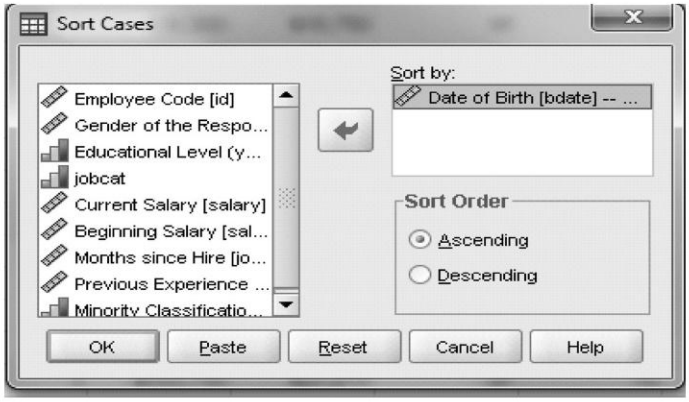
The contents of the filter variable, filter_$ change if one rerun the Select Cases with a different logical expresssion. One can take a copy of the filter variable into a new column. Alternatively, one can create a new filter variable using **Transform → Compute**.

Selecting all cases again: Switch the filtering off by choosing **Data → Select Cases...** while the Data Editor is active and choose **All Cases** option.

3. Sort Cases

The Data → Sort Cases... is used to rearrange the data in the data editor by the values of a specified variable, or set of variables. The data will be sorted by as many variables as are entered in the dialog box **Sort by:**. By default the cases are sorted in **Ascending** order. If one wishes to sort in descending order then select the variable and choose the **Descending** button.

When the data is sorted on multiple variables, data is sorted by the first variable and within that sort the cases are sorted by the second variable.



4. Split File

The split File can be used to split the data into groups for analysis. Once split, each group is analysed separately until the SPSS session ends, or until **Split File** is switched off. The **Split File** is one of the procedures, which makes use of **Sort Cases**. In order to split the file select **Data → Split File.**

And in order to deactivate the Split, this needs to be switched off. This is done by choosing **Data → Split File...** and selecting **Analyse all cases** from the dialog box.

5. Weight Cases

At the bottom of the **Data** menu is an item called **Weight Cases...** It is used to multiply with the effect of a single case by values called weights. Often weighting is used to get estimates for a

population using a sample, whose cases have not been evenly drawn. These weights are usually calculated based sampling theory.

If the data file with weighting "on" is saved then it will be on when the files is opened again. The weights can be switched off by choosing **Data → Weight Cases...** again and selecting **Do not weight cases**. If a case has a weighting value of zero, it will be excluded from analysis until the weighting is removed.

CREATING CROSS-TABLES

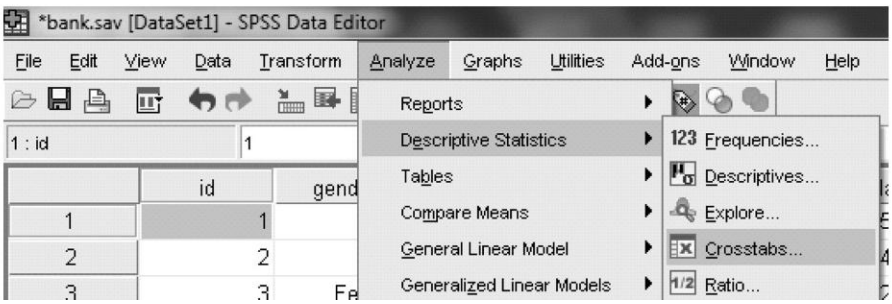
The cross-tabulation is one of the most useful analytical tools and is a main-stay of the market research industry. One estimate is that single variable frequency analysis and cross-tabulation analysis account for more than 90% of all research analysis. The cross-tabulation analysis, also known as contingency table analysis, is most often used to analyse categorical (nominal measurement scale) data. A cross-tabulation is a two (or more) dimensional table that records the number (frequency) of respondents that have the specific characteristics described in the cells of the table. The cross-tabulation tables provide a wealth of information about the relationship between the variables. The frequencies deals with variables separately but Crosstabs displays two, or more categorical variables in association with each other in a table.

The cross-tabs or cross tabulation is a quantitative research method appropriate for analysing the relationship between two, or more variables. The data about variables is recorded in a table or matrix.

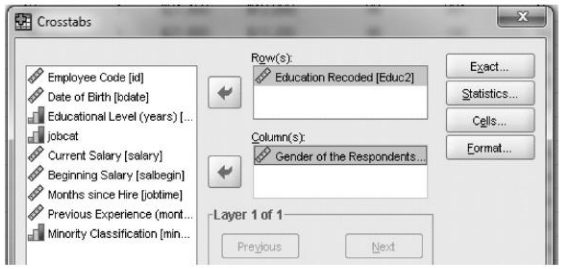
Once the Education Levels variable is recoded as per the defined categorisation, one can determine the difference in the percentage of males and females, who have completed senior school and graduation. Again, making this comparison will help in assessing the plausibility that difference in educational levels actually explain the difference in salaries between male and female respondents?

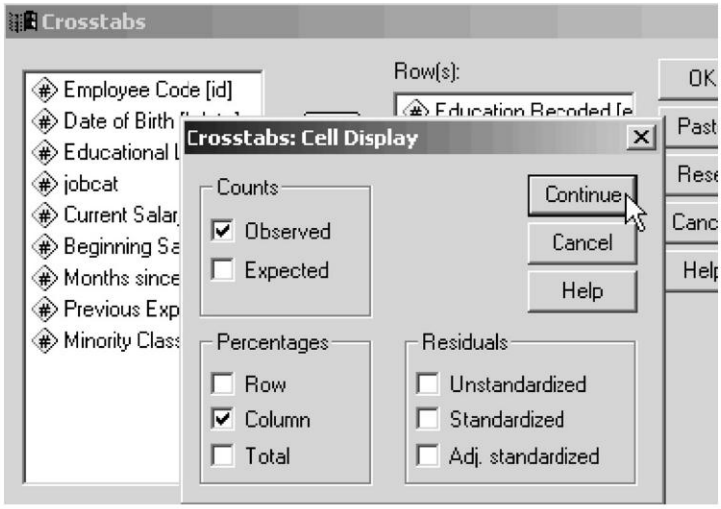
Since both the new education variable and the gender variable are categorical variables, the appropriate procedure to assess differences in educational level across the two genders is to generate a Cross-Classification table, also called a CrossTab. In order to create a crosstab in SPSS, one needs to follow the following steps:

1. From the main menu, select **ANALYSE → DESCRIPTIVE STATISTICS → CROSSTABS.**



2. In the dialog box, from the left-hand side, select the select EDUC2 for the Row and GENDER for the Column, using the arrow buttons. Usually, by convention, one puts dependent variables in the rows and independent variables in the columns of a crosstab table.
3. Click on the "Cells" button on the right side of the dialog box.
4. In the "Cell Display" options dialog that pops up, check the boxes for Observed counts and Column percentages.
5. Click on "Continue" on this dialog box when done.
6. Click "OK" on the Crosstabs dialog box.





The Output should look like this:

Crosstabs

Case Processing Summary						
	Cases					
	Valid		*Missing*		*Total*	
	N	*Percent*	*N*	*Percent*	*N*	*Percent*
Education Recoded * Gender of the Respondents	470	99.2%	4	.8%	474	100.0%

Education Recoded* Gender of the Respondents Crosstabulation

		Gender of the Respondents		
		Male	*Female*	*Total*
Education Did Not	Complete Count	23	30	53
	% within Gender of the Respondents	9.0%	14.0%	11.3%
At Least Senior School	Count	150	160	310
	% within Gender of the Respondents	58.8%	74.4%	66.0%
At Least Graduate	Count	82	25	107
	% within Gender of the Respondents	32.2%	11.6%	22.8%
Total	Count	255	215	470
	% within Gender of the Respondents	100.0%	100.0%	100.0%

From this table, it is clear that while 32% of male employees are having graduation, or higher qualification, only about 12% of female employees have similar qualification. Whereas, about 75% of female employees are having at least senior school certificate as compared to about 59% of male employees who have the similar qualification.

In order to fully assess whether education accounts for the salary difference, one can execute the procedure called Linear Regression. Using Regression, one can also examine the influence of the other factors that might account for salary differences like age, previous job experience, and length of tenure with the bank.

Using the Pivot Table Editor

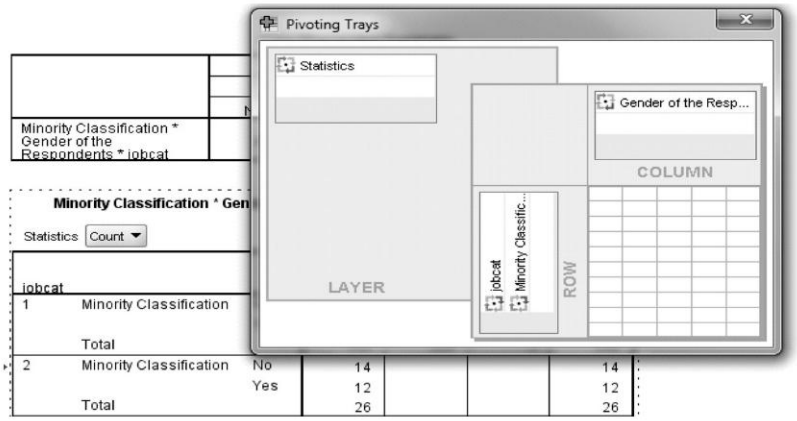
The results from most statistical procedures are displayed in **pivot tables**. There are many statistical terms, which are displayed in the output and definitions of these terms can be accessed directly in the Viewer.

The default tables produced may not display information as neatly, or as clearly as one would like. With pivot tables, one can transpose rows and columns, adjust the order of data in a table, and modify the table in many other ways. For example, one can change a short, wide table into a long, thin one by transposing rows and columns. Changing the layout of the table does not affect the results. Instead, it's a way to display the information in a different or more desirable manner.

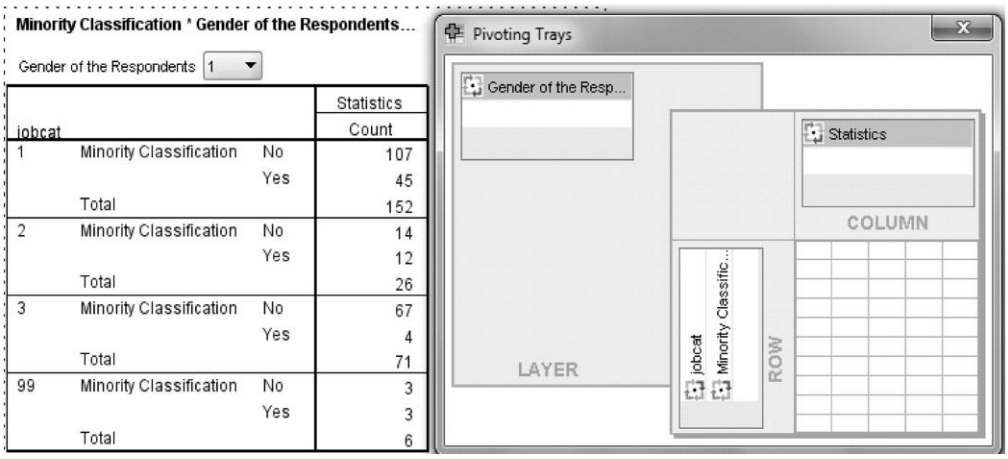
Double-click on the cross-table in the output viewer. Pivoting Tray is activated. If the Pivoting Trays window is not visible, than choose from the menu: **Pivot → Pivoting Trays**

The Pivoting trays provide a way to move data between columns, rows, and layers.

Drag the *Statistics* element from the Layer dimension to the Column dimension, below the *Gender*. The table is immediately reconfigured to reflect the changes. The order of the elements in the pivoting tray reflects the order of the elements in the table. Layers can be useful for large tables with nested categories of information. By creating layers, one simplifies the look of the table, making it easier to read and interpret.



Drag the *Gender* element from the Column dimension to the Layer dimension and see the effect of change. In order to display a different layer, select a category from the drop-down list in the table. Use the pivoting trays to explore how to change the look of the table. Move items from one tray to another and look at the effect. Or, change the order within the rows.

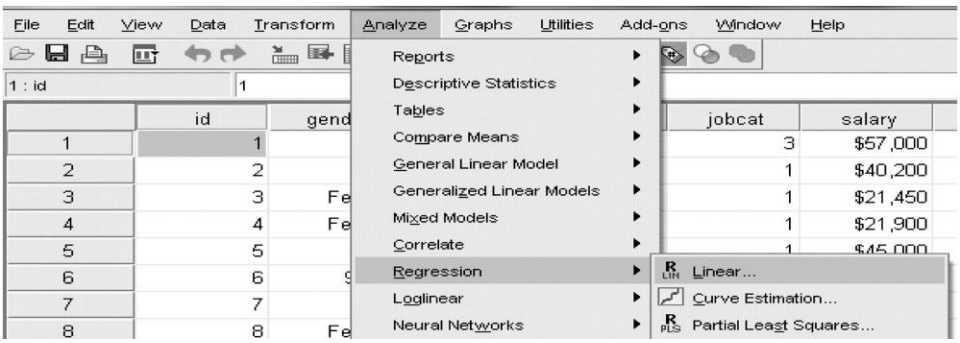


jobcat			Statistics Count
1	Minority Classification	No	107
		Yes	45
	Total		152
2	Minority Classification	No	14
		Yes	12
	Total		26
3	Minority Classification	No	67
		Yes	4
	Total		71
99	Minority Classification	No	3
		Yes	3
	Total		6

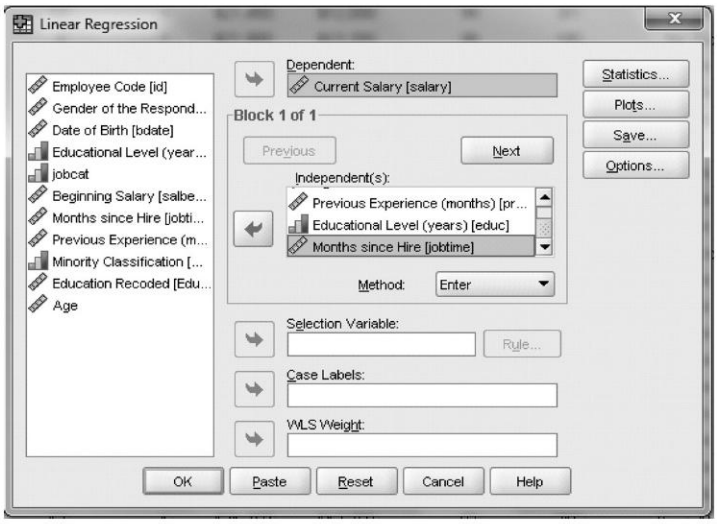
LINEAR REGRESSION

The Linear Regression procedure examines the relationship between a dependent variable and a set of independent variables. One can use the procedure to predict a dependent variable based on independent variables. In order to execute Linear Regression that addresses the research question, one needs to open the Regression dialog box and define the dependent variable and various independent variables that will help in predicting the dependent variable. The steps the needs to be followed are as follows:

1. From the main menu, select **ANALYZE → REGRESSION → LINEAR**.



2. In the Regression dialog box, from the left-hand side box, move SALARY to the Dependent box, and pull all of the predictor variables (i.e. GENDER, AGE, EDUC, JOBTIME, and PREVEXP) to the Independent box.
3. Click "OK" when done.



Depending on the options that one has selected for the regression, the output may have many different parts, but the following output is important for our example:

Regression

Model Summary

Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
1	.700[a]	.490	.484	$12,265.425

(a) Predictors: (Constant), Months since Hire, Previous Experience (months), Gender of the Respondents, Educational Level (years), Age

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.691E10	5	1.338E10	88.957	.000[a]
	Residual	6.965E10	463	1.504E8		
	Total	1.366E11	468			

(a) Predictors: (Constant), Months since Hire, Previous Experience (months), Gender of the Respondents, Educational Level (years), Age

(b) Dependent Variable: Current Salary

Coefficients[a]

Model		Unstandardised Coefficients		Stadardised Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	–8322.087	7014.442		–1.186	.236
	Gender of the Respondents	–8757.588	1325.243	–.256	–6.608	.000
	Age	95.477	85.390	.066	1.118	.264
	Previous Experience (months)	–7.893	9.890	–.049	–.798	.425
	Educational Level (years)	3395.978	222.921	.573	15.234	.000
	Months since Hire	63.364	56.954	.037	1.113	.266

(a) Dependent Variable: Current Salary

The regression results indicates that education does have a significant effect on salary (significance level of the parameter estimate is displayed in the column labeled "Sig."). However, even after controlling for the effects of educational differences between the Gender, gender continues to have a significant effect. Specifically, female employees make almost $9000 less than male employees, after controlling for education, previous job experience, and tenure with the bank. This suggests the possibility of either some other factors influences the model.

MULTIPLE RESPONSE ANALYSIS

The two procedures are available for analysing multiple dichotomy and multiple category sets. The Multiple Response Frequencies procedure displays frequency tables and the Multiple Response Crosstabs procedure displays two- and three-dimensional cross-tabulations. Before this can be used one needs to define the multiple response sets. The concept of Multiple Response is explained using the following problem:

Problem: A Cyber Café owner wanted to study the perception of the users of the cyber café and to understand the important factors required to manage the cyber cafés better in competing environment. As part of this, a market research survey was conducted and one of the questions in that survey was to understand the Internet usage behavior across various internet applications like email, chat, browsing, download etc. In total 12 options were given and the respondent is expected to select at least four of these 12 options. This is a multiple response question, since the respondent

can choose more than one options. However, this question cannot be coded directly because a variable can have only one value for each case. There are two ways to do this. One is to define a variable corresponding to each of the choices (for example, variable for email, chat, browsing, download, and others). If the respondent select Email, the variable corresponding to Email is assigned a value of 1, otherwise 0. This is a **multiple dichotomy method** of mapping variables. The other way to map responses is the **multiple category method**, in which one estimate the maximum number of possible responses to the question and set up the same number of variables, with codes used to specify the Internet applications. By perusing a sample of questionnaires, one might discover that no user has used more than four different applications of Internet. Using the multiple response method, one may define four variables, each coded as 1 = email, 2 = chat, 3 = browsing, 4 = downloading, 5 = shopping, 6=telephony and so on. If a given respondent selects email, chat, downloading and telephony, in this situation, the first variable will have a code of 1, the second variable has a code of 2, the third has a code of 4 and the fourth variable will have 6. Another respondent might have selected email, chat, browsing, and shopping. Thus, the first variable has a code of 1, the second has a code of 2, the third has a code of 3 and the fourth will have 5. If one uses the multiple dichotomy method, on the other hand, one ends up with 12 separate variables as compared to 4 variables in multiple category method. Although either method of mapping is feasible for these kinds of survey, the method one will choose depends on the distribution of responses.

Multiple Response Define Sets

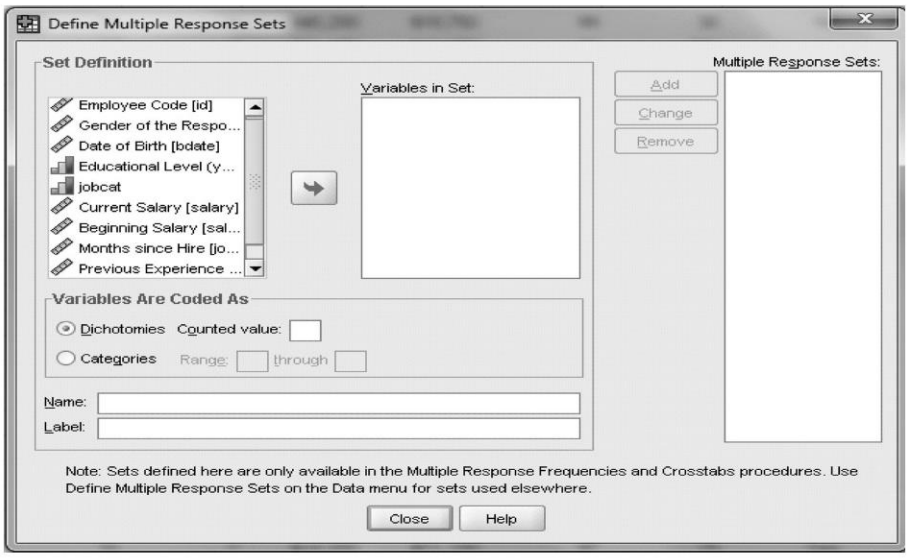
The Define Multiple Response Sets procedure groups elementary variables into multiple dichotomy and multiple category sets, for which one can obtain frequency tables and cross-tabulations. One can define up to 20 multiple response sets. Each set must have a unique name. In order to remove a set, highlight it on the list of multiple response sets and click Remove. In order to change a set, highlight it on the list, modify any set definition characteristics, and click Change.

Each multiple response set must be assigned a unique name of up to seven characters. The procedure prefixes a dollar sign ($) to the name that is assigned. The name of the multiple response set exists only for use in multiple response procedures. One cannot refer to multiple response set names in other procedures. In order ***to Define Multiple Response Sets,*** From the main menus one needs to choose: **Analyze → Multiple Response → Define Sets...**

Select two, or more variables. If the variables are coded as dichotomies, indicate, which value one wants to have counted. If the variables are coded as categories, define the range of the categories. Enter a unique name for each multiple response set. Click Add to add the multiple response set to the list of defined sets.

Multiple Response Frequencies

The Multiple Response Frequencies procedure produces frequency tables for multiple response sets. One must first define one, or more multiple response sets. For multiple dichotomy sets, category names shown in the output come from variable labels defined for elementary variables in the group. If the variable labels are not defined, variable names are used as labels. For multiple



category sets, category labels come from the value labels of the first variable in the group. If categories missing for the first variable are present for other variables in the group, define a value label for the missing categories.

Multiple Response Crosstabs

The Multiple Response Crosstabs procedure cross tabulates defined multiple response sets, elementary variables, or a combination. One can also obtain cell percentages based on cases, or responses, modify the handling of missing values, or get paired cross-tabulations. One must first define one, or more multiple response sets. The procedure displays category labels for columns on three lines, with up to eight characters per line. In order to avoid splitting words, one can reverse row and column items or redefine labels.

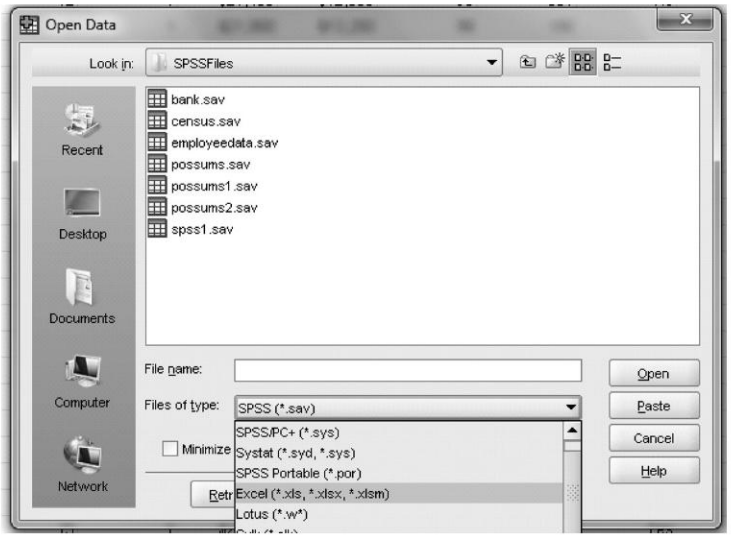
READING DATA FROM OTHER PROGRAMS

1. Microsoft Excel File

Reading an Excel file in SPSS is very simple and straightforward. In order to read an Excel file in SPSS, simply go to **File → Open**, select Excel from under the option box "Files of Type," and locate the file.

Once the file is located and file name is given, SPSS checks, whether the Excel file has variable names that appear in the first row of the data set. If the Excel data file have such variable names, check this box. The SPSS assign names to each of the new variables.

If the Excel file consists of data in multiple sheets, SPSS checks the sheet name and also the range that one wants to copy to SPSS. SPSS also allows picking up the data from the Named Ranges of Excel sheet.



2. Reading Tab-Delimited Data File

In order to read a plain ASCII text data that is delimited by tabs again one can simply load the file by going to **File → Open** menu and select Text file from under the option box "Files of Type" and locate the file.

The text import wizard will open to walk you through the import of the text file. One needs to select the delimiter, formats for the variables, whether the text file has the variable names in the first row of the data set, etc.

SUMMARY

- Most of the decision making is statistics based and SPSS is a tools that provides a statistical and data management for analysts and researchers. With SPSS one can generate decision-making information quickly using powerful statistics, understand it and effectively present the results with high-quality tabular and graphical output, and share these results with others using a variety of reporting methods.
- The SPSS originally it is an acronym of Statistical Package for the Social Science but now it stands for Statistical Product and Service Solutions enables the user to get a quick look at the data, formulate hypotheses for additional testing, and then carry out statistical and analytic procedures to help clarify relationships between variables, create clusters, identify trends, and make predictions.
- The SPSS has four main windows, plus a menu bar at the top. These windows allows the user to (1) work on data, (2) get the statistical output, (3) see the programming commands that was written and (4) provides the opportunity to write full-blown programs. Each window corresponds to a separate type of SPSS file.
- The Data Editor allows the user to see and manipulate the data. One can open at least one Data Editor. The data files are saved with a file type of ".sav".
- The Output Viewer displays output and errors. The extension of the saved file will be "spv." This is a very powerful tool for manipulating and modifying the SPSS output.

- Each row of the data editor in Data View represents a case, or a record as referred in common database terms. The cases are the units, or individuals that make up the study, e.g. survey responses, products in an inventory, schools in a city, countries etc.
- Each column of the data editor in Data View represents a variable. A variable is a particular type of measurement for each case, e.g. it could be someone's name or age, or height or marks in some subject etc. A variable can be changed in the Variable View, including what type of measure it is.
- Each column head in the Data View represents the variable, which has a variable name. The variable names can be up to 64 characters long and must start with a letter and can have any letter, number or @, #, _ or $.
- The variables can also have a variable label. It is a description of the variable without the restrictions of the variable name. The SPSS uses the variable label while analysis and also in the output.
- Each cell in the Data View is known as a variable value. It represents the variable measurement for that particular case, or row. These variable values can be numbers, numbers representing codes (nominal/ordinal), or text. The SPSS assumes that the data is numeric unless it is told otherwise.
- The value Label is a piece of text called a value label that can be associated with each variable value.
- The scale is for variable values measured on a continuous scale, such as height, weight etc. The scale variables have a ruler icon.
- The ordinal is for variables whose values represent categories with some inherent order between them, such as social class, attitudinal scales (e.g. agree, neutral, disagree). The ordinal variables have a bar chart icon.
- The nominal is for categorical variables with values, which are not sequentially ordered, they are just names.
- The Analyse menu contains the statistical analyses available in SPSS. This is the most important menu option of SPSS. An arrow beside a menu item indicates that it has a sub menu.
- The frequency distribution is one of the simplest procedures for summarising the data on a selected variable to look at the number of cases associated with each value of a variable. In SPSS, the Frequencies procedure generates summary tables of frequencies of each value for a variable. It can also be used to calculate summary statistics and charts for each variable individually.
- A Value label is a powerful utility to define codes and categories. These value labels are printed in all analytical procedures and reports.
- The SPSS has two types of missing values that are automatically excluded from statistics procedures: system-missing values and user-missing values. Any variable for which a valid value cannot be read from raw data, or computed is assigned the system-missing value. The user missing values are values that one tells SPSS to treat as missing for particular variables.
- The data Menu allows to manage data files in terms of sorting, splitting, or weighted for purposes of analysis. All of these procedures are used to reorganise the data, or change the way SPSS deals with it.
- The cross-tabulation is quantitative research method appropriate for analysing the relationship between two, or more variables.
- The Linear Regression procedure examines the relationship between a dependent variable and a set of independent variables. One can use the procedure to predict a dependent variable based on independent variables.
- The multiple Response Analysis is available in SPSS for analysing multiple dichotomy and multiple category sets.

KEY TERMS

SPSS
Analysing Data
Compute
Count
Cross Tabulations
Data Editor
Data View
Decision Making
Descriptive Statistics
Dialog Recall
Frequency Tables
Mean
Measure
Median
Missing Values
Mode
Modeling Techniques
Multi Response Analysis
Opimisation
Output Viewer
Pivot Tables
Recode Data
Regression
Script Window
Select Cases
Sort
Standard Deviations
Statistical Tools
Syntax Editor
Value Labels
Variable View
Weight Cases

SELF-STUDY QUESTIONS

1. In SPSS, _____ provides instant access to many useful features.
   (a) Menu Bar (b) Tool Bar (c) Command Bar (d) Title Bar
2. The _____ allows the user to see and manipulate the data.
   (a) Data Editor (b) Output Viewer (c) Syntax Editor (d) Script Window
3. In the Variable View one can see and edit the information that defines each variable in the Data set.
   (a) Data View (b) Variable View (c) Output View (d) Script Editor
4. _____is for categorical variables with values, which are not sequentially ordered, they are just names.
   (a) Scale (b) Ordinal (c) Ratio (d) Nominal
5. The _____ procedure generates summary tables and charts of frequencies and is also be used to calculate summary statistics.
   (a) Cross Tables (b) Regression
   (c) Frequency (d) Descriptive Statistics
6. _____ values are values (other than blanks) that one coded into the data to indicate non-acceptable responses.
   (a) Recoded (b) Variable (c) Missing (d) Meta Data
7. The _____ submenu on the Analyse menu provides techniques for displaying descriptive statistics and testing, whether differences are significant between two means for both independent and paired samples.
   (a) Compare Means (b) Standard Deviations
   (c) Cross Tabulations (d) Regressions
8. _____ Procedures are used to change, convert, or regroup values in a variable.
9. _____ can be used to split the data into groups for analysis.
   (a) Select Cases (b) Split Files (c) Weight Cases (d) Filter
10. One can use _____ procedure to predict a dependent variable based on independent variables.

REVIEW QUESTIONS

1. List five business applications of SPSS.
2. List some of the procedures using which one can calculate Measures of Central Tendency.
3. Why one needs to sort the data to Split Files?
4. How many types of multi response variables are there?
5. What is the utility of defining value labels? Describe the complete process of defining value labels.
6. How one can recode the Age of respondents into young, not so young and old categories? Explain the steps.
7. How one can process only a set of cases say for salary > 30000.
8. Write the steps required to create a three-dimensional Pivot Table.
9. How one can create a new variable based on some expressions on existing set of variables.
10. What is the concept of Missing values?

QUESTIONS FOR DISCUSSION

1. Copy the Internet.sav data file from the book website to solve the following questions. This data file consists of responses from 45 respondents about the services being provided by their ISP (Internet Service Provider). The coding scheme used to capture the data is defined as part of variable view.
   (a) Recode the salary variable and prepare a frequency distribution for new salary variable using the following class intervals:
   10000 – 15000
   15000 – 20000
   20000 – 30000
   30000 – 40000
   40000 and above
   (b) Compute the Mean, Median, and Mode along with the relative and cumulative frequencies.
   (c) Compute the Mean, Mode, Standard Deviation, and Variance for the age and salary variables.
   (d) Compute the relative frequency for qualification and ISP used at.
   (e) Arrange the data in increasing order of age and salary.
   (f) Create a new variable called bonus and compute bonus as 20% of salary.
   (g) Assume score of 6 and 7 of satisfaction level represent most satisfied users of ISP and a score of 4 and 5 represent satisfied users and score of 1-3 represent not satisfied, prepare a cross table for:
      (i) Satisfaction level vs. education
      (ii) Satisfaction level vs. sex
      (iii) Satisfaction level vs. salary (respondents needs to be classified as per classification defined in part (a))

(iv) Satisfaction level vs. Age (where age is to be recoded as : below 25 as Young, 25 to 35 as Not so Young, 35 to 50 Not so Old and above 50 as Old)

(v) Satisfaction level vs. Age vs. ISP

(vi) Satisfaction Level vs. Qualification vs. ISP Used at

(h) Export the output to word file.

2. Copy the café.xls data sheet from the book website to solve the following questions. This data file consists of responses from 100 respondents about the management of cyber cafes in Delhi.

(a) Transfer the data from Excel file to SPSS

(b) Coding scheme used to capture the data is defined in the enclosed sheet. Use the coding scheme to define the variable properties, value labels, and missing codes.

(c) Recode the age variable as per the following scheme

Upto 21	Student
22 to 30	Professional
31 onwards	Matured Professional

(d) Recode the Income variable as per the following scheme:

Upto 19,999	Low
20,000 to 49,000	Average
50,000 onwards	High

(e) Identify the Profile of Internet Users accessing through Cyber café

(i) Male Vs. Female

(ii) Single Vs Married

(iii) Students Vs. Professionals Vs. Matured Professionals

(iv) Low Income Vs. Average Vs. High Income

(v) Education Profile

(vi) Profession Profile

(f) Identify the reasons for accessing Internet from Cyber Café

(g) Identify the major applications for which user access Internet from Cyber Café.

(h) On an average how frequently user access Internet through Cyber café

(i) Compute the Frequency for the applications of Internet.

(j) Prepare Cross Tables for:

(i) Behavior of Café Owner Vs. Age

(ii) Behavior of Café Owner Vs. Profession

(iii) Behavior of Café Owner Vs. Education

(iv) Behavior of Café Owner Vs. Age Vs. Profession Vs. Education

APPLICATION EXERCISES

1. Refer the Case-2 of Chapter 6 and solve the same case using SPSS.
2. Using the bank.sav data file, Recode the **AGE** variable into a new variable called agegrp, into 3 groups where **AGE** is 30, or less, between 30 to 45 and, where **AGE** is over 45. Label the new variable's values. Draw a pie-chart of this new variable.

3. Using the bank.sav data file, find the Maximum and Minimum Salary and redefine the salary into a new variable NSalary. The NSalary variable will have five groups as follows:

Category	*Salary Band*
Worst Salary	0 to 20000
Average Salary	20001 to 40000
Good Salary	40001 to 70000
Best Salary	70001 to Maximum

Gender code	*Gender*
1	Male
2	Female
99	Missing

Job Category Code	*Job Category*
1	Trainees
2	Clerical Grade
3	Officers

(a) Crosstab the NSalary variables against the Gender variable to look at the Gender composition of the best paid group compared to the worst paid.

4. Using the bank.sav data file, compare the average beginning and current salaries between male and female employees only for the clerical grades.
5. Produce a pie chart to show the gender composition of the office trainee grades only. Calculate mean current salary and education level for each gender group of the trainees.
6. For those in ageGRP = 31, compute a new variable INC which is the difference between their initial salary and their current salary. And calculate the average increase for each gender combination using the Means procedure.
7. Produce a Crosstabs table of AGEGRP against JOBCAT for those in the two youngest age groups.

GROUP PROJECTS

1. Search the Internet and try to find the add-in tools available for decision-making using SPSS. Describe each one of these tools with problems and solutions.
2. The number of decision tools like decision tree, decision tables and OLAP techniques are quite prevalent among the decision-makers. The SPSS supports most of these decision tools. Search your library and also the Internet to write a report—how one can use these tools and techniques for effective decision-making using SPSS.

Caselets

1. Students Management System

What makes a college student stay in school? Over the years, educators have held a lot of theories – from student demographics to attendance in college prep courses – but they've lacked the hard data to prove conclusively what really drives retention. As a result, colleges and universities have struggled to understand how to lower drop-out rates and keep students on track all the way to graduation.

That situation started changing in this American University, which is serving 70,000 distance learners from across the globe when they started using the SPSS predictive analytics.

As an online university, it has a rich store of student information available for analysis. All of the activities are technology-mediated, so a very good record of what goes on with the student is maintained. One can pull demographic data, registration data, course level data, and much more. For example, one can look at the last time a student logged into the online system after starting a class. If too many days have passed, it may indicate that the student is about to drop out. The educators at the university combine such online activity data with a sophisticated end-of-course survey to build a complete model of student satisfaction and retention.

For the first time, the university used a statistical model that can show, based upon data, which students are most susceptible to attrition. Before the university started using SPSS analytics, they were just guessing from among hundreds of variables and trying to put them together by hand. It turns out that the student's sense of being part of a larger community – his or her "social presence" – is one of the key variables affecting the student's likelihood of staying in school. Another one is the student's perception of the effectiveness of online learning.

Some of the findings generated by its predictive models actually came as a surprise. For example, it had long been assumed that gender and ethnicity were good predictors of attrition, but the models proved otherwise. The next step for the university is to put its new found predictive intelligence to work. Already the university is building online "dashboards" that are putting predictive analytics into the hands of deans and other administrators, who can design and implement strategies for boosting retention. The specific action plans could include targeting individual at-risk students with special communications and counseling.

While predictive modeling gives university an accurate picture of the forces driving student attrition, tackling the problem means deciding among an array of possible intervention strategies. In order to help administrators sort out the options, university plans to implement the SPSS Decision Management, a solution that turns Modeler's predictive power into intelligent, data-driven decisions. The solution will draw from Modeler's analysis of at-risk students and suggest the best intervention strategies for any given budget.

Questions for Discussion

1. What are the other kinds of analysis the university can carry out using the SPSS?
2. What are some of the limiting factors of using the SPSS for such kind of predictions?

2. Insurance Management System

PICA Inc is a provider of personal automobile insurance with an emphasis on nonstandard auto insurance. The nonstandard auto insurance provides coverage to drivers, who because of their driving record, age, or vehicle type, represent higher than normal risks and pay higher rates for coverage. PICA distributes its products primarily through the Web and a network of independent agencies.

Because PICA insures drivers, who have higher incidences of accidents and claims, its profitability is

highly dependent on its ability to identify fraudulent claims. It also needs to both maximise and accelerate the collection of subrogation payments, which are sought when a claim is the responsibility — or partial responsibility — of a driver who is not a policy holder.

Couple of years ago, PICA began looking for ways to automate the workflows and data gathering related to fraudulent and subrogated claims. The identification of potentially fraudulent claims was the responsibility of claims adjusters, who had varying degrees of training and used inconsistent practices. As a result, data related to potentially fraudulent claims was typically not gathered rapidly, or completely enough. The speed of investigation and the early gathering of key, data are both important for claims investigators. The prompt initiation of fraud investigation tends to reduce factors that inflate the values of fraudulent claims, such as the number of injured parties and the extent of their injuries.

PICA began looking for a solution that would enable the company to more rapidly identify and investigate suspicious claims. PICA also wanted to be able to identify unsuspicious claims so that they could be handled rapidly in order to improve customer satisfaction. After evaluating number of solutions, company chooses the SPSS solution for a number of reasons including:

- SPSS could be deployed on an on-premise basis, and they can maintain sole ownership of both the deployment and the underlying data.
- The SPSS platform could be expanded beyond claims management and could also be used for other insurance-specific functions including predictive models for pricing strategies, marketing strategies, product and agency management, and customer retention.
- Rules building. The parameters were adjusted in SPSS to match PICA's intended workflows.
- Fine tuning of red flags. The team fine tuned the settings in the SPSS so that claims would be flagged as suspicious based on the geographic markets PICA operates in and the riskier nature of its customer base.
- Testing. Once the rules and the parameters were set, the tool was tested using an old body of claims for which the actual incidence of fraud was known. Based on these results, the tool was further fine tuned for deployment.

Adopting SPSS Predictive Claims enabled PICA to reduce claims payments and accelerate the collection of subrogation payments. The key benefits from the solution include:

- Accelerated payment collection.
- Reduced cost of claims payments.

Questions for Discussion

1. What is the strategy the company followed in deployment of the solution?
2. What are the best practices being followed by the company?

Answers to Self-Study Questions

1. (b)	2. (a)	3. (b)	4. (d)
5. (c)	6. (c)	7. (a)	8. Recode
9. (b)	10. Linear Regression		

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Section IV

Inter and Intra-organisational Systems

Chapter 9: E-Business Models

Chapter 10: Integrated Enterprise Systems

CASE IV: Enterprise Systems

The emergence of Digital technology has created a far reaching impact on economic markets. Perhaps the most important, will be the increasing use of market mechanisms to solve resource allocation problems; this will be made possible by the role of Internet to transfer information swiftly among large numbers of economic agents. At the same time, e-commerce intermediaries that have emerged to supply information and facilitate trades over time; various forms of auction—such as the 'reverse auction', 'vickery auction', and 'double auction' have become popular. The virtual environment has allowed unprecedented customisation and bundling of products. The organisations that leverage these and other features will be more successful than those that try to replicate traditional business models.

Today's managers have number of options to manage competition and strategic thinking in the era of information economy. Managers need to re-think and create an effective e-commerce strategy. Where organisations do have strategy, they focus on four key areas: technology, branding, service, and market growth. Developing technology just for the sake of developing generally does not pay off—organisations with good e-strategies simply 'pick up' the technology in developing information or marketing strategy. The organisations need to adopt new methods of running business by integrating e-commerce into their business strategy, if they are to exploit information asymmetries and fully leverage relationships with customers and partners. There are three levels of strategic sophistication. At the most basic, individual departments take a lead in developing specific Internet applications; the result is disparate 'island' of e-commerce initiative not tightly tied to business strategy. At level two, companies incorporate e-commerce to support their current business models by integrating across functional departments. To reach the third level, however, a 'breakout' strategy which disrupts the *status quo* is likely to be necessary. Such a change may be too radical for many companies to undertake immediately.

SMARTER SUPPLY CHAIN

The supply chain management is about optimising the overall activities of companies working together to create bundles of goods and services. The aim is to manage and coordinate the whole chain across the value system, from raw material suppliers to end customers. This would help the organisation to develop highly competitive chains. A common view of the chain is as a streamlined pipeline which processes raw materials into finished goods and delivers them to consumers. But this is simple; the reality is a much more complex network. A network of vendors, supplies a company which in turn supports a network of customers, with third-party service providers (such as transport firms), helping to link the companies.

For a business, the objective is to establish a portfolio approach for working with suppliers and customers. It needs to decide with whom to work more closely and how to establish the infrastructure in terms of processes and information systems that will best support the working relationships. The first step is to pose the problem in terms of the 'demand chain'. The demand chain thinking starts from the customer's needs and works backwards replacing narrow focus on transport costs with consideration of how to achieve the 'mass customisation'. This entails even more precise, swift, and efficient delivery of product/service bundles, which in turn places considerable demands on the information systems along the chain. But given good management of the right systems, suppliers should be able to anticipate customer companies' needs and deliver what is needed without the need for ordering. Internet technology—by which suppliers can hook up to customers' intranets at very little cost—can play a big part in this. Such approaches require companies to continuously transform the way they work together. The information systems are important but are best seen as a fast follower of this strategic process rather than as a driver.

The information systems required to support demand chain management necessarily focus on optimising cross company processes. This implies tailored business process re-engineering. The dictates of excellent demand chain management also require 'flawless execution'. Whatever the bundles of goods and services needed by particular customers, they must be supplied flawlessly and efficiently. The schedules for making and delivering goods need to be able to satisfy increasingly the exacting demands, such as shorter delivery times. All of this puts major demands on information systems.

ENTERPRISE SYSTEMS

The information systems also required to coordinate companies with the demand chain require a new and different approach to that required within individual companies. Some managers believe that if they and their suppliers choose the same standard software package, such as SAP they will be able to integrate their information systems. In fact, most of these 'enterprise resource planning' (ERP) systems are focused not on integration of the demand chain but on integration within a company.

The enterprise resource planning systems are packages that enable companies to meet the information needs of all their functions. They are fully integrated across functions and offer a 'process' view of business. But while these systems remove a substantial barrier to process management other measures are needed, such as, changes in styles of leadership and in the organisational structures. There are no quick fixes; process management must always be responsive to the changes in the business environment and the advanced technology available.

If the supplier knows the needs of customers, it does not have to guess or forecast that, nor does it have to wait until these customers place the orders. For example, Intel has been able to work in this way with several of its major customers. If a supplier can work with customers in ways that allow it to use its discretion over when and how much to deliver, major savings can be achieved. But eliminating ordering again requires new processes, supported by new approaches to information systems, in both the customers and suppliers.

Rationalisation in demand chain management is another reason why practices, processes, and information systems need to be tailored to the needs of the marketplace. Most of the global companies strive to set up their manufacturing unit or warehouses in the regional markets to serve their customers more better and more faster. The coordinated scheduling implies some centralisation of that activity. It also implies information linkages, so that actual demands in all areas can be seen quickly and integrated accordingly into the planning.

Important Enterprise IT Tips

ERP

- Target fitment to processes that makes organisation competitive and contribute most to the organisation.
- The flexibility to meet changing business needs.
- Define the scope of the ERP project appropriately, and define the desired benefits.
- Build the champion team and deflect the internal conflicts.
- Define the implementation approach.

SCM

- Understand the complexities of current processes and the needs to change.
- Identify the integration ability with current ERP.
- Identify the level of trace ability and integration options.
- Ability to locate and allocate anything, anywhere, and at any time.

Source: Adapted from DataQuest, 30 April, 2007

INTERNET DISTRIBUTION STRATEGIES

The Internet has become an integral part of best practice demand chain integration. It is important for all type of organisations to seriously assess the potential of Internet and other related technologies in its management of the supply/demand chain. The Internet gives companies an opportunity to boost profits by selling directly to consumers. But before thinking of implement-

ing such a strategy, the CIO should ask themselves three questions. Is there really a new opportunity to implement dis-intermediatory model? Is it possible to do so profitably? And what resources does the intermediary have to defend themselves? In order to see how these questions might be answered in practice, look at air travel and grocery distribution. In the case of air travel, they have bypassed the travel agencies, which take up profitable corporate business that airlines could easily handle directly—and which they can easily target, given all the customer information they have. But matters are less straightforward in the grocery distribution channel. The retailers hold detailed information about customers that manufacturers lack and until e-shopping is established can retaliate against competitive manufacturers by not cooperating in promotion. Ultimately, the online grocery shopping may come from companies over which retailers currently have no power, such as Internet service providers.

Like all innovations in distribution the Internet can disrupt businesses as readily as it can transform them. The different industries—and different companies within the same industry—have been affected in different ways. Just as television, and later home video extended the film industry's distribution channels, similarly the Internet looks to be expanding the market for retail investment brokers. The travel agents, on the other hand, are suffering as airlines reach out directly to the consumers. The cannibalisation is a danger—but history suggests that most companies cling to declining distribution network far too long.

The role of management in developing new information systems is to support the demand chain. The managers need to see information systems as a 'fast follower', not the leader of their efforts. It is a serious mistake to believe that demand chain management is about information systems. Rather, it is about new ways of doing business. It is strategic, it requires choices, and the change management issues must not be underestimated.

Questions to Think About

1. Identify the Indian manufacturing organisations who have implemented the smarter supply chain. What are the benefits these organisations have achieved? Have they followed the intermediation or dis-intermediation models?
2. What are the different Internet distribution strategies that are being adopted by some of the Indian retailers?

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Chapter 9

E-Business Models

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What is e-commerce and e-business?
- Why organisations need to develop e-business models?
- What are different e-business models?
- What are different e-business technologies?
- How secure is the technology?
- What are the legal complexities of e-business models?

INTRODUCTION

The Internet was hyped as a revolutionary tool of the twentieth century like the telephone and television. Today, Internet has virtually become a household name in India. In a short span of time, the Internet and World Wide Web has been viewed as the most vital medium for information, entertainment, communication, and commerce. No wonder that the Internet has become a necessity for every one. With the proliferation of Internet, the e-commerce and e-business concepts have expanded. Therefore, a boost in the expansion of the Internet in the country will not only help countries to become a vital player of the emerging global economy, but will also enable the citizens of the country to avail the benefits associated with the web technologies.

Over the years, Internet has reached to the lower strata of the society and to the smaller cities as well. Initially Internet was restricted to the homes of the rich class, but with the falling of PC prices and telecommunication rates, Internet has found its way to the middle income class as well. Internet has added a new channel for many businesses to reach out to their customers, suppliers, and business partners. With this, customers and organisations are doing business transactions over the Internet medium. For the new generation or the tomorrow's customer, it has become the

first search stop. It is more important for all kinds of businesses to be on this medium. If these businesses do not appear in the search results of their prospective customers, it simply means they do not exist for them. In this competitive environment, businesses cannot afford to loose a single customer.

In the emerging global economy, e-commerce and e-business have increasingly become a necessary component of business strategy and a strong catalyst for the economic development. The integration of Information and Communication Technology (ICT) in business has revolutionised relationships within organisations and those between and among organisations and individual customers. Specifically, the use of ICT in business has enhanced productivity, encouraged greater customer participation, and enabled mass customisation, besides reducing costs to a great extent.

With developments in the Internet and mobile based technologies, distinctions between traditional markets and the global electronic marketplace are gradually being squeezed. The name of the game is strategic positioning, the ability of a company to determine emerging opportunities and utilise the necessary human capital skills, such as intellectual resources to make the most of these opportunities through an e-business strategy that is simple, workable, and practicable within the context of a global information and new economic environment. With its effect of leveling the playing field, e-commerce coupled with the appropriate strategy and policy approach enables small and medium scale enterprises to compete with large and capital rich businesses.

The methods of conducting business have changed since the inception of business communities. This change happened with the growth and integration of ICT into businesses. Today's business enterprises are in the process of major transformation in order to meet the challenges of network economy. We are all living in a period of profound change and transformation of the shape of society and its underlying our economic base. All economies, however simple, are based on Information and Communication Technology (ICT) based business models, but the degree of incorporation of technology into economic activity may differ. The customers have started doing banking transactions over the Internet, booking tickets, planning tours, buying products, getting after sales support, and many more. All this happened when organisations started implementing e-business technologies into their businesses.

It is recognised that in the Information age, Internet commerce is a powerful tool in the economic growth of businesses. While there are indications of e-business patronage by large firms, simultaneously there are changes taking place as more and more small and medium enterprises are also starting to use this concept. The e-business promises better business for organisations and sustainable economic development for countries.

CONCEPTS OF E-BUSINESS AND E-COMMERCE

Many different concepts exist about e-business. In simple words, e-business is a method of doing business using technology. People tend to mix up the two terms e-commerce and e-business. Some tend to use these two terms interchangeably also, but at the core the two are different.

E-Commerce vs E-Business	
Electronic commerce (E-commerce) can be defined as any business transaction conducted using electronic means.	E-business does not mean only buying or selling products online, but also leads to significant changes in the way products are customised, distributed and exchanged, and the way consumers search and bargain for the products, and services and consume them.
E-commerce is the use of electronic communications and digital information processing technology in business transactions to create, transform, and redefine relationships for value creation between or among organisations, and between organisations and individuals.	E-business revolution has its effects on processes. It is a 'dynamic trade' which provides the ability to satisfy current demand with customised response.
E-commerce is usually associated with buying and selling over the Internet, or through new media including mobile.	E-business, refers to the integration of tool and techniques based on ICT to improve the functioning in order to create value for the organisation, its customers, its employees, and its business partners.

The customer focused process allows the organisation to understand the customer and customer needs better. This will allow the organisation to customise its offering to each customer and also helps the customer to complete the buying cycle seamlessly. The production process will help organisations to streamline its production facilities as per the customised offerings. This would include procurement, ordering and replenishment of stocks; processing of payments; electronic networking with suppliers; and production control processes. The employee management process would include better management of employee resources for the growth of the organisation. This would include employee services, training, compensation management, workgroup communication, tele/video-conferencing, and recruiting. This imperative integration of electronic applications enhances information flow between various functional areas like production and sales forces to improve sales force productivity. The workgroup communications and electronic publishing of internal business information are likewise made more efficient.

The e-business is about enhancement of the customer, production, and employee processes using the power of new media technologies like Internet and Mobile.

There are three relationships that exist between e-commerce and e-business. Firstly, e-commerce is a subset of e-business; second, e-commerce is same as e-business and third, there is some degree of overlap between the two. Irrespective of this fact, both are part of the Internet economy.

The Internet economy pertains to all economic activities using electronic network as a medium for commerce or those activities involved in both building the network linked to the Internet and the purchase of application services such as the provision of enabling hardware and software and network equipment for Web based business transactions. **It is made up of three major segments: physical (ICT) infrastructure, business infrastructure, and commerce.**

The *e-business concept* describes the rationale of the business that will help in earning revenue, given its goals and vision, and products offerings. A successful model is based on a market opportunity analysis that will help in identifying customer's expectations and needs. The e-business concept should be based on goals and objectives of the organisation. In order to achieve these goals and objectives the organisation would prepare a **business plan** process if it's a start-up organisations, otherwise the **implementation plan** is required to be considering. While looking at the business model, it is sufficient to know what the goals and objectives are, and whether they are being pursued. So the e-business are primarily addresses inter-organisational activities, while supporting internal operations, processes, and systems.

GOALS OF E-BUSINESS

The goal of any e-business solution is to create value, which can be created in the following manner.

Increasing Profitability

The e-business helps in reducing the production costs by:

- Expanding the marketplace to global markets
- Reducing the cost of creating, processing, storing, and disseminating information
- Allowing reduced inventories and overhead by facilitating 'pull' type supply chain management
- Reducing the time between the outlay of capital and the receipt of products and services
- Developing better supplier relationship
- Increasing the quality of products or services
- Reaching out to new customers
- Better customer relationship leading to increasing customer loyalty
- Increasing the efficiency of internal functioning

Increasing Customer Satisfaction

It helps in providing customised products and services leading to customer satisfaction. It also helps in providing real-time connectivity to its customers and suppliers.

- Enables customers to shop or do other transactions 24 hours a day, all year round from almost any location.
- Offering cost effective products and services to customers to their satisfaction.
- Allows quick delivery of products and services in some cases, especially with digitised products.
- Makes it possible to participate in virtual auctions.
- Allows customers to interact with others to share their experience and exchange notes.

Increasing Employee Motivation

The e-business helps in interconnecting employees and providing transparent work environment by sharing overall organisation strategy, policies, and culture. It also helps in promoting team work between local and dispersed group of employees.

Improving Supplier Relationships

Helps in building strong relationships with suppliers, distributors, retailers, and other business partners. It also helps in creating just-in time manufacturing process by sharing customer orders and also other resources.

CHARACTERISTICS OF E-BUSINESS

The e-business has multiple characteristics, which makes the concept different from the traditional methods of doing the business. It adds lot of flexibility and adaptability to the business framework, which forces many organisations to integrate e-business into their business strategies.

1. The basic technological framework used for e-business is Internet, which is available across the globe on 365 × 24 × 7 model.
2. The power of Internet offers an opportunity to e-business organisations to extend their market across the globe, which can be accessed at any time from anywhere. This helps in increasing customer value.
3. It follows one global standard that allows seamless connectivity of wide variety of hardware, software, databases, and networks.
4. It allows sharing of all kinds of data—text, numeric, audio, video, and spatial across networks; offers enormous power to organisations to share and analyse any kind of data.
5. It is a medium that is interactive, which allows organisations to engage its customers into productive interactions and sometime forces them to complete the transaction.
6. It is a medium that is complete. It allows organisations to target its customers, acquire them by allowing them to complete the transaction, retain them, and move them to higher levels in the business chain.
7. It is a medium that allows customisation/personalisation and tailoring of various offering. This would help organisations in implementing one-to-one marketing.

CATEGORIES OF E-BUSINESS SOLUTIONS

The business organisations have created different categories of e-business solutions to meet their business needs. The major categories of e-business solutions that have been implemented by the different organisations worldwide are: Business-to-Business (B2B); Business-to-Consumer (B2C); Consumer-to-Consumer (C2C), and Consumer-to-Business (C2B). Other than these four, there are some more categories that are commonly used by businesses like Business-to-Government (B2G); Business-to-Employee (B2E); Government-to-Business (G2B); Peer-to-

Peer (P2P); and Mobile commerce (M-commerce). If one tries to do detailed study of all the categories, one will find most of the B2G and G2B are similar to B2B or may be same; B2E is similar to B2C and P2P is similar to C2C. Each of these is briefly explained below:

Business-to-Business (B2B)

The Business-to-Business (B2B) e-business deals with relationships between and among businesses. More than 80 per cent of e-business is of this type, and most experts predict that B2B will continue to grow faster than the B2C segment. The B2B e-business is being driven from two sides which is one from the business side who wants to take advantage of these technologies and other from the service provider perspective. The business organisations are looking at this technological concept to develop better and effective methods of working with their business partners on either side of the supply chain. This would help business organisations to develop better relationships with their suppliers, distributors, retailers, and business partners.

The Business-to-Business (B2B) means a commercial relationship between businesses using e-busines concepts. In this, business is originated by the business (organisation) and selling is to the business (organisation).

Dell implemented a strong B2B e-business model to manage its suppliers on both sides of the supply chain. The more common B2B examples and best practice models are IBM, Hewlett Packard (HP), Cisco, and Dell. Cisco, for instance, receives over 90 per cent of its product orders over the Internet. Most common B2B applications are in the areas of supply chain management, inventory management, distribution management, channel management, and online payment management.

The other drivers of B2B e-business are the product and service providers. They keep developing new ideas and concepts for the business organisations to implement and take advantage. Some of these service providers created very powerful B2B models, but most did not see the light of day, as business organisations never bought those ideas. Most popular B2B models were e-marketplaces, and e-exchanges, but in reality most of the actual use is at a lower level in the e-business implementation cycle. All this happened because there is confusion and managers are not very clear about how to define these and, more importantly, how to implement. The popular models that are being used by organisations and/or at least being considered are e-procurement and e-distributors.

B2B e-Business Helps Organisations to

- Target, attract, develop, retain, and expand relationships with its customers.
- Develop effective and efficient supply chain both at upstream and downstream levels.
- It also helps organisations in streamlining its internal supply chain, which is a very important factor for success and failure of e-business models.
- Automate procurement process, implement just-in-time manufacturing, zero inventory systems.

- Automate organisational processes to deliver the right products and services to customers at the right time and right place while managing the cost effectively.
- Collect, store, process, and disseminate information about business transactions and company operations in a more transparent manner to help decision-makers to make better and more informed decisions.
- Manage transaction costs. The B2B helps in reducing search costs, as buyer organisations can directly search for information about suppliers, products, and prices without going through intermediaries.
- It improves efficiency, as effort, time, and money spent, is much less on Internet medium as compared to the traditional channel. It also helps in reducing the transaction processing costs, as B2B allows for the complete automation of transaction processes. Online processing improves inventory management and logistics.
- The B2B models creates opportunity for manufacturers to interact and transact directly with buyers, thereby eliminating intermediaries like distributors and retailers. However, there are many examples where while implementing e-business models manufacturers have introduced intermediaries to attract more customers. One can also consider all e-market or e-distributor models as intermediaries models as they serve suppliers and buyers in the supply chain.
- The rapid growth of B2B models creates traditional supply side economies of scale. Furthermore, the bringing together of a significant number of buyers and sellers provides the demand-side economies of scale or network effects. Each additional incremental participant in the e-market creates value for all participants in the demand side.

IndiaMart.com: Testing Different Shores

Story of Dinesh Agarwal *reflects on how his risk-taking spirit and vision enabled his success as an internet technology entrepreneur*

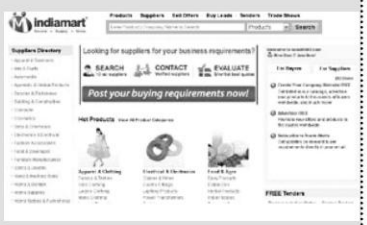
"Finding a day when you are remotely aware of the hustle and bustle of activities around you is quite difficult these days. I was lucky to find one when I found myself drifting to the days gone by. I clearly remember the decision to move away from the family-run business. It meant proving my own footing in whatever I pursued. My employment with DOT Alcatel Research Center and HCL America as a network consultant, prior to starting my own company, provided just the right platform and helped me create my own identity.

While working as a network consultant in the US, I sensed a lot of potential in internet, which was fast taking over business space. Already churning the wheels of developed countries in motion, internet was emerging as a necessity in the business world. India was also getting a taste of this technology, and this gave me the idea of testing the shores of entrepreneurship.

I realised mixing internet technology with the large base of MSMEs, who were biggest contributors of growth in India, could possibly turn the tides in their favour and help them draw huge benefits from it. Exposing them to the online medium could propel them to the next level of growth and in turn also benefit the Indian economy.

The entrepreneurship does not merely mean pursuing an idea, it is all about passion and perseverance to succeed. It was the same passion that pushed me to leave US and return to India to give shape to the idea and realise my dream. With my familys support I started planning the launch of my own company.

The launch was not as smooth as I thought it to be. As unique to every start-up, we too faced our own set of challenges. Since in 1996 there were only 500 subscribers of internet in India, therefore, we realised there was a lot of groundwork to be done. This was a clear indication of the challenges that lay ahead. We pulled up our sleeves to begin with the education of MSMEs and create enough awareness to bring them online. It proved difficult but we were able to conquer every obstacle with continued efforts and lan.



We were raring to go and our confidence paved a successful path in the online space. The success became even sweeter when we realised that while we were cruising through the online market, other internet based companies were finding it difficult to create a foothold in it.

For the last 15 years, we have been growing from strength to strength. Initially starting out as a website making company, we created a complete B2B marketplace. Over the years, we also ventured into offering innovative services such as providing a business verification service called 'TrustSEAL'. The service bridges the trust gap between buyers and suppliers online and also helps build confidence in online business transactions. With a view to encourage SMEs to easily move onto online services, we provide free registration on our website.

Bringing a pool of information on tenders under one roof, we introduced an exclusive portal on IndiaMART.comwww.tenders.indiamart.com that allows free access to tender information. This portal allows easy navigation and provides location-wise, industry-wise, and authority-wise search to help users find relevant tenders free of cost.

Apart from this, IndiaMART.com has been participating in several industry-specific domestic and international trade shows to facilitate B2B matchmaking for SMEs. It has gone a long way in introducing SMEs to technological innovations and business developments around the globe.

In these years, we have been conducting seminars and conferences in conjunction with trade bodies such as IAMAI, ASSOCHAM, etc, to strengthen the status of SMEs in the economy. The objective has been to place SMEs in the mainstream and make ICT an integral part of their business operations.

We also braved the grave situation of economic slowdown and worked towards profit successfully. This also boosted the confidence of Intel Capital and BCCL in our business model who became our investors. What worked in our favor was the belief we showcased in the idea and our commitment to execute the same to the best of our ability. Today, we are counted among the top online B2B marketplaces in the world. Also, the company offers a platform and tools to over 1 mn suppliers to generate business leads from over 5 mn buyers, who use the platform to find reliable and competitive suppliers. IndiaMART.com also has over 4,000 employees located across 75 offices in the country.

Its products enable small and medium size businesses generate business leads (online catalogs/store-fronts), establish their credibility (third party verified trust profile), and use business information (finance, news, trade shows, tenders) for their business promotion.

Our understanding of SMEs all these years also prompted us to bring due recognition to them through IndiaMART 'Leaders of Tomorrow Awards,' an initiative in conjunction with a leading business news channel. The objective of these awards is to acknowledge most deserving and emerging leaders in the Indian SME space. In fact, this year we have received over 50,000 nominations for the awards.

It has been a roller-coaster ride for us that was full of learning. I have thoroughly enjoyed my journey so far and look forward to many such years ahead."

Source: *Dataquest*, October 15, 2011

Business-to-Consumer (B2C)

The Business-to-Consumer (B2C) e-business is the one in which business organisations attempt to build relationships with its customers. This is the second most popular model of e-business after B2B. Each individual customer who has an access to internet has tried doing some transaction online. There are number of B2C models exists, but B2C is more popularly being used by customers for gathering information, buying products, or services like tickets, hotel bookings, banking transactions, etc. It is also known as e-retailing or e-tailing as it tries to replicate the retailing model of traditional space.

The Business-to-Consumer (B2C) means a relationship between a business and consumer. This is also referred as e-tailing or e-commerce. In this, business is originated by the business (organisation) and selling is to the consumer.

Some of the popular examples of B2C are Amazon.com, Barnes and Nobel, IRCTC.com, Makemytrip.com, and other travel websites, and bank websites.

B2C e-business helps organisations in the following:

- Reducing transactions costs particularly the search costs.
- Increasing customer access to information.
- Allowing customer to find and compare the most competitive price for a product or service.
- Lowering the market entry barriers since the cost of creating and maintaining the online e-business site is much less as compared to creating and establishing the 'brick-and-mortar' retail outlet.

In the case of information goods, B2C e-business is even more attractive because it saves organisations from factoring in the additional cost of a physical distribution network. Moreover, for countries with a growing and robust Internet and mobile population, delivering information goods becomes increasingly feasible. The B2C service providers have developed different models to reach out to customers and serve them better. Some of the popular ones are portals, brokers, content providers, and retailers.

Consumer-to-Consumer (C2C)

The Consumer-to-Consumer (C2C) e-business models means providing interface to customers to buy/sell to customers. It is an old concept re-packaged using technology. It is also known as Peer-to-Peer (P2P) where two or more users of the same or different network can share resources. **One of the best and popular examples of C2C is e-bay, which allows customers to buy/sell their products from/to other customers**. In C2C e-business models the customer prepares the product for market, places the product for auction or sale, and relies on the market maker to provide catalogue, search engine, and transaction clearing capabilities so that products can be easily displayed, discovered and paid for. The complete trading infrastructure is being provided by the intermediary.

The Consumer-to-Consumer (C2C) means a relationship between two or more consumers. This is also referred as peer to peer (P2P). In this, business is originated by the consumer and is sold to the consumer.

This type of e-commerce comes in at least three forms:

- Auctions facilitated at a portal, such as eBay, which allows online real-time bidding on items being sold on the Web;
- Peer-to-Peer systems, such as the Napster model and other file exchange and later money exchange models; and
- Classified ads at portal sites such as Excite Classifieds on interactive, online marketplace where buyers and sellers can negotiate and which features 'Buyer Leads and Want Ads'.

In Peer-to-Peer (P2P) based models, technology enables Internet users to share files and computer resources directly without having to go through a central Web server. In purest P2P form, no intermediary is required, although in reality, most P2P networks make use of intermediary 'super servers' to speed operations. Some of the most common examples of P2P are Napster, Kaza, BitTorrent, and eDonkey. One may find lot of illegal data movement taking place on P2P kind of solutions. The business models that support P2P E-business are unusual, while in many cases illegal, and under constant attack by authorities. Napster, which was established to aid Internet users in finding and sharing online music files, was the most well-known example of P2P E-business until it was put out of business in 2001 by a series of negative court decisions.

Consumer-to-Business (C2B)

In the C2B e-business models, customer originates the business to sell it to the business. The C2B e-business is characterised by the growth of electronic marketplaces, and online auctions, particularly in vertical industries where business organisations can bid for what they want from among multiple suppliers. It perhaps has the greatest potential for developing new markets. The Consumer-to-Business (C2B) transactions involve reverse auctions, which empower the consumer to drive transactions.

The Consumer-to-Business (C2B) means a relationship between consumer and business. In this category of e-business, business is originated by the consumer and selling is to business.

A best example of this model is when competing airlines gives a traveller best travel and ticket offers in response to the traveller's request. One of the most popular examples of the C2B models is Priceline.com, which allowed the airline traveller to bid for ticket between two cities. These customer bids are submitted to partner airlines, which may accept or reject these bids. The model became quite successful with bid acceptance rate of 50 to 60 per cent. Later Priceline added many more services for its customers.

Mobile Commerce

The Mobile Commerce (M-Commerce) is the buying and selling of goods and services through wireless technology. The handheld devices such as cellular telephones and personal digital assistants (PDAs) are the common means adopted. As content delivery over wireless devices becomes faster, more secure, and scalable, some believe that m-commerce will surpass wire

based e-business as the method of choice for digital commerce transactions. The m-commerce involves the use of wireless devices like mobile phones, hand-held devices, and networks like wire or wireless or mobile. Instead of using computer based Internet connectivity, it uses the mobile based Internet connectivity. Once connected, the user can conduct the business transaction in the same manner as it does using the computers. Since the penetration of mobile technology is increasing faster as compared to computer penetration, the m-commerce has become quite popular among users who are more on the move.

The Mobile Commerce (M-Commerce) means the use of wireless digital devices to conduct business transaction over the web.

The m-commerce is quite popular in financial services including mobile banking. Customers are using their mobile phones to access their accounts and pay their bills. The customer is also using this facility for utility services, information services, and entertainment.

BUILDING E-BUSINESS MODELS

The e-business model is like any business model, which describes how an organisation functions, how it offer its products or services, how it generates revenue, and how it will create and adapt to new markets and technologies. It has five traditional components; market opportunity analysis, value proposition, online strategy, resource management, and sources of revenue. A business model is not always the same as a business strategy although in some cases they are very close. In this, the business model explicitly takes into account the competitive environment and is at the centre of the business plan.

Market Opportunity Analysis

The market opportunity analysis allows the organisation to define how an organisation's product or service fulfils the needs of customers. In order to find the opportunity in the market, one may try to find answers to:

- Why will customers choose to do business with the organisation instead of another?
- What will the organisation provide that others do not or cannot?

The market opportunity analysis is a prime tool to determine attractiveness and probability of success in the growing market.

Once the above questions are answered, then, analyse the technology environment which might reveal the readiness of the particular technology, as well as any alternative technologies, on which the manager anticipates deploying the organisational offerings. Also, analyse the organisational environment that may provide the current state of the organisations resources. And analyse the competitor environment which might reveal the structure of the industry and market, key competitors in the marketplace, and the relative organisational advantage to each of the key players.

The complete framework of Market Opportunity Analysis is defined in following steps:

1. **Identify unfulfilled and/or underserved needs of a customer:** One may analyse the customer environment to find unfulfilled or under served customer needs, as well as the

market they occupy. The unfulfilled needs are those that are not serviced by existing competitors and under served needs are those that are not fully met by the competitors. In order to identify the unfulfilled and under served needs of the customers, one may need to study the customer buying process and identify the gaps.

2. **Identify the customer that the organisation intends to purse:** This is possible by doing the segmentation analysis. One may do the segmentation analysis on various standard parameters like demographic, firmographics, geographic and psychographics. This market segmentation allows the organisation to
   - Understand the different behavioural patterns and decision-making processes of different group of consumers
   - Select the most attractive segments or customers the organisation should target
   - Develop a strategy to target the selected segments based on their behaviour
3. **Evaluate competitor profile with respect to direct and indirect competitors:** The direct competitors are the rivals in the same industry or may be in the same product line. Indirect competitors are those who offer substitute or adjacent products. The competitor profiling would assess competitive intensity, an organisation needs to map the competitors to the target segments; it will help the organisation to separate the under served areas from the competitive areas; helps in identifying the organisations with whom it will compete and also identify the organisation with whom it can collaborate.
4. **Defining the resources and technology needed to deliver the benefits:** The resources required delivering the benefits of the offering, and assessing whether they are available or can be created in the company or can be provided through business partnerships. The resource system is a discrete collection of individual and organisational activities and assets when taken together create organisational capabilities that allow the organisation to serve customer needs.
5. **Analyse the technology environment:** This might reveal the readiness of the particular technology, as well as any alternative technologies, on which the manager anticipates deploying the offering.

Value Proposition

The definition of the *value proposition* is the result of a combination of choices about the customers, the benefits offered and the unique capabilities of the organisation. The value proposition is a business offering summarises why a consumer should buy a product or service. With a value proposition, the organisation attempts to offer better value than competitors so that the customer will benefit. The value offered need not be always considered in terms of price, but may include better service, better quality, better packaging, convenience, efficiency, and much more.

The value proposition describes the value that the organisation will provide to its customers and, sometimes, to others as well.

Adding value in an e-business model may follow the same approach as adding value in any business, although it may require different skills and capabilities. Common to both are the

customers who seek out value in a business transaction. The integration of internal and external systems can provide value for both customers and the organisation. The internal integration may allow the organisation to manage activities like order processing, production management, and order fulfillment, etc. The external integration helps the organisation in building effective supply chain management, which allow digital exchange of information. The implementation of supply chain transactions helps in effective management of the resources of all the chain partners, which can be planned and managed for an efficient operation. For creation of value one may address the following issues:

- What is the degree of asymmetric information between buyers & sellers that trap values?
- What is the amount of time & resources required to bring people together to make a transaction or complete a task?
- Why customers will prefer to do business transaction with the organisation instead of the competitor?
- What is the target segment that the organisation should focus on?
- Identify the combination of customer benefits that the organisation is intending to offer.
- What makes the organisation and its partners better positioned to deliver the product or service offering than anyone else in that market?

There can be multiple type of value models that the organisation can create for its customers. Some of them are:

- **Trapped value:** The value that is hidden, for example, efficiency, accessibility, customer empowerment etc.
- **New value:** The value that is new to the organisations, for example, personalisation, extension, community-building, collaboration etc.
- **Horizontal plays:** It expands the offering to improve functional operations.
- **Vertical plays:** It expand the operation to improve industry specific business activities.

From the customers viewpoint it may be the customisation or personalisation of the offering, reduction in product search cost, an online experience, product cost, or may be the faster and effective delivery of the product and service.

For example, a local fresh flower company by deciding to implement e-business model, may create the value proposition as 'Organisation serves the special occasion segment by providing fresh flowers and unique complementary gifts'. They created this after identifying the special occasion needs as their target segment group and thought of offering fresh flowers with complementary gifts at lowest possible price as the key benefits to their customers. The uniqueness of the model is the online experience anywhere anytime.

Online Strategy

The next stage in the e-business model is defining the online strategy. As part of the online strategy, one needs to decide on the online product, services or information offering. Defining the online offering requires organisations to identify the scope of offering; identify the customer

decision process, and also to map the offering to the customer buying process. All these tasks need to be performed in a sequential manner. The basic objective of formulating the online strategy is to identify the activities or tasks that need to be performed in the online space and the activities or tasks to be performed in the offline space using traditional infrastructure.

The online strategy defines the clear scope of the offering in terms of products, services, or information keeping the customer segment in mind.

On the basis of market opportunity analysis, one tries to understand the customer buying process and map the scope of offering on the customer buying process. In order to do so, one needs to answer the following issues:

- Identify the occasions that trigger the need for the product/service or information.
- Identify the tactics that can be used to stimulate demand.
- Identify the information that the customer would need to make a selection.
- Identify the key evaluation criteria that the customer would use to evaluate the product/service.
- Identify the information that the website should display and offer to the customer to make comfortable decision as per the evaluation criteria.
- Identify the functionality that the website should display to communicate security, trust, and privacy.
- Identify the after sales services that can be offered to the customer through the website to create customer loyalty.

Resource Management

This helps in identifying various types of resources that the organisation would need to perform various activities. An organisation requires several tangible and intangible resources. The human resources are in particular the skills and knowledge of employees that are required to manage the e-business operations. The tangible resources include the physical and technology infrastructure required to build and manage the business models. The intangible resources, on the other hand, include intellectual property, business processes that can be patented, brands, customer profiles, and personalisation of data in databases, and customised software. The supporting systems include organisational structure, information systems or communications processes that may have little value as stand-alone resources.

The resources management focuses on how the organisation aligns its resources to deliver the perceived benefits to its customer.

The resources system focus on how the organisation align its resources to deliver the benefits proposed in the value proposition to its customer. There are numbers of activities, which are required to construct a powerful resource system. These activities include:

- Identification of resources on the basis of core benefits identified in the value system.
- Segregating the benefits that the organisation can deliver on its own and the benefits that needs to be delivered in association with other business partners.

The development of resource system helps the organisation to clearly identify the resources that they need to manage and the resources that they need from some of their partners. It also helps in identifying the offline and online resources required by the organisation to deliver the benefits to its customer as per the value proposition.

Sources of Revenue

Depending on the business model, several revenue sources may be available to an e-business organisation. If one studies the existing e-business models, one will find that most of the organisations will have three to four of these revenue sources. A mix of revenue sources is often referred to as a revenue model.

The revenue model describes how the e-business organisation is going to earn revenue and generate profits.

There are many revenue models that exists on the Internet, but some of the most popular ones are:

- **Advertising:** The advertising revenues can be generated by selling online advertisements, site sponsorships or online event management, etc. In this the content provider (or organisation) website provides a platform for the advertiser to advertise for which advertising fee is charged. There are different kinds of advertising models exist on the Internet from banner ads to button ads.
- **Affiliation:** The revenue generated for facilitating the sales transaction to happen on the affiliate site. The organisations that facilitated the transaction receive a referral fee or percentage of the revenue from any resulting sales.
- **Licensing:** The licence fee is generated from the licensing of online content. This model is mostly followed by the content developers and software companies.
- **Sales:** The revenue, which is generated from the sales of products, services or information. This revenue model is more popular with online retailer who sell products and services like Amazon.
- **Subscription:** The revenue, which is generated from the subscription of online information or services. In the subscription model, the content provider website offers its users valuable service or information on subscription basis. This model is more popular with information providers and they charge its user for the updated quality content.

E-BUSINESS MODELS

There are number of business models which have evolved over the period, some of which are specific to B2B, some to B2C and some to other e-business categories. Most of these e-business models actually fit with the business strategy being followed by the organisation. Though we try to classify these e-business models into broader categories, but there is no clear cut process of classification. The basic idea of this section is to sensitize the reader with different models that are prevalent in the market. Some models are quite simple, whereas some are complex. It all depends on how the e-business organisation is generating the revenue.

Some of the major e-business models are discussed in the following paragraphs. The models are implemented in a variety of ways, as described below. Some of the organisations have followed a hybrid approach and combined the different models to achieve the business benefit.

Broker Model

The brokers are third party service providers which bring buyers and sellers together and facilitate transactions. They play an important role in almost all categories of e-business. The broker revenue model is dependent on the commission or broker fee, which may vary from service provider to service provider. The B2B broker model that is prevalent in the market is exchange model, which offers a complete range of services from market identification to fulfillment. The exchanges in this case are independently owned online marketplaces that connect hundreds of suppliers to potentially thousands of buyers in a dynamic real-time environment. The exchanges operates typically in vertical markets in which spot purchases can be made for direct inputs, for example, e-steel.com, clickforsteel.com, and paperexchange.com.

In B2C category, number of transaction broker models exist, which allow the buyer and seller to complete a transaction for which charges are decided on transaction basis. For example, e-bay.com, paypal.com. Priceline.com are the famous broker models, which allow the buyers to bid for a product/service and charges the supplier only on transaction basis.

Auction Brokers

The auction brokers conduct auction for buyer or seller and charge brokerage. There are two types of auctions—forward and reverse auctions. ***In forward auctions, bidders quote in such a way that price line goes upwards***. ***In reverse auctions, bidders similarly quote such that price line goes downwards***. The reverse auctions hold relevance for government procurement and is mainly for purchasing standardised items. The government may use forward auctions for selling the excess items. The auction may be used to select the L1 (lowest) bidder after the technically qualified bidders have been identified. Different types of auctions include English, Dutch, Vickery, and Reverse Auction.

(a) **English auction** is a highest bidder auction.

(b) **Dutch auction** is a lowest bidder auction.

(c) **Vickery auction** is a sealed bid auction in which the item is awarded to the highest bidder, but at the second highest price that was bid.

(d) ***"Name-your-own-price"*** model: This model in which would-be buyers specify the price (and other terms) they are willing to pay to any willing seller; a C2B model, pioneered by Priceline.com

(e) **Reverse auction:** *The* ***auction in which the buyer places an item for bid (*****tender*****) on a request for quote (RFQ) system, make potential suppliers bid on real-time, with price reducing sequentially, and the lowest bid wins***; used mainly in B2B e-business. It is a type of auction in which the role of the buyer and seller are reversed, with the primary objective to drive purchase prices downward. In an ordinary auction, buyers compete to

obtain a good or service. In a reverse auction, sellers compete to obtain business. The steps followed in reverse auction are as follows:

- A buyer contracts with a Reverse Auction (RA) service provider to help make the necessary preparations to conduct the reverse auction. This includes: finding new suppliers, training new and existing suppliers, organising the auction, managing the auction event, and providing auction data to buyers to facilitate decision making.
- The RA service provider, on behalf of the buyer, issues a request for quotation (RFQ) to purchase a particular item or group of items. At the designated day and time, several suppliers, typically 5–20, log on to the auction site and input several quotes over a pre-defined 30–90 minute time slot. These quotes reflect the prices at which they are willing to supply the requested good or service.
- The quoting performed in real-time via the Internet results in dynamic bidding. This helps achieve rapid downward price pressure that is not normally attainable using traditional static 3 quote paper based bidding processes.
- The prices that buyers obtain in the reverse auction reflect the narrow market which it created at the moment in time when the auction is held. Thus, it is possible that better value—i.e. lower prices, as well as better quality, delivery performance, technical capabilities, etc.—could be obtained from suppliers not engaged in the bidding or by other means such as collaborative cost management and joint process improvement.
- The buyer may award contracts to the supplier who bids the lowest price. Or, a buyer could award contracts to suppliers who bid higher prices depending upon the buyer's specific needs with regards to quality, lead time, capacity, or other value-adding capabilities. However, buyers frequently award contracts to existing (i.e. current) suppliers, even if prices are higher than the lowest bids, because switching costs are zero.

Advertising Models

The web advertising model works in similar manner as the traditional broadcast model works. The e-business organisation creates an e-business model comprising of website and mobile interface. On the website, organisations may also create an advertising space for the advertisers to advertise and charge advertising fee from the advertiser. The advertising model works best when heavy traffic is moving to the website. In order to attract traffic onto the website, organisations create different advertising models like classified banner ads, click based banner ads, pop ups, pop under, intermercials, and portals. The banner ads are the most common method of advertising on the web, where the advertiser pays the fixed advertising fee to the website owner. The click based banner ads are a more effective method of advertising on the web. In click based, there may or may not be any fixed advertising fee, but the website owner charges the advertiser predefined percentage on each click on the advertiser ad. The pop up is the advertisement mechanism in which the ad pops up on the user screen, when the user visits the ad based website. In the pop under advertisement, the ad will be loaded on the user screen but at the back of the current

surfing window. As soon as the user completes its surfing work and closes the window, the ad is shown. The pop under ads are more effective as compared to the pop-ups. The intermercials are animated ads placed at the entry of a site before a user reaches the intended web page. Like the television commercial that appears between two programmes, intermercials also appear between two web pages.

Portal

The portal is a powerful concept to attract more and more number of users on to the website and allowing them to remain there for longer time by providing them with wide variety of services like e-mail, news, games, sports, stocks, calendars, shopping, music, etc. ***The portals are always viewed as one stop solution for all needs or it is also referred as shopping malls of online space***. The portal business model is more of a destination site. They are marketed as places where customers want to start their web search and hopefully stay a long time to read news, find entertainment, and meet and interact with other users. The portals normally do not own the complete content and services. They integrate the necessary services to offer a one stop solution to its users. The portals generate revenue primarily from the advertisers for ad placement, collecting referral fees for steering customers to other sites, and charging for premium services. Yahoo, MSN, Indiatimes, Rediff are some of the popular portal sites. There are two types of portals that exist on the Internet—horizontal portals and vertical portals. The horizontal portals are the one that offer all kinds of products and services like Yahoo, Rediff, etc. The vertical portals sometimes called Vortals provide similar services but are focused around a particular industry or segment. For example, Plasticnet.com offers all information services related to plastic industry users.

Infomediary Models

The infomediaries are information intermediaries that support the buyer and seller with correct and reliable information. Some of the experts refer these service providers as content providers. The content providers are the one that distribute information content in digital form like information, music, video, photos, etc. These infomediaries earn revenue either through periodic subscriptions or follows a transaction based revenue model or follow advertising stream. For example, Harvard publishing or Mckinsey online follow both the revenue streams while selling their content online. Apart from organised information intermediaries there are number of free information providers; these free information providers earn their revenue through the advertising model. With the popularity of e-books, more and more publishing houses are also moving their copyrighted material on the Internet space and adding a new channel for business. Some of the models in this space are of Metamediary, which facilitates transactions between buyers and sellers by providing comprehensive information and additional services, without being involved in the actual sales of goods or services between the parties.

Merchant Models

The merchant models are either retailers or wholesalers driven, where sales transaction between two parties takes place. The sales can be either transaction based or through auction

process. The online retail stores, often called e-tailers, are available in all sizes. The e-tailers either have a global presence or might have a presence in a defined locality. The online retailers are quite similar to retailers in the traditional environment except that the total offering is made online and the customer also has to complete the transaction using online technologies. Other kinds of models that have emerged are 'brick and click' models in this space, where the retailer has a presence in both traditional as well as in the online space. Some of these models are more e-catalogue based and follow payment on delivery or through the online payment. Some of these are created by the manufacturers and are called direct models, as they try to remove the intermediaries, for example, Dell created this kind of direct model.

Community Models

The community model is based on collecting and organising the like-minded users across the globe to interact with each other. The viability of the community model is based on user loyalty. The revenue of these models is based on hybrid revenue generation model like transaction fee based, the sale of ancillary products, and services or voluntary contributions; or revenue may be tied to contextual advertising and subscriptions for premium services. The Internet is inherently suited to community business models and today this is one of the more fertile areas of development, as seen in the rise of social networking. The community model providers create a website where users with similar interests can transact, share interests, information, photos, videos, and communicate with like-minded people. There are number of social networking sites that got developed in the last five years like Facebook, Linkedin, Orkut, Hi5, and MySpace. The value proposition that these community sites provide is to create an easy, convenient, one stop solution where users can focus on their most important concerns and interests, share the experience with friends and acquaintances. Some of these sites also help users to find and develop relations with old friends. There is the Open Source software, which is developed by a global community of programmers who share code openly. Instead of licensing code for a fee, Open Source relies on revenue generated from related services like systems integration, product support, tutorials, and user documentation. Another example of Open source is openly accessible content developed collaboratively by a global community of contributors who work voluntarily, for example, Wikipedia.

E-procurement

The e-procurement is the collaborative term for range of technologies that can be used to automate the procurement process. The e-procurement broadly splits into e-sourcing and e-purchasing and applies to both the internal and external processes associated with strategic sourcing and purchasing. There are number of reasons why an organisation would like to implement e-procurement process. There may be lack of a common public procurement policy; lack of transparency in procurement leading to corruption and pilferage of public money; malpractices by vendors by cartel formation. The e-procurement process is mainly being followed by B2B. Most of the e-procurement service providers are third party vendors and they make money through transaction fees, or on annual licensing fees. They offer buyers a sophisticated set of sourcing

and supply chain management tools that permit buyers to reduce supply chain costs. For example, Ariba and CommerceOne are most popular in this field.

Govt of Assam: Setting Tendering Standards

With the implementation of an online solution, Assam is reaping rich benefits from its e-tendering process

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Challenges

- Inefficiencies attached with the traditional system hampered timely use of funds.
- Huge amount of paperwork involved was difficult to manage.
- Collusion among vendors bidding for contracts left the government with very limited vendor options.

Solution

- Electronic tendering
- Payment gateways
- Digital signature
- Anti collusion security system

Benefits

- Greater transparency
- Overall costs saving
- Access to new vendors
- Reduced tender cycle
- Reduced human error and misuse
- Reduced vendor collusion
- Onsite service and training

Source: *Dataquest*, February 28, 2007, Vol. XXV No. 04

(To read the complete case study visit www.mhhe.com/behl2e)

E-BUSINESS SECURITY ISSUES

The security of an organisation data and servers is of critical importance. It should be noted that fraud and other security threats are nothing new. The basic e-business security issues centre on providing security for communication networks and data that move between networks. There is no lock in the world that cannot be broken. So while implementing security system, one need to evaluate how critical the security is to the success of an organisation. An organisation that is implementing e-business models needs to secure their models from multiple levels of threats—from hackers, insiders, pirates, and thieves. As per strategic research, 83 per cent of data loss is caused by human errors or system failures; 72 per cent of the companies have no recovery plans; 62 per cent of time backup fails because of hardware or media; and 60 per cent of corporate data reside unprotected on PCs. So, it is important for all e-business organisations to protect their

models from intentional or unintentional threats. One of the biggest potential security problems in an e-business is of human, rather than electronic, origin. The technological solutions that are available are strong, but the people who manage these are vulnerable.

There are two broad levels of threats that are common. One is the *network level threat* and the other is the *data level threat*. In a network level threat, one needs to ensure the security of the complete network, including the LANs, WANs, Internet, intranet, and extranets. This will enforce that only the right users or the authorised users are accessing the network. The basic threat is from the hackers who try to hack the network to get unauthorised access. In data level threat, one needs to ensure the security of data when it is on the move from one computer to another. Here, the basic threat is either from the hackers or even from the insiders.

Network Security

There are a large number of potential risks that an e-business faces. Most can be addressed using a best practices approach to security. Most of us have heard of, or have experienced viruses. However, one may not be aware of problems such as denial of service attacks or data spills or other common hacking techniques that the hacker tends to use to get an unauthorised access to the network. It is important to emphasise that while prefect security is not possible, routine security precautions such as secure servers, data encryption, and proper physical network design defeat amateur hackers and many more talented interlopers.

Hacking

The hacking is a technique used by hackers who monitor e-mail, web server access, or file transfers to extract passwords or important access codes or steal network files, or to plant data that will cause a system to welcome intruders. They may use remote services that allow one computer on a network to execute programs on another computer to gain privileged access within a network. The **hacker** is an individual who intends to gain unauthorised access to a computer system, whereas the **Cracker** is the term typically used within the hacking community to denote a hacker with criminal intent. There are three types of hackers:

- White hat hackers are 'good' hackers who help organisations locate and fix security loop holes.
- Black hat hackers are the hackers who act with the intention of causing harm.
- Grey hat hackers are hackers who believe they are pursuing some greater good by breaking in and revealing system flaws.

The hacking means infringement on the privacy of others or damage to computer-based property such as data, websites, and/or softwares.

The following are some of the common techniques that the hackers tend to use.

- **Denial of Service (DOS) Attacks:** The hackers flood the website with useless traffic to intrude and overwhelm the network. Depending on the capacity to process the data, server starts sending DOS messages to its authorised users. The system assets or information become unavailable or are rendered unavailable. The distributed denial of service attack uses number of computers to attack the target network from multiple launch points.

- **Sniffing:** The sniffing is a type of eavesdropping programme that monitors information travelling over a network. The unauthorised party gains access to information by browsing through files or reading communications.
- **Spoofing:** The spoofing is misrepresenting oneself by using fake e-mail addresses or masquerading as someone else. The spurious information is inserted into the system or network by making it appear as if it is from a legitimate entity.
- **Malicious code/Applet (MalWare):** The malicious code or Applets includes a variety of threats such as viruses, worms, Trojan horses, and 'bad applets'. The **Virus** is a computer programme that has the ability to replicate or make copies of it and spread to other files. The **Worm** is designed to spread from computer to computer. The **Trojan horse** appears to be benign, but then does something other than expected.

The corporate networks are built to protect the flow of information passing through them. When these networks are connected to public networks, like the Internet, a safer and more secure intelligent route is to be used to get connectivity. The Figure 9.1 illustrates the basic design for a secure network infrastructure. As one may notice, the infrastructure relies upon layers of devices that serve specific purposes, and provide multiple barriers of security that protect, detect, and respond to network attacks, often in real time.

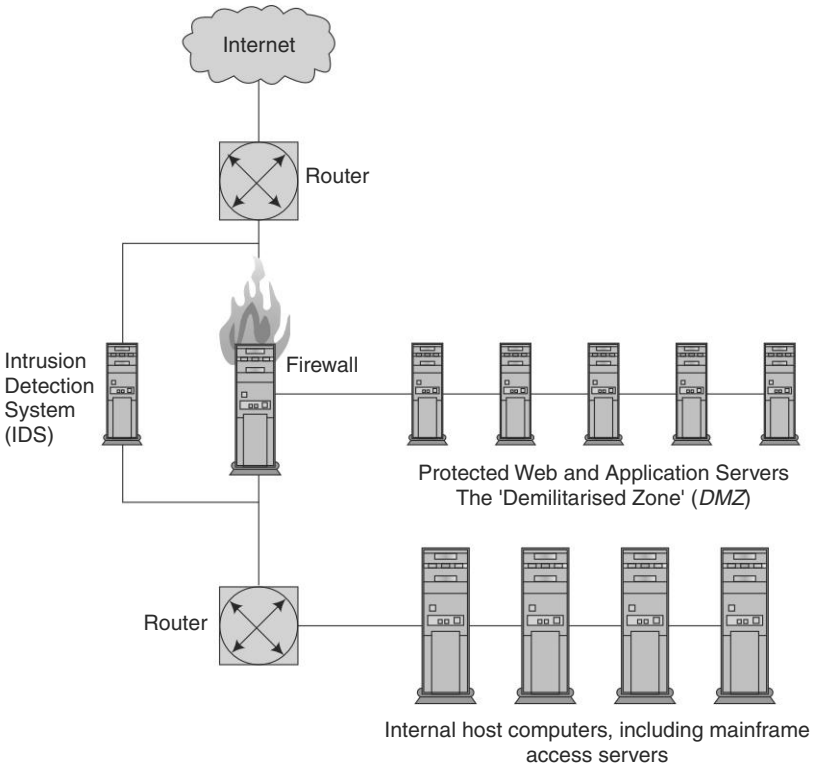

Figure 9.1 A Basic Network Security Model

E-procurement: Some Facts

The reasons for the increasing tendency to switch to e-procurement in recent times are certainly speed and efficiency. But in the government space especially in a democracy no advantages can substitute the need for national security and transparency. In fact, if anything, e-procurement should be better than manual tendering in these aspects of security and transparency.

While changing over to e-tendering/e-procurement, it must be ensured that under the pretext of reengineering, the e-procurement software does not in any way compromise on legal, security, and transparency related aspects of public procurement. Well established practices of manual tendering (especially those relating to security and transparency) should have corresponding electronic equivalents in e-tendering/e-procurement.

There could be many areas of compromise/attempted compromise of security and transparency in an e-procurement process. Here are the most common ways of manipulating the e-procurement process.

1. In most e-procurement systems, the Bid-sealing/Bid-encryption methodology is poor/flawed. Specifically, where PKI is used for bid-encryption, clandestine copies of bids can be stolen through spyware and secretly decrypted before the Online Public Tender Opening Event, resulting in compromise of confidentiality. Similarly, confidentiality can be compromised where the main bid-encryption is done at database level, and only SSL encryption is done during the transit phase from bidders system to the e-procurement portal.
2. In most e-procurement systems, instead of Online Public Tender Opening Event, there is only a rudimentary Online Tender Opening. Merely opening the bids online, and then separately making them available for display to the bidders subsequently, and/or from a different location/screen (*i.e.*, user interface) without the simultaneous online presence of bidders, does not fulfil the requirements of a proper and transparent online public TOE. The transparency related significance of opening bids in public, and carrying out various activities such as countersigning of each opened bid by the TOE officers in the simultaneous presence of the bidders has been given done away with. The e-procurement systems where online TOE is conducted in this non-transparent fashion, without the simultaneous online presence of the bidders, gives rise to the possibility of bid-data tampering.
3. Most e-procurement systems do not have the functionality to accept encrypted (*i.e.*, sealed) detailed bids. Some systems do not encrypt the technical bid at all, *i.e.*, neither the electronic template of the technical bid, nor the detailed technical bid. In such systems, typically only summarised financial data in electronic templates is encrypted. This is against the established practices of ensuring confidentiality of technical bids.
4. Many e-procurement systems do not have the functionality for digital signing of important electronic records which are part of the e-procurement application. As a result, such e-procurement systems are not in full compliance of the IT Act 2000, and certain guidelines of the CVC.
5. In most e-procurement systems, functionality of the e-tendering system is limited (*e.g.*, all types of bidding methodologies are not supported). In some cases only single-stage-single-envelope bidding is supported. Similarly, many systems do not support the submission of supplementary bids viz, modification, substitution, and withdrawal after final submission, but before elapse of deadline for submission. This is against the established practices of manual tendering.
6. The entry barriers are being created in many RFPs for e-procurement, on the entry of new players on the basis of unjustified eligibility criteria, and by insisting on irrelevant experience.

7. Many e-procurement systems are such that it results in abdication of powers of the concerned officers of the government purchase department. Furthermore, in some situations it results in handing over the private keys (PKI) of the concerned officers to others, which is a violation of s-42(1) of the IT Act.
8. There is lack of clarity about where e-reverse auction is to be used. It is obvious that the government does intend to replace sealed-bid tendering with e-reverse auction. Also, there are guidelines about not negotiating after the financial bids are opened, except possibly with L1 (which is contrary to the concept of reverse auction). At the same time, reverse-auction could be useful in some situations, *e.g.*, commodity purchases. In such a scenario it is important to clarify where reverse auction can be resorted to.

Source: Adapted from *Dataquest*, April 30, 2011

Firewall

The firewall is hardware or software solution that insulates a private network from a public network using carefully established controls on the types of request they will route to the private network for processing and fulfillment. It appears primarily in two flavours; application level gateways and proxy servers. Other uses of firewalls include technologies such as **Virtual Private Networks** (VPN) that use the Internet to tunnel private traffic without the fear of exposure. As explained in figure 9.1, firewall is a collection of components or a system placed between two networks with the following characteristics:

(i) It Allows the internal or external traffic to flow via the firewall.

(ii) Only the authorised traffic, as defined by the security policy, is allowed to pass through it.

(iii) Sometimes, it uses a Routing device called Router to manage the network traffic. The Router is a device that sits in between the networks and routes for which traffic is intended, or emanating from the segments to which it is attached.

Data Security

The second level of security threat is the data level security. The data, when communicated between two parties for business purpose, needs to meet the following challenges:

- **Confidentiality:** It is important to keep the transaction data secret from all those who are not authorised to see it. What happens in a sealed bid tender when the tender price is known to all unauthorised users? So one needs to maintain the secrecy and privacy of transaction data while it is transmitted between two parties.
- **Data integrity:** It ensures that the transaction data has not been altered by unauthorised or unknown means while being transmitted.
- **Data authentication:** The transaction data is sent by an authenticated party. It is about corroboration of the identity of the user or the means used. It is also about corroborating the source of information; also known as data origin authentication.
- **Non-repudiation:** It is about preventing the denial of previous commitments or actions by the parties involved in e-business transaction.

- **Authorisation:** It alerts us about the authorisation practice. Is the user authorised to do the e-business activity? If not, has the user authorised another party to do the similar activity?
- **Access control:** It restricts access to resources to privileged or authorised users.
- **Validation:** It means to provide timeliness of authorisation to use or manipulate information or resources.

The cryptography is the study of mathematical techniques related to aspects of information security.

Ensuring the overall security of the e-business model is an extremely complex task. Different kinds of cryptography systems have been developed and are being used by business worldwide. The cryptography is a means of providing information security. ***The cryptography is the study of mathematical techniques related to aspects of information security such as confidentiality, integrity, authentication, and non-repudiation, which form the main goals of cryptography***.

Asian Paints

This service is like a 'sweet spot' for companies. You get good service, not too costly, and you do not need to keep worrying about the latest threats.

The Asian Paints group portfolio includes paints (decorative paints for walls, wood finishes, industrial coatings, motor applications, and so on) and various related products and services. The group has a strong presence in 21 locations across India, South East Asia, the Far East, the Middle East, the South Pacific, the Caribbean and Europe. Asian Paints Limited was incorporated in 1942.

Need for E-mail Security

In 2006, the company's offices in India were plagued with spam issues; the existing spam filtering solution was only partially successful in dealing with the problem. "We were on the lookout for something better," states M R Parasuram, chief manager–IT, Asian Paints Limited.

The company decided to consider Logix Secure Relay, after a 15-day trial period, in which the 3,000 odd users of the company used the solution. The Logix was then given the go ahead. 'We looked at the quality of service,' says Parasuram, explaining that there was a 'measurable drop' in spam with Logix Secure Relay. "What was also appealing was that this is Logix's core line of business. So, they have great focus on improving quality and keeping pace with the rapid changes in the spam world," he adds.

The Deployment Experience

Parasuram states that the deployment was very simple and involved just a couple of steps. Apart from changing and replicating DNS records, the company decided to manage the user list on the Logix server. So, a bulk upload of user IDs was undertaken; subsequently, if any user joins or leaves the company, the ID is updated on Asian Paints' mail server and the Logix server. He also states that there are not too many complexities in the way the solution runs. "Our experience with their technical team and their support has been pretty good," he says.

The Usage Experience

"Since spam filtration works on heuristics, some false positives will always exist. The question is how they are managed," explains Parasuram. According to him, Logix Secure Relay has been 99 per cent accurate in identifying spam and avoiding false positives. Also, each user can get a customised list of quarantined e-mail in their in box every morning. The users can then scan this list for any legitimate mail, release it, and also white list the address.

Similarly, if any spam seeps through—which happens 'maybe once in a couple of months,' users just need to forward it to the support team and it is blacklisted.

"The other good thing is that they are flexible in their licensing. They understand how corporates work," says Parasuram. He explains that if he bought a specific number of user licences based on recruitment estimates, but the actual number of users is more than the number of licences, "they (Logix) don't stand on the doorstep; they give you a tolerance limit of 5–10 per cent".

Results

- Immense cost savings by eliminating spam and viruses.
- Bandwidth saving: Though bandwidth is not as costly as before, it is not 'exactly cheap'. Saving the bandwidth helps ensure that enterprise applications run smoothly.
- Easy to use management consoles enable mail administrators to manage their domains independently, without having to rely on Logix's administrators for routine tasks.
- If there are problems with the internal mail server, the Logix server can queue mails and hold it for up to two days.
- Users can check quarantined e-mail easily and white list any legitimate mail.

Source: *Dataquest* IT Case book, 2008

The encryption is a crypto technique which is the process of transforming plain text into cipher text. The purpose of encryption is (a) to secure stored information and (b) to secure information transmission. The key or cipher is a method for transforming plain text to cipher text, which is of two types—substitution and transposition. The substitution cipher is the one where every occurrence of a given letter is systematically replaced by another letter. The transposition cipher changes the ordering of the letters of each word in some systematic way. The different kind of cryptographic techniques that are being used by e-business organisations are:

The cipher text is an encrypted text that cannot be read by anyone other than the sender and the receiver.

(a) **Symmetric Key Cryptography:** ***In symmetric key or secret key encryption, the sender and the receiver use the same key to encrypt and decrypt the message*** (refer Figure 9.2). The data Encryption Standard (DES) is the most widely used symmetric key encryption, developed by the National Security Agency (NSA) and IBM. It uses a 56-bit encryption key. Majority of the cipher systems prior to the 1980s were symmetric cipher systems. Indeed, symmetric systems are still heavily used today and there is no sign that their popularity is fading. The risk of the symmetric key is that it uses the same key to encrypt and decrypt the data. What happens if the hacker gets the key?

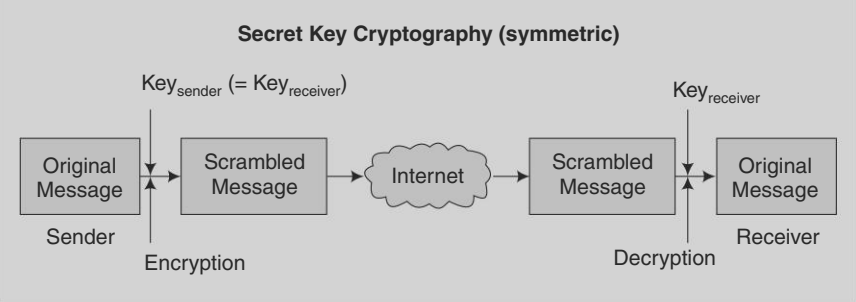

Figure 9.2 Symmetric Key Cryptography

(b) **Public Key Cryptography:** ***In public key cipher systems, it is computationally infeasible to determine the decryption key from the encryption key. In this case the encryption key and the decryption key must be different. For this reason, public key cipher systems are sometimes referred to as asymmetric cipher systems. In this, a key pair comprising of public key and private key is generated by the receiver of the data on its computer*** (refer Figure 9.3). The private key is retained by the receiver of the data on its computer and the public key is sent to all the senders. The sender will use the receiver public key to encrypt the data and send it over the Internet. The receiver receives the encrypted data and uses its private key to decrypt the data and use it. The public key of the key pair is used only to encrypt the data. The public key is a powerful security solution as it addresses the issue of confidentiality, integrity, and privacy.

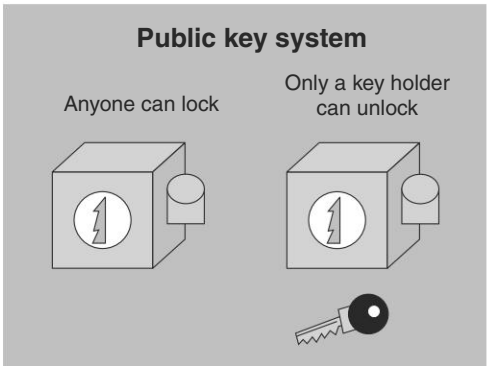

Figure 9.3 Public Key Cryptography

(c) **Digital Signature:** Though the public key cryptography is a powerful crypto solution but it does not address concerns related to authentication, non-repudiation and credibility. A digital signature is a technique that addresses some of these concerns. The digital signature is a signed cipher text that can be sent over the network. Data is electronically signed using message originator's private key. The digital signature is mathematically generated key which is a unique composite number generated using private key of message originator plus the document message. This security technique verifies the identity and origin of the sender. It guarantees that the document has not been modified since signed and ensure the non-repudiation, integrity, and authentication. The digital signature uses two key pairs, one for the digital signature of the sender and the second for the public key encryption.

The digital key pair is generated by the sender of the message on its computer using digital signature software. The sender digitally signs the message using its private key and then encrypts the message and digital signature using the public key of the receiver. The digitally signed encrypted message is then sent over the network to the receiver. The receiver uses its private key to decrypt the digitally signed message and then uses the public key of the sender to verify the digital signature to ensure the authenticity of the sender.

(d) **Digital Certificate:** The digital certificate ensures that the parties involved in e-business transaction are authenticated, trustworthy, and credible parties. The digital certificate is issued by third party certifying authority. The certifying authority after necessary verification of the e-business organisation issues the digital certificate for a period of one/two years. The digital certificate comes along with the digital signature and public key encryption tool kits. Once the organisation obtains the digital certificate, they need to attach the certificate with all e-business transactions. The Verisign is the base level worldwide certifying authority. In India, TCS, NIC, IDRBT, MTNL, Safescript are some of the older certifying authorities. There are different categories of certifying authorities—Root Certificate Authority, Brand Certificate Authority, Geo-political Certificate Authority, Cardholder Certificate Authority, Merchant Certificate Authority, and Payment Gateway Certificate Authority. The basic purpose of these certifying authorities is to ensure safe and authenticated transaction between virtual organisations.

The other security technologies that are prevalent are Secured Socket Layer (SSL), S-HTTP and Virtual Private Network (VPN). The SSL is a protocol that operates at the TCP/IP layer. It encrypts communications between browsers and servers. The SSL supports a variety of encryption algorithms and authentication methods. Then, there is secure negotiated session, a client-server session in which the URL of the requested document, along with the contents, the contents of forms, and the cookies exchanged, are encrypted. The secure Hypertext Transfer Protocol (S-HTTP) is a secure message oriented communications protocol designed for use in conjunction with HTTP. The S-HTTP cannot be used to secure non-HTTP messages. The Virtual Private Networks (VPN) allows remote users to securely access internal networks via the Internet, using Point-to-Point Tunnelling Protocol (PPTP). The PPTP is an encoding mechanism that allows one local network to connect to another using the Internet as a conduit.

E-BUSINESS STRATEGY

An effective e-business strategy is built on a solid business strategy at its core. Recognising the importance of core business strategy starts with a thorough understanding of business in terms of its products, markets, sales channels, customer requirements, competitive differentiators, priorities, organisational structure, and growth plans. Once these basic business fundamentals have been established, a solid foundation is formed, on which an effective e-business strategy can be built. The e-business strategies take note of the fact that businesses are vulnerable to competition, yet new opportunities are offered at the same time to those willing to take on global markets and new innovations.

The e-business strategy can be summarised as the strategies governing e-businesses through effective information dissemination.

The basic set of benefits that e-business offers for a competitive advantage are as follows.

- Improved customer service gives customers tangible benefits, i.e., faster delivery times, and a better understanding of needs.
- An increase in business opportunities is another one of the greatest benefits of e-business; it can result in improved brand image and enhance a company's stock market valuation.
- The greater efficiency enables shorter product development cycles and enhanced inventory turnover, thus freeing up capital by receiving payment earlier in the purchase process.
- The greater profitability is attained, as companies make money, by utilising the e-business methodologies explained, companies could improve overall effectiveness and directly increase profitability.

The question of readiness for e-business depends on both organisational and technical factors. By using a fully integrated e-business as a yardstick, most organisations are not ready to realise the potential of e-business. The customer facing applications have been implemented independently of existing core business applications, and few companies have enabled their core applications for e-business to date.

The e-business is more than just effective IT operations, it is about people and relationship building; it is changing many companies from being product centric to customer centric, focusing on satisfying customers as its key initiative, as well as maximising on partner and supplier relationships across the supply chain. The e-CRM and e-SCM integration and management are currently under developed across most industries, as they require complex collaboration, that usually take time to develop, with external partners. An extreme care is very important while choosing the right systems, partners and suppliers, as it is critical that their strategies complement your organisation's strategy.

E-Business Competitive Advantage

In order to gain fundamental competitive advantage over others, leaders need to develop business strategies that accurately identify their specific key business objectives and then implement e-business technologies and functions that support those objectives. Many leaders will need to decide whether to outsource business functions to best-of-breed solution providers instead of trying to do everything themselves, allowing them to focus on their individual strengths.

What's more the business leaders must not make the mistake that e-business is an optional to their current corporate strategy—e-business strategy is mandatory. In order to remain competitive on a global level, companies need to move away from a 'bricks and mortar' alone strategy, to a more 'bricks and clicks' strategy, in order to thrive. In order to put it in action it is essential for these leaders to partner with e-business visionaries who have the technology road map that supports their vision.

In order to be effective in the long term, e-business solutions need to ride on top of a high performance, reliable, flexible, secure network that is constantly evolving to take advantage of the latest technology advances. The future of e-business is about sharing ideas and information and using those ideas quickly to innovate and better serve customers' leading edge unified networks,

and integrated e-business solutions, that companies need to keep ahead of the competition. As e-business continues to change the marketplace rapidly, so companies need to remain alert in order to succeed in the long run.

The inward differentiation strategies that focused heavily on product functionality are quickly being overtaken by customer focused differentiation strategies, which look outward. In order to be competitive in today's new business paradigm, clever strategies need to be developed to help in turning would be, one time purchases into recurring revenue streams and reaching out to customers who cannot be reached by existing sales forces. It also requires to expand an organisation's supplier base, by letting more firms bid or tender online by means of online auctions and marketplaces.

The e-enabling one's entire corporation allows one to reach out beyond traditional geographical markets nationally, as well as internationally. It can also open up new opportunities to offer new services, whilst managing all customer interactions seamlessly and intelligently. One of the key drivers of better service comes from a quicker response time to requests by customers, especially if it is coupled with a higher standard of service offering, which is now possible with knowledge management and business intelligence tools, as explained earlier. All this becomes easier through internal working methods becoming easier for employees who were previously hampered by legacy systems.

As customers become more knowledgeable, they automatically demand more, so companies need to have effective systems in place to be able to respond to these market pressures. The companies also need to look beyond the current concept of return on investment, to return on relationship (ROR). It is the ability to model, measure, and subsequently maximise a company's ROR with each individual customer that will offer the broadest competitive differentiation and, with it, market success.

Implementing effective e-business strategies meant more than being business savvy and heavy management skills: it requires a reliable and intelligent understanding of key Internet demographics, horizontal markets, such as market size and growth trends and vertical markets, such as a subsection of e-business that your company is interested in. The organisations that effectively utilise the Internet to reach out and build relationships with consumers will have a competitive advantage.

Role of M-Commerce

The Mobile Commerce (M-commerce) has picked up in the recent years with mobile penetration rate increasing manifold. Such penetration rate has happened because of availability of technology that provides for the faster transfer of data on mobile networks, standardisation of protocols and the very personal nature of mobile telephone. ***The m-commerce allows integration of the traditional e-business models on the mobile networks***. The wireless network technology is used to enable the extension of existing e-business models to service the mobile work force and consumer of the future. Touted as the next generation of e-business, m-commerce enables users to access the Internet without needing to find a place to plug in. It is one of the fastest growing e-business markets and will involve the development and design of a host of new applications, services,

business models, and technological solutions. In fact, it is seen as a complementary service option to both B2B and B2C e-commerce. According to market reports, the term m-commerce has recently not only achieved widespread recognition but is also becoming a highly visible symbol in the contemporary language of the information technology culture that has brought significant changes in the consumer era, along with profound changes in the terminology and technology of e-business.

The major advantage of m-commerce is that it provides Internet access to anyone, anytime, and anywhere, using wireless devices. The key technologies that are used in m-commerce are the mobile phone network, wi-fi, and bluetooth. The server-side hardware and software platform is nearly in place, and the basic bandwidth is ready. As with all areas of e-commerce, the challenge for businesses will be finding ways to use m-commerce to make money while serving customer needs. Currently, the demand is highest for digital content such as downloads of ringtones, music, video content, television, news, listings, reviews, and notices. In many places around the world, mobile commerce is a viable part of e-business. Combining voice, data, images, audio, and video on a handheld wireless device in a high-bandwidth network is becoming common with m-commerce. The search engine like Google has also started offering the search on cell phones to support its mobile users. There are number of other players like advertisers, gaming, and loyalty service providers who have developed applications for the mobile users.

The main forces that will drive the m-commerce revolution include 3G technologies, wireless protocols, and handset penetration. The current generation of wireless network and handsets support the very slow data rates. The mobile phones are currently the largest providers of wireless access to the Internet today because it is the single most widely adopted electronic device. The success of the mobile industry is also dependent on the convergence of data, voice, and entertainment. The first generation mobile networks were analog-based. The second generation (2G) cellular networks are relatively slow circuit-switched digital networks that can transmit data at about 10 Kbps—one-fifth the speed of a home modem. In some of the countries, mobile companies have developed the 2.5G. A 2.5G network provides speeds of 60 to 144 Kbps using GPRS (General Packet Radio Services), a packet-switched technology that is much more efficient and hence faster than dedicated circuit-switched networks. An enhanced version of GPRS called EDGE can carry data up to 384 Kbps. The third generations (3G) mobile networks have speeds ranging from 384 Kbps to around 2 Mbps. The high speed at which Internet data can be downloaded is one of the important characteristics of new networks.

The leading platforms for delivering the Internet content on mobile phones and other wireless devices are the wireless protocols. These protocols are designed to take into account the constraints of wireless communications; limited bandwidth and end system processing and user interfaces. Each platform defines a standard markup language that permits an application's user interface to be specified independently of the end device. The delivery of these services is independent of the underlying networking technology, so applications can be used on different networks, just like Internet applications. The handset penetration is also the key to the success of m-commerce.

As content delivery over wireless devices becomes faster, more secure, and scalable, there is wide speculation that m-commerce will surpass wire based e-business as the method of choice for digital commerce transactions. The industries affected by m-commerce include:

- Financial services, which includes mobile banking (when customers use their hand-held devices to access their accounts and pay their bills) as well as brokerage services, in which stock quotes can be displayed and trading conducted from the same hand-held device;
- Telecommunications, in which service changes, bill payment and account reviews can all be conducted from the same hand-held device;
- Service/retail, as consumers are given the ability to place and pay for orders on-the-fly;
- Information services, which include the delivery of financial news, sports data, and traffic updates to a single mobile device.

The number of applications of m-commerce has increased in the recent past and users have started using these quite effectively worldwide.

Mobile Ticketing. The tickets can be bought using the mobile phones and can also be recieved on mobile phones. The tickets are available for use by presenting the mobile phones at the venue.

Mobile Coupons. The mobile ticketing technology is also being used for the distribution of vouchers, coupons, and loyalty cards. The voucher, coupon, or loyalty card is represented by a virtual token that is sent to the mobile phone. Presenting a mobile phone with one of these tokens at the POS allows the customer to receive the benefits as mentioned in the coupon or loyalty card.

Mobile Content. The mobile content can be purchased online and it can be delivered instantly. Some of the common content consists of ringtones, wallpapers, and games for mobile phones. The convergence of mobile phones, mp3 players, and video players into a single device will result in an increase in the purchase and delivery of full length music tracks and videos.

Local Services. The user can find the location or any local information using the local maps, local weather information, local GPRS service, local news, traffic updates, stock updates, etc.

Mobile Banking. The banks and other financial institutions have started offering mobile banking service to its customers. Under this service banks not only allow their customers to access account information, but also allow them to make transactions. Some of the stock broking firms have also integrated m-commerce concepts to allow its customers to do stock trading using mobile technologies.

Mobile Marketing. The companies have started using the mobile to market their products. The mobile marketing is an emerging concept. The companies are using SMS based, MMS based, and phone based advertising techniques.

M-Commerce: Airtel—Pay on the Go

With its mobile commerce platform, Airtel empowers its post-paid customers with anytime, anywhere bill payment.

For telecom operators, managing the churn and improving customer loyalty are some of the biggest challenges today. Offering customers the convenience of anytime, anywhere bill payment can help in tackling some weighty issues. Airtel identified the mobile commerce platform to offer convenience in bill payment to its customers, which, in turn, would help improve customer satisfaction.

Since the formal launch of its mobile bill payment service for its post-paid customers, in September 2007, the company has witnessed repeat usage, indicating improved customer retention levels.

As of January 2008, Airtel has 60,000 customers transacting on mChek, with the transaction value of Rs 100 mn. Out of these 60,000 customers, 90% have consistently seen repeated usage.

According to V Venkatesh, CEO, Mobile Services, Bharti Airtel, Karnataka, "there are two things that we need to provide to customers—peace of mind and ease of transaction. The more these services move into that realm, the greater will be the customer loyalty."

Airtel allowed its customers to pay the bill through various modes—dropping a cheque, going to Airtel centers and paying by cash, card, etc, or going to the company's website and paying online. However, these modes of payment did not allow the much needed anytime, anywhere bill payment facility to the customer. Customers still had to go to a particular location to pay the bills. According to Venkatesh, "With our online payment service, the customer doesn't need to stand in the queue. However, we wanted to take this a step ahead, and allow our customers to pay their bills on the go".

Airtel found that the mobile phone is one thing that customers carry, most certainly, all the time. Therefore, the company decided to leverage the mobile platform to offer the envisaged convenience levels to its customers.

In September 2007, the company launched the mobile bill payment service for its post-paid customers with the help of mChek, a Bangalore-based mobile payment company. Currently, the service has support across all the circles of the operator, and is compatible with all the handsets in the market. It is integrated into the main 121 system of Airtel. In order to sign up for this service, Airtel users need to SMS MCHEK to 121, or go to www.mchek.com.

The signing-up involves registering the credit card and creating a 4-digit mChekPIN. This mobile number plus mChekPIN is all that the customer needs to transact. The mobile mChekPIN is tied to a particular mobile number.

The service is aimed at empowering the customers to make transactions in a safe and secure manner while providing the convenience of anytime, anywhere payment. It was critical that there is no ambiguity in the customers' mind with respect to the security aspect of the service. The security aspect is taken care of by the fact that mChekPIN is linked to a particular mobile number upon registration.

The service allows the customer instant sign-up and payment by SMS. This self-care services provide empowerment to customers who don't have time. Now, time is not a constraint anymore for Airtel post-paid customers as the mobile bill payment service offers the convenience of bill payment on the move and in a secure manner. What this translates into for the company is greater customer satisfaction scores, leading to customer delight.

With the help of the service, the company wants to help improve customer loyalty and retention, by providing it a competitive edge in the market. Further, the system allows instant posting into the Airtel billing or IN systems.

Considering the benefits, Airtel will consider extending the mChek mobile bill payment service to its pre-paid and broadband customers in the future.

At a Glance

Challenges

- Customers had to stand in queues or had to physically go and drop cheques to pay their bills. Also, not all customers may have internet connection to be able to pay their bills online.

- Once the bill payment was done, reconciliation took time.
- Chances of errors with manual reconciliation.

Solution

- mChek mobile bill payment service.

Benefits

- Post-paid customers can pay their bills on the go—anytime and anywhere.
- Increased customer satisfaction, which will ultimately help improve customer loyalty and help reduce churn.
- Instant posting of the bill payment into the Airtel system.

Source: *Dataquest*, February 29, 2008, Vol. XXVI No. 04

SUMMARY

- There are many different concepts exist about e-business. In simple words, e-business is a method of doing business using technology. The electronic commerce (E-commerce) can be defined as any business transaction conducted using electronic means. The e-commerce is usually associated with buying and selling over the Internet, or through a computer mediated network. Whereas, e-business does not mean only buying or selling products online, it leads to significant changes in the way products are customised, distributed and exchanged, and the way consumers search and bargain for the products and services, and consume them. The e-business revolution has its effects on processes.
- The business organisations have created different categories of e-business solutions to meet their business needs. The major categories of e-business solutions that have been implemented by the different organisations worldwide are: Business-to-Business (B2B); Business-to-Consumer (B2C); Consumer-to-Consumer (C2C) and Consumer-to-Business (C2B). Other than these four, there are some more categories that are commonly used by businesses which are Business-to-Government (B2G); Business-to-Employee (B2E); Government-to-Business (G2B); Peer-to-Peer (P2P); and Mobile commerce (M-commerce). If one tries to do detailed study of all the categories, one will find most of the B2G and G2B are similar to B2B or moreover same. The B2E is similar to B2C and P2P is similar to C2C.
- The mobile Commerce (M-Commerce) is the buying and selling of goods and services through wireless technology, by means of hand-held devices such as cellular telephones and personal digital assistants (PDAs). As content delivery over wireless devices becomes faster, more secure, and scalable, some believe that m-commerce will surpass wire based e-business as the method of choice for digital commerce transactions. The m-commerce is quite popular in financial services including mobile banking. The customers are using their mobile phones to access their accounts and pay their bills. The customers are also using this facility for utility services, information services and entertainment.
- The e-Business model is like any business model, which describes how an organisation functions, how it offer its products or services, how it generates revenue, and how it will create and adapt to new markets and technologies. It has five traditional components; market opportunity analysis,

value proposition, online strategy, resource management, and sources of revenue. A business model is not always the same as a business strategy although in some cases they are very close. The business model explicitly takes into account the competitive environment and is at the centre of the business plan.

- There are number of business models, which have evolved over the period, some of which are specific to B2B, some to B2C, and some to other e-business categories. Most of these e-business models actually fit with the business strategy being followed by the organisation. Though, we try to classify these e-business models into broader categories, but there is no clear cut process of classification. The models that were discussed in the chapter include broker model, auction brokers, reverse auction, advertising model, portals, infomediaries, merchant models, e-procurement, and community models.
- An organisation that is implementing e-business models needs to secure their models from multiple levels of threats—from hackers, insiders, pirates and thieves. One of the biggest potential security problems in an e-business is from humans, rather than electronic origin. The technological solutions that are available are strong, but the people who manage these are vulnerable.
- There are two broad levels of threats that are common. One is the network level of threat and the other is the data level threat. In a network level threat, one needs to ensure the security of the complete network, including the LANs, WANs, Internet, intranet, and extranets. This will enforce that only the right users or the authorised users are accessing the network. The basic threat is from the hackers who try to hack the network to get an unauthorised access. In data level threat, one needs to ensure the security of data when it is on the move from one computer to another. Here, the basic threat is either from the hackers or even from the insiders.
- The hacker is an individual who intends to gain unauthorised access to a computer system, whereas Cracker is the term typically used within the hacking community to denote a hacker with criminal intent. There are three types of hackers, white hat, grey hat and black hat hackers. The hackers use different kind of techniques that may include denial of service, spoofing, sniffing, and password cracking.
- The firewall is a hardware or software solution that insulates a private network from a public network using carefully established controls on the types of request they will route through to the private network for processing and fulfillment. All the types of firewalls are functionally equivalent. The type of mechanism used determines the *granularity* of the firewall: how much security work it can accomplish. For example, the packet filters are least granular. On the otherhand, application gateway firewalls are the most granular. A packet inspection firewall can be made almost as granular as an application gateway firewall.
- Another level of security threat is the data level security. The data when communicated between two parties for business purpose needs to meet the challenge like confidentiality, authenticity, integrity, non-repudiation, privacy, authorisation, and validation.
- The business leaders need to take a hands-on, holistic, and practical approach to their e-business strategies, while educating employees to drive towards the same vision. The companies and the governments need to focus on retraining people to keep pace with rapid change and redesigning business processes that integrate best-of-breed technological solutions. The organisations can no longer afford to wait and see what happens to others before embarking on true e-business, they need to take action now and get their systems in place, or they will force a large risk of being gobbled by one that has adopted the systems.

KEY TERMS

Advertising Model
Auction Models
Broker Model
Business-to-Business (B2B)
Business-to-Consumer (B2C)
Community Model
Consumer-to-Business (C2B)
Consumer-to-Consumer(C2C)
Cryptography
Digital Certificate
Digital Signature
E-Business
E-Commerce
Encryption
E-Procurement
Firewall
Hacking
Infomediaries
Information and Communication Technology (ICT)
Market Opportunity
Merchant Model
Mobile Banking
Mobile Commerce (M-commerce)
Mobile Content
Mobile Coupons
Mobile Marketing
Mobile Tokens
Packet Filtering
Peer-to-Peer (P2P)
Portal
Public Key Encryption
Resource Management
Revenue Model
Reverse Auction
Routers
Symmetric Key Encryption
Value Proposition

SELF-STUDY QUESTIONS

1. One of the best examples of C2C e-commerce business model is
   (a) Amazon (b) eBay (c) Priceline (d) MakemyTrip
2. In _____, business is originated by the business (organisation) and selling it to the business (organisation).
   (a) B2C (b) B2B (c) C2C (d) C2B
3. Amazon.com was one of the most successful pioneers of
   (a) B2B Commerce (b) C2C Commerce (c) B2C Commerce (d) C2B Commerce
4. The major impact of e-commerce upon strategic planning has been
   (a) The need for faster action and reaction.
   (b) The omission of the external and internal analysis stage of the classical process.
   (c) The obsolescence of the concept of a corporate mission/vision.
   (d) The obsolescence of the strategic planning process.
5. Which of the following is a software application that acts as a filter between a company's private network and the Internet?
   (a) Firewall (b) Virtual private network
   (c) Proxy server (d) Router
6. A Denial of Service (DoS) attack can compromise a website's
   (a) Integrity (b) Authenticity (c) Availability (d) Confidentiality
7. The encryption can provide all of the following dimensions of e-commerce security except
   (a) Authentication (b) Confidentiality (c) Message integrity (d) Privacy

8. The value proposition is composed of
   (a) Choosing target segments.
   (b) Focusing on a particular combination of customer benefits.
   (c) A rationale for the firm's ability to deliver those benefits better than competitors.
   (d) All of the above
9. Which of the following refers to the ability to ensure that messages and data are only available to those who are authorised to view them?
   (a) Privacy (b) Confidentiality (c) Availability (d) Integrity
10. Which of the following is a hacker that believes he or she is pursing some greater good by breaking in and revealing system flaws?
   (a) Cracker (b) White hat (c) Black hat (d) Grey hat

REVIEW QUESTIONS

1. How is e-commerce different from e-business?
2. List some of the benefits of implementing an e-business.
3. What are the major constraints of implementing an e-business?
4. What are the common hacking techniques?
5. List the major steps of creating e-business models.
6. What is SSL? What level of security it provides to the user?
7. Define reverse auction. What benefits it offer to the buyer?
8. Why does an organisation need to procure digital certificate?
9. List the steps required to define the value proposition of the e-business model.
10. What are the different revenue streams that most of the e-business models follow?

QUESTIONS FOR DISCUSSION

1. List reasons why dot coms failed.
2. If dot coms have failed in the past, why organisations implement e-business models?
3. List organisational, management, and societal benefits of implementing e-business.
4. Describe the major components of e-business framework.
5. Outside firewall, what are some of the major technologies used to ensure security of the e-business models?

APPLICATION EXERCISES

1. Search the Internet to identify the two Indian organisations that are using broker model. Study the application for which these organisations are using the broker model. List out the competitive advantages that these organisations have achieved as compared to the similar models implemented in the traditional space.

2. Search for an online travel agent and compare its e-business model with one of the traditional travel agent. Identify the level of benefit that they offer to the consumer and service provider.

GROUP PROJECTS

1. Identify a product that your group wants to launch on the Internet space. Create a complete e-business model for your product after doing the complete market opportunity analysis, defining the value proposition, the resources required and the sources of revenue. Prepare a report and make presentations.
2. Travel industry has adopted the Internet technology in a big way in India. There are number of travel websites exist. Each group may select one travel site and develop the market opportunity analysis and value proposition that these sites offer to their customers.
3. Study the security system followed by your institution. Prepare a report and present the same to the group.

Caselets

1. Web Based GIS System

The sustained oceanic observations and focused research of the Indian National Centre for Ocean Information Services (INCOIS) is uploaded to its dynamic ocean portal (incois.gov.in). This serves as a rich source of ocean information and advisory services to the society, industry, government, and scientific community.

INCOIS is responsible for collecting huge amounts of data from various institutions in India, which are involved in marine data collection, ocean observation, and oceanic/atmospheric sciences. The website is then responsible for translating it into deliverable products to a range of users—the fishing community, State Fishery Department officers, Planning Commission, ports and harbours, the shipping industry, the Navy, Coast Guards, NHO Central Pollution Control Board, etc.

Prakash Kumar, Joint Secretary, Ministry of Earth Sciences says. "All the data that we get has to be archived and kept somewhere." "It is immediately uploaded to the website," he adds.

"The department essentially provides three kinds of services," says K Somasundar, Scientist e-director, Ministry of Earth Sciences. "Firstly, it plays a crucial role in sustaining fisheries' development plans. Then the fishing community makes use of the information that we provide them with."

The department is also responsible for the weather forecasts for coastal states. "Information relating to the state of the ocean, wind direction, etc., is vital for coastal states. All this information based on winds, waves, swells, and tidal waves is generated and then put on our website," says Somasundar.

"This information—updated every three hours—is valid for five days" he says. This forecast of the state of the ocean is vital to the shipping and fishery sectors for safe travel in the sea. The Navy, offshore industry, ports, and harbours require this information for cost-effective and safe operations.

In order to be able to successfully do all this, INCOIS is using the advanced remote sensing platform, Argos, which collects information from the oceans and then transmits it to the satellite, which in turn is reflected on the website. According to Kumar, there are very few websites in India, which are based on the Web-Geographical Information System. The website enables a person to retrieve data from the portal without knowing much about computers.

"The Web-GIS allows the user to query, analyse, and visualise spatial and non-spatial data over the web. The information required by the client can be fetched from the RD-BMS/Spatial Server and displayed on the web as intelligent maps," says Somasundar.

"Our ocean portal is a crucial link in the chain. It is dynamic website which is fully automated," says Somasundar.

The Web-GIS allows the user to query, analyse, and visualise spatial and non-spacial data over the web. The information required by the client can be fetched from the RDBMS/Spatial Server and displayed on the web as intelligent maps.

The website was developed by INCOIS in collaboration with TCS. While the design and operations were managed by INCOIS, TCS provided the back-end software support, which is now being maintained and continuously upgraded by INCOIS. "The website is a single window solution for the entire ocean community," he says.

The website is being built in four phases. The first two phases are already over and the department is now expected to have design availability for WAP enabled information systems.

The portal is supported in multiple languages—Hindi, English, and other Indian languages, including all coastal languages.

Questions for Discussion

1. What are the challenges being faced by the organisation?
2. What is the solution that the management proposed?
3. What are the benefits that are perceived by the proposed solution?
4. Is implementing the e-business solution the right approach?

Source: *Dataquest*, February 28, 2007, Vol. XXV No. 04

2. E-Procurement System

KSPHC undertakes the construction of buildings that house employees of the state government in the police, prisons, home guards, and fire departments.

In 2000, transparency in dealings was included in the Public Procurement Act (PPA), and the Right to Information Act was enacted. This compelled the Karnataka State Police Housing Corporation (KSPHC) to set up the electronic tendering system.

The conventional tendering process led to the KSPHC overshooting tender cycle times, resulting in delays in project completions. Prior to the implementation of the e-tendering solution, KSPHC had its own web based project management system. The need to speed up the process was felt as well.

Driven by this, and the need to comply with the provisions of the PPA, KSPHC had to look for an e-tendering solution provider. The search for the e-tendering solution ended with Wipro, which deployed the Electronic Government Procurement System with an online reverse auction. The system facilitated the display of notices inviting tenders incorporating the qualifying requirements—on the KSPHC's website. It also enabled KSPHC to post and amend tender documents, and view and compare bids online.

"The solution enabled us and the other departments to leverage the system and conduct online tendering with ease. It is helping the state government to save immensely on costs," says Sri Kumar, chairman and managing director, KSPHC.

The system provides for a registration process which is open ended, and those agencies which are registered with KSPHC can participate in the tender process. It facilitates vendors to electronically download and upload tender documents, track the status of the tenders, and receive e-mail alerts. The bids are stored in the computer and can be opened only at the specified date and time of opening of the tender.

Before the closed bids are opened, an online reverse auction is conducted and the bidders have the option of revisiting their closed bids. During the reverse auction process, the bidders get to know only the prevailing lowest bid at any given point of time and the identity of the other bidders, including the one with the lowest bid is kept a secret.

The system facilitates the bidders to enter their bids from the place of their choice, and a username and password is given to them to regulate their entry into the auction rooms. After the online reverse auction is completed, the lowest bid is determined therein.

The solution also provides for payment gateways, and issues digital certificates to ensure secure online transactions between the department and the vendors.

The Karnataka government's Rural Development and Panchayati Raj (RDPR) is now utilising KSPHC's system, to invite tenders for award of contracts in the Pradhan Mantri Gram Sadak Yojana. The projects worth Rs.100 crore in Phase IV are currently being e-tendered, thereby ensuring a transparent process in the award of contracts for the construction of rural roads. In just six reverse auctions so far, KSPHC has been able to save a substantial amount in the RDPR project alone.

Added to this, transparency has led to sound decision-making, and an improvement in the pace at which orders are finalised. The human errors have also been minimised.

Questions for Discussion

1. What are the challenges being faced by the organisation?
2. Why the organisation implemented the e-tendering system?
3. What are the benefits that are perceived by the proposed solution?
4. List some of the drawbacks of implementing the e-procurement systems in government systems.

Source: *Dataquest*, February 28, 2007, Vol. XXV No. 04

Answers to Self-Study Questions

1. (b)	2. (b)	3. (c)	4. (a)
5. (c)	6. (d)	7. (a)	8. (d)
9. (b)	10. (d)		

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Chapter 10

Integrated Enterprise Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What are Integrated Information Systems?
- What are different types of Integrated Systems?
- Understand ERP, CRM and SCM Systems
- Role of Integrated Systems for competitive advantage
- Identify the advantages and disadvantages from business perspective.

INTRODUCTION

The major challenges faced today by global business organisations are expected to grow in intensity and complexity as they move forward into the present century. The increased global competition has become a reality rather than the exception, with an unprecedented number and variety of products available to satisfy customer needs and desires. The dynamics of faster product development, more customised manufacturing, and quicker distribution have benefited the customers. At the same time, these changes have led to new and increased customer expectations and standards for organisations to meet in the marketplace. Satisfying the customer's desire for high quality and quick service in the current business environment has added pressures for the organisations.

In order to meet these new challenges, organisations world wide have invested heavily in information technology, taking advantage of IT systems to radically alter the way business is conducted in both domestic and global markets. In particular, many organisations have implemented enterprise wide integrated systems. The objective of these systems is to integrate and optimise various business processes such as order processing, inventory management, production planning, and accounting across the enterprise.

The organisations that want to grow and remain competitive, have been exploring ways to improve business practices and procedures. One of the most talked about information technology integrated enterprise solution enabling business organisations has been the emergence of Enterprise Resource Planning (ERP) systems. A well-implemented ERP system can bring numerous benefits to an organisation. However, the implementation is resource intensive and complex, with success dependent on critical factors. The organisational, cultural, and operational challenges also affects ERP implementation. Implementing ERP systems is always a challenge, since most of the organisations rarely possess the resources needed for a successful implementation and also have serious cultural and operational issues. The objective of this chapter is to define integrated systems, and the interrelationship among systems like Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply Chain Management (SCM).

With the emergence of global economy, organisations across the world started facing competition on real time. These organisations, which have automated systems were in the same boat as most of those now have automated only the major functional areas of business applications. The essential functional applications that were automated by majority of the organisations worldwide included finance, marketing, production, and human resources. These organisations followed the traditional approach of building the functional systems, which was need based. The marketing departments felt the need for which they automated the marketing function. Later accounting and finance departments felt the need and also adopted the system. These functional systems were introduced to create effectiveness and efficiency in the functional area by understanding the internal needs of the area. This approach created islands of information systems within an enterprise meaning no functional system interacting with any other system.

In order to understand the concept of integrated systems better, let us take the example of a sales team trying to sell the products to its customers. When the sales team book the sales order, it is entered into the sales order processing system of the sales department. While finalising the sale order, the sales department needs to get the inventory information from the store manager, who maintains the inventory management system. When the order fulfilment with respect to same booking is to be done, it is the logistic department that will capture the data into its logistics system. When the accounts department receives the payment from customer against the same sales order, it updates its accounting information system. If one studies the above process in detail, one will find that the sales transaction that is initiated by the sales team leads to number of interrelated transactions in many other functional systems. As per traditional information systems, each of these functional information systems like sales order system, inventory system, logistics and accounting system would capture data related to same transaction independent of other functional system. This will lead to data duplication, data redundancy, and data inconsistency, which results in inefficient, ineffective process leading to poor customer service.

The businesses work in integrated manner whereas departments may not. In order to overcome the problems associated with individual functional information systems, organisations created integrated enterprise wide information systems. In order to create integrated enterprise wide information systems, one may create a common cross-function information system or integrate the individual functional systems to create effective communication, coordination, and control

among systems while maintaining the individual existence. The integrated enterprise systems may be created in-house by integrating the legacy applications or can be purchased off the shelf.

The approach towards integrated enterprise systems started quite early with material resource planning (MRP) systems. The initial MRP systems allowed the organisations to start with a sales forecast to develop production and raw material plans. For organisations, those were dealing with large number of products and raw materials were sharing production resources, which was not possible without computer based MRP systems. The MRP basically helps organisations to manage production schedules with material management. As competitive pressures increased and users became more sophisticated, advances in planning systems became more advanced accordingly and it was integrated with financial accounting systems to create an integrated system for manufacturing execution, which was referred as MRP II. The sharing of long range production schedules between manufacturers and suppliers was the beginning of the concept of Supply Chain Management (SCM). This integration of manufacturing with supply chain introduced the concept of Enterprise Resource Planning (ERP).

The ERP systems can be understood as an extension of MRP II systems. The ERP systems are the integrated enterprise information system solutions that integrate modules for accounting, finance, sales and distribution, human resources, material management, and other business functions based on a common architecture that links the enterprise to both customers and suppliers. An enterprise can implement all the modules or some select modules as per the information system plan of the enterprise. Many ERP systems also provide industry specific solutions.

INTEGRATED INFORMATION SYSTEMS

The organisations started using computers to manage business functions way back in the 1950s. That time the basic objective followed by most of the organisations was to simply automate the processes like inventory management, payroll, billing, etc. The major objectives of automating these processes were to reduce cost and increase efficiency by building transaction processing systems. For many years, most of these organisations continued to develop and manage independent functional systems either by using their internal teams or buying some standard off-the-shelf solutions. The market for standard off-the-shelf solutions was developed because most of the organisations started looking for automated solutions for the same set of functions and processes.

As business expanded, business complexities increased and the need for these standard solutions also changed, which led to automation of new functions and processes. As a result, organisations have created a fully automated information system, but all components of the system may not be interacting with each other. This might have happened because some of these organisations implemented different functional systems from different vendors using different technologies. Integrating the solutions provided by different vendors on different technological platforms may not be easy and very effective. Most of these functional systems were developed for the functional areas/department, independent of each other. Since these were developed for specific functional area, they have become more and more powerful and sophisticated over a period of time.

For the organisations to remain competitive in the present century, it is important for them to integrate their functional systems. As explained in the sales process in the above box - Sales transaction data will be captured by the sales information system; the same part of the data is again captured by the production system; and then by the logistic system and then by the financial accounting systems. This leads to ineffective communications, data duplication, and data redundancy.

An integrated information system helps the organisation to integrate all the functional systems (refer Figure 10.1). This allows the organisation to capture the data from source and share it across the organisation without re-typing, re-validation. The data is captured where it makes more sense. The data is validated at source. This also addresses the problem like data duplication, data redundancy, data inconsistency, and also improves communication between functional areas. The integrated information systems also allow organisations to extend their systems to their business partners like suppliers, distributors, retailers, and customers.

The integrated information systems allow sharing of data across functional areas, across levels, across locations to allow joint execution of business processes across the organisation for the effective management of cross-functional teams.

The organisations realised the power of integrated systems quite early during the 1960s, when some of the leading organisations implemented the concept of production scheduling. The ***production scheduling is a concept of integrating inventory management with procurement***. This integrated system approach lead to the concept of Material Requirement Planning (MRP). The MRP model integrated inventory, procurement, and production processes. The success of MRP leads to automation of scheduled inventory procurement process. The MRP was improved to integrate the labour and financial planning resources into the system. The improved version of MRP was called MRP II. The MRP and MRP II were quite successful in managing the manufacturing resources very well, but their benefits did not extend to other applications. To coordinate manufacturing with other internal resources like human resources, finance, marketing,

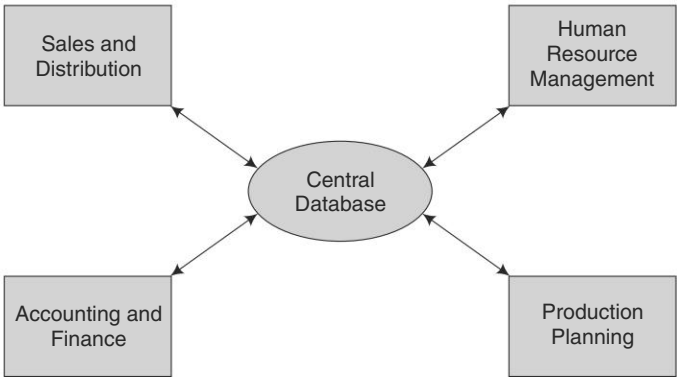

Figure 10.1 Data Flow in Integrated Information System

etc. the concept of Enterprise Resource Planning (ERP) was introduced. The ERP systems integrated the transaction processing systems with other routine processes from all functional areas in an enterprise. In the initial phase, ERP integrated only the routine functions and offered solution to its internal users (cross-functional, across departments). In the second phase of ERP, the solution was extended to integrate the external users — suppliers and customers. The current phase of ERP includes the complete solution for its players in the value system. The current ERP systems are also known as 'Integrated Enterprise Systems,' which includes end-to-end ERP system with web integration, supply chain management (SCM), customer relationship management (CRM), knowledge management (KM), and business intelligence (BI).

	Evolution of ERP
1960s	Production Scheduling Systems to control inventory
1970s	MRP Systems: Integration of Production scheduling with Materials Management
1980s	MRP-II Systems: Integration of Financial systems with MRP
1990s	Extended MRP with complete integration with Manufacturing Execution
Late 1990s	Enterprise Resource Planning (ERP)
2000s	Integrated ERP: Integration with New Media across Value System

This integration of functional systems across the value system has resulted in better customer service in terms of cost, quality, delivery, and technology. The new forms of information revolutions and organisational relationships have introduced concepts like SCM, CRM, BI, e-business, and KM. The organisations have started investing into these technological solutions to gain competitive advantage. The integrated information systems like ERP may also provide the interface for the e-business models for customised orders, order tracking, inventory management, and many more. In the subsequent section, we would explain what ERP is all about and its integrations with other functionalities like SCM, CRM, etc.

ENTERPRISE RESOURCE PLANNING (ERP)

The enterprise resource planning (ERP) is an integrated enterprise wide information system solution that integrates across functions, across management hierarchies and across locations. The ERP is a system solution that is designed to integrate all data, resources and processes that are required to complete business functionality, like, managing inventory, production scheduling, etc. An ERP system is usually based on a common database that allows every user to store and retrieve information on real-time basis, irrespective of department, management level, and location. The information should be reliable, accessible, and easily shared. The ERP can cut down costs; improve the quality; and increase efficiency. In short, it helps in making the maximum use of technological advancements. For instance, the executive in the sales department will be able to respond to a customer query immediately by checking the status of the product's delivery, which would not have otherwise been possible without ERP in the organisation. The ERP has enabled organisations to do away with laborious and time-consuming process.

The ERP is an integrate information systems solution that integrates departments, functions, and processes across the organisation.

It is always difficult to build a single software solution that serves the needs of users in finance as well as in human resources or in the warehouse departments. Each of those departments typically might have their own information systems, which optimise the department needs. But ERP integrates all of them into a single information system that runs on a single database, which provides the users from various departments to share information and communicate with each other seamlessly. The integrated approach can have tremendous benefits if organisations install the solution correctly. The ERP can also integrate the old stand-alone or legacy systems in various functional areas like, finance, HR, manufacturing, sales, and inventory management. All these old functional systems might be getting their own data except that the ERP software now is integrated. This helps the user from the finance to cross-check the inventory system to see if an order has been shipped or not.

Prior to the concept of ERP systems, every department within an organisation was having its own customised information system. The typical limitations were integration of data from potentially different databases and systems. ***For example, the HR computer system would manage employee information while the payroll department would generally calculate and store paycheck information for each employee, and the financial department would normally store financial transactions for the organisation. Each system would have to integrate using a predefined set of common data which would be transferred between each system. Any deviation from the data format or the integration schedule often resulted in problems***. The ERP systems combined the data of earlier separate applications. This simplified the system of keeping data in synchronisation across the enterprise as well as reducing the complexity of the required computer infrastructure.

ERP system has three basic properties:

- Multifunctional – It allows tracking a range of activities such as financial results, procurement, sales, manufacturing, and human resources.
- Integrated – It means that when data are entered into one of the functions, information in all related functions is also changed immediately.
- Modular – It means they are modular in structure and usable in any combination of modules.

An organisation can implement all the modules or a subset of them, as well as connect them to other support systems. Many ERP systems also come with industry-specific solutions, or templates, that enhance the standard system by addressing key issues or business processes within an industry group. The organisations can get the end-to-end ERP system from a single vendor or may get it in a modular manner from multiple vendors. A multi-vendor may help the organisation in getting the best functionalities for each of its modules, but there would be implementation issues, which are more complex. Some of the common modules that are supported by a good ERP system includes: manufacturing, sales and distribution, financial accounting, human resource systems, supply chain, customer relationship management, and warehouse management.

Legacy System versus ERP Systems

The legacy systems are those which are developed primarily in-house on need basis using conventional programming languages. The ERP systems are integrated information system solutions.

Legacy Systems

- Automates running processes.
- Normally not driven by organisation strategy and business vision.
- Develops one application at a time. No integration between applications—just-transaction passing.
- Decentralised applications.
- Are relatively inflexible to accommodate changes in the business environment.
- Written in language/platform prevalent at the time of development.
- Upgradation to latest technology is difficult.
- Usually not well documented.
- Maintenance is a problem—largely because of poor documentation and staff attrition.

ERP Systems

- Enterprise Resource Planning (ERP) program are software used by companies to manage information in every area of the business.
- ERP programs help manage company-wide business processes using a common database and shared management reporting tools.
- ERP software supports the efficient operation of business processes by integrating activities throughout a business.
- Allows automation and integration of business processes.
- Enables data and information sharing.
- Enterprise-wide system.
- Introduces 'best practices'.
- Overcomes inefficiencies of independent systems.
- Integrated data supports multiple business functions.

The organisations were using the computer systems for management of manufacturing systems for over four decades. Those systems were used for calculating materials requirements. In mid-1980s, frequent changes in sales forecasts lead to continuous readjustments in production schedules, which led MRP to evolve into a new concept known as Enterprise Resource Planning (ERP). The first generation of ERP was created as an extension of MRP; later computer integrated manufacturing (CIM). The ERP systems as introduced by Gartner in 1990 cover all basic functions of an enterprise, regardless of the organisation's business or industry types. The ERP systems are now popularly being used by all kind of organisations in non-manufacturing, non-profit and government sectors. The second generation ERP leveraged the existing integrated system to increase efficiency, improve decision process, and extended the integration to link the external partners. Some of the common ERP solution providers include: SAP, Oracle, and JD Edwards. The ERP systems saw a major demand in the 1990s, the period when organisations were facing problems with respect to the millennium change, which was the Y2K problem with their legacy systems. Many organisations replaced their legacy information systems with ERP systems during the same period.

Best Practices: One of the key characteristics of ERP is that it implements best practices. ***The best practices are the tested effective and efficient practices being followed across the world to accomplish a process***. The best practices represent the way an ERP solution provider feels a particular business transaction should be carried out to maximise efficiency. While customers can customise their ERP systems to represent their own particular way of doing business, staying too far from 'best practices' might mean that they will not get the benefits the ERP integration promises. While implementing an ERP system, organisations can choose between customising the software or modifying their business processes to the 'best practice' function delivered by the ERP solution provider. Owing to the complexities of most ERP systems and the negative consequences of a failed ERP implementation, most ERP vendors have included the 'best practices' into their software. The use of 'best practices' allows the organisation to comply with the international business standards like Basel II.

The 'Best Practices' are the most efficient and effective way to carry out a particular business process in an Integrated Enterprise Wide system.

ERP Components

The ERP systems are modular. It supports multiple modules for a given functionality. All functional modules share data amongst themselves using common databases, which forces the organisation to follow standards and best practices. The ERP systems are also adaptable, flexible, secure with lots of features that can help in accomplishing the tasks efficiently at lower costs. The ERP systems always offer real-time solutions, with updated data about any activity of the entire organisation. The ERP also comes with web interface, which allows the organisation to remain connected from anywhere at anytime. The ERP modules allow the organisation to integrate all the departments. Some of these modules are explained below.

Finance: The financial accounting is one of the main modules of ERP, which allows the user to manage the complete financial transactions. It is used to generate financial statements like profit and loss statement and balance sheet for external reporting purpose. It also helps in managing the costs that are assigned to various products and cost centres. The ERP helps to manage all kinds of taxes, bank reconciliation, and everything else that is required for efficient and complete financial accounting. The kind of data that is maintained includes: general ledger, cash management, accounts payable, accounts receivable, fixed assets, etc.

Human Resources Management: The human resource module facilitates management of employee resource, which includes employee recruitment, hiring, training, payroll, time and attendance management, compensation management, and travel management. Thus, human resources offer comprehensive HR solutions, from recruitment to compensation to work force development.

Production, Planning and Control: The production planning and control is one of the most important modules of ERP that enables the user to plan for material requirements based on a production planning process. The system reports inventory requirements based on work orders initiated, stocks committed and existing stocks. The type of functionalities that are covered in

this module include: engineering, bills of material, scheduling, capacity, workflow management, quality control, cost management, manufacturing process, manufacturing projects, manufacturing flow, costing, billing, time and expense, activity management.

Business-to-Business (B2B): The ERP is being used widely to manage industrial buying process, which is done with the help of this module. The B2B module helps the organisation in building strong relationships with its suppliers, distributors, retailers, and customers. The functionality that is offered with this module include: order to cash, inventory, order entry, purchasing, product configuration, supply chain planning, supplier scheduling, inspection of goods, claim processing, and commission calculation.

Sales and Distribution: The sales and distribution module records sales order and schedule deliveries. It helps to optimise daily activities that are carried out in sales, delivery and billing. The key elements are: pre-sales, inquiry processing, quotation processing, sales order processing, delivery processing, billing, and sales information system. The information like pricing, how and where to ship products, how the customer is to be billed, etc. is maintained in this module.

Materials Management: The materials management module manages the acquisition of raw materials from suppliers (purchasing) and handling of raw materials inventory.

Other vendor specific modules may include:

- The Quality Management module, which helps to plan and record quality-control activities, such as product inspections and material certifications.
- The Plant Maintenance module, which allows planning for preventive maintenance of plant machinery and managing maintenance resources.
- The Asset Management module, which helps the company to manage fixed asset purchases (plant and machinery) and the related depreciation.
- The Project System module, which allows for planning and control of special projects like Research and Development or Marketing Campaigns or low volume, highly complex projects like, aircraft or ship construction.
- The Customer Relationship Management (CRM) module, which covers sales and marketing, commissions, service, customer contact, and call centre support.

Characteristics of an ERP System

- Enables high levels of integration across business functions and units
- Provides for widespread sharing of data from a single information repository
- Drives extensive business transformation and changes management efforts
- Requires high levels of implementation effort and support
- A powerful software tool
- Enables data and information sharing across enterprise-wide system
- Introduces ‘best practices’
- Common set of applications

- Usually requires re-engineering of business processes
- Offers limited customisation
- Overcomes inefficiencies of independent systems

Advantages and Disadvantages of ERP

It is interesting to know about the advantages and disadvantages of implementing ERP. The most popular advantage of an ERP system is bringing down the costs and saving valuable time which would have otherwise been wasted in procedural hurdles and unwanted delays. The different software programs are maintained in the departments that neither talk to each other nor interface effectively. Since ERP is a uniform platform it ensures that there is no discrepancy in the information that is processed. The ERP systems are also not free from limitations. The ERP calls for an exorbitant investment of time and money. The problems with ERP systems are mainly due to inadequate investment. The problem is also with lack of corporate policy protecting the integrity of the data in the ERP systems and the ways in which it is used. Table 10.1 lists out the advantages and disadvantages of ERP.

Table 10.1 Advantages and Disadvantages of ERP

Advantages	*Disadvantages*
• Streamlines or eliminates inefficient manual processes. • Eliminates disparate stand-alone systems. • Provides integrated, enterprise wide common tools, processes and systems leading to proper communication, productivity, and efficiency. • Establishes a backbone structure that can be leveraged to handle all operational processes. • Integrates and increases control of budgeting, planning, and financial management processes. • Order tracking, from acceptance through fulfilment. • Managing interdependencies of complex processes. • Tracking the three-way match between purchase orders, inventory receipt from suppliers, and supplier payments. • More secured system from intentional and unintentional risks. • Each department works independently of the other department in an integrated system. • Serves the customers efficiently by way of prompt response and follow-up. • The database not only becomes user friendly but also helps to do away with unwanted ambiguity. • The ERP is suitable for global operations as it encompasses all the domestic jargons, currency conversions,	• Focus on applications rather than business processes. • Lack of ERP project management expertise. • Scope and change management. • Sub optimisation of system capabilities. • Staffing and retaining full time project resources. • Experienced implementation partners. • Product maturity and limitations. • Customisation of the ERP software is limited. • Re-engineering of business processes to fit the 'industry standard' prescribed by the ERP system may lead to a loss of competitive advantage. • The ERPs are often seen as too rigid and too difficult to adapt to the specific workflow. • Resistance to share internal data by key employees, results in low effectiveness of the software. • The system may be too complex measured against the actual needs of the customers. • The ERP systems centralise the data in one

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diverse accounting standards, and multilingual facilities.
- Provides enterprise wide reporting and decision support.
- Presents opportunity for re-engineering with industry best practices and templates.
- Presents opportunity to lever vendors' future investment in enhanced functionality.
- Incorporates new functionality and technology— provides a springboard to e-business.
- Eliminating legacy systems - reduces incompatible data.
- Creates foundation of e-business
- Standardisation.
- Helps obtain and maintain competitive advantage.
- Improved interactions with customers and suppliers.

place, for example, customer, financial data. This can increase the risk of loss of sensitive information.

Telecom: IT and the Telecom Revolution

One of the key challenges in support IT is the complexity in managing a plethora of technology component providers that need to be stitched together in an end-to-end architecture-based delivery model.

The telecom sector has witnessed a fascinating growth in India over the past several years. The sector comprises two classes of operators integrated service providers, such as providing services to all screens (like Bharti Airtel) and pure play mobile operators (like Vodafone). ITs significant role in both classes of operators may be categorised as support IT and product IT.

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Source: *Dataquest*, 29 February 2008, Vol. XXVI No. 04

(To read the complete case example visit www.mhhe.com/behl2e)

Implementing an ERP System

The ERP systems are complex integrated systems, needing different implementation strategies. Some organisations use in-house IT skills to integrate multiple software products, whereas some choose to implement only portions of an ERP system and develop an external interface to other ERP or stand-alone systems for their other application needs. In earlier days of ERP, methodologies deployed by the various systems integrators were not adequately tailored to the unique requirements of ERP. Most organisations relied heavily on first understanding the current process and then on understanding the organisations future processes before implementing a solution. The weakness of these methodologies is that it laid unnecessary thrust on redundant processes. In the second generation of ERP, new methodologies emerged that more directly addressed enterprise software implementations and stressed speed through a more direct approach, which included the use of conference room pilots, the deployment of templates, and greater leverage of best practices. In a short period, the market was saturated with 'success' stories of six month, four month or even two week implementations. While it is true that these new methodologies reduced the time needed to implement, the sheer acceleration created new problems, such as inadequate knowledge transfer,

abbreviated change management, and deficient post-implementation planning. Over a period of time, most of these methodologies have been refined to address such problems.

Owing to their wide scope of application within a business, the ERP systems are typically complex and usually forces significant changes within organisational work culture and practices. Implementing ERP systems using 'in-house' skills may not be possible, as the internal teams may not bring in the right kind of expertise and knowledge required for the project. It is advisable to hire ERP consultants even for smaller projects, as they can even be more cost-effective. The length of time to implement an ERP system depends on the size of the business, the scope of the change, and willingness of the customer to take ownership for the project. In order to implement ERP systems, organisations often seek the help of an ERP vendor or of third party consulting organisations. These consulting organisations typically provide three areas of professional services: consulting, customisation, and support. The client organisation may also employ independent program management, business analysis, and change management to ensure their business requirements remain a priority during implementation.

Some of the important guiding strategies for successful ERP implementation include:

(i) ERP plans of the organisation must match with its business plan;

(ii) ERP may lead to business process re-engineering, which brings in structural changes, roles changes, and process change;

(iii) Organisations need select the balanced ERP team with strong commitment from the top management;

(iv) Need to provide effective training to its users; and

(v) Appropriate selection of implementation methodology with strong commitment to change.

The ERP implementation is usually being done in the same manner as any other software project. So even for ERP projects, one needs to do the system planning, system analysis, system design, system building, and system implementation. The system planning deals with defining the scope and objectives of the system. The system analysis helps to understand the system the way it exists. The system design is to create new system specifications. The system building helps in creating the system in physical shape and form. The system implementation deals with appropriate conversion from the old existing system to new modified system. All these stages of system development and implementation are described in details in the subsequent chapter.

ERP Team. The ERP systems are very complex and it is not possible for one person to understand it completely. A team, including external consultants, is probably needed to select and build the best ERP system for the organisation. The selection of team is to be done with care and should made up of project sponsor, consultants, technical experts, business experts, and end users, who can determine how to configure ERP software properly.

Process Identification. It is important for the ERP team to identify the processes and carry out a detailed requirement analysis of these processes. Most of the ERP vendors have designed their systems around standard business processes, based upon best practices. The organisations that want to implement ERP systems are forced to adapt these standard processes. It is important for the organisation to identify the key business processes. If one does not map these processes, it may

lead to incomplete ERP implementation, which leads to failure of ERP. It is, therefore, important that organisations perform a thorough business process analysis before selecting an ERP vendor. This analysis also helps in identifying the right ERP vendor on the basis of maximum best fits.

Configuration. The ERP configuration is an activity through which one tries to configure the ERP to suit organisational needs. One may select the modules to install and then adjust the system using configuration tables to get the maximum benefit for the organisation. The configuration also involves mapping of existing processes onto the best fit processes offered by the ERP vendor. Most of the ERP vendors offer modular systems, that offer more flexibility. Depending on the nature of the business and scale of business, one can pick and choose different modules. The larger number of modules selection will lead to more integration benefits, but the implementation time and cost may go up. Next in the configuration is the Configuration table, which enables an organisation to tailor specific aspects of the system as per the line of business. For example, an organisation can select the type of inventory accounting—FIFO or LIFO. The organisations always have the option of modifying the code to customise the offering, but it always has number of drawbacks associated with customisation.

Customisation. The customisation of ERP means modifications or extensions of the standard ERP system to suit the organisation needs. The customising of an ERP system can be an expensive and complicated proposition. Some ERP vendors do not recommend customisation as they are not designed to support it. The idea behind discouraging customisation is to force organisations to implement the best practices embedded in the acquired ERP system and not to dilute that. Whereas some ERP vendors offer very generic features, customisation becomes the standard solution for effective implementations. Examples of customisation include creation of process triggers and workflow; system optimisation; extra reports; and complex data extracts or implementing business intelligence. The customisation also leads to re-writing some of the codes, which means dilution of integration benefits. The customised systems will always face problems with respect to updation and also reduces the communication level with the vendor. The customisation can be classified into:

- **Core system customisation:** The core system customisation is one where customers are allowed to change the vendors' proprietary code. This means that the software will no longer be supported by the vendor for the particular function that was customised as the code would be modified to the customer's need.
- **Custom extensions:** These are the ones where a customer builds bolt-on custom applications that run parallel to the standard system, i.e., custom extended applications. The modules that are extended will always have the core code that is not changed. Most of the ERP vendors share the source code with the organisations for customisation purpose.

Data Migration. In order to implement ERP system succesfully, it is important to migrate the data from old independent functional and legacy systems to common ERP databases. The steps that are important for successsful data migration includes:

(i) Identification of data that needs to be migrated;

(ii) Time plan of data migration;

(iii) Creating the data templates;
(iv) Tool selection for data migration; and
(v) Identification of data archiving techniques.

Maintenance and Support. The maintenance and support services involve monitoring and managing of an operational ERP system. This function is often managed by the internal IT department, or may be by an external consulting organisation.

Ambuja Cements: ERP Masonry

One of India's largest cement manufacturing companies, Ambuja Cements has taken many IT initiatives to integrate the latest technologies into its operational systems, so as to reap business benefits at every level of the supply chain. The IT team at Ambuja has always been forthcoming in experimenting new technologies. For example in 2001 the cement company was one of the first to deploy Red Hat Linux at remote sites for critical business applications.

Trend-setter

In 2008, Ambuja Cements launched Connect India Plus, which has proved to be one of the most significant, large scale IT deployment within the company so far. As the company's manufacturing plants are located in remote areas where the scope of connectivity was minimal, the resources, namely hardware, software, and people were located at plant sites. The overall integration of data was transferred and carried out in batches. During 2006, Ambuja decided to go for SAP as it is a standard system for all the group companies.

Within two years, Ambuja rolled out 'Connect India Plus' that was conceived as an ERP implementation program for installing SAP with all its modules at 200 locations across India and 2,500 users with a single instance on a server in Mumbai. The project kicked off on June 1, 2007 and went live on August 1, 2008, within a period of just fourteen months.

One of the prime reasons for deploying this ERP was to have a uniform, standard, and ubiquitous system across the organisation not only in India but abroad, so that Ambuja Cements could easily align with other group company processes. The project also promised a reduction in cost of operations and maintenance of the IT system. It would also enable Ambuja Cements to respond quickly to changes in the business environment.

Challenges

However, the IT team faced immense challenges while implementing this enterprise-wide ERP. Since the company had multiple plants, each with their own computer systems and processes, there was a need to create a single business blueprint across the organisation. On the people front, there was a need to integrate individuals with diverse background to be able to work as a focused team.

Besides, the core team consisting of 75 members, there were 150 people involved indirectly or directly for data migration, training, etc. All this required enormous amount of man-management skills. The refreshing of the infrastructure was another critical challenge as the IT team took on the task of setting up an adequate and reliable WAN using MPLS and VSATS, connecting 200 locations including factories, bulk cement terminals, grinding units, regional offices and warehouses.

The data migration was another major challenge since data had to be imported from eight different legacy systems. The standard master data codes had to be mapped with the legacy codes and data had to

be updated at one go. The company had a dedicated team and full support of business users from various locations, who worked relentlessly to achieve this mammoth task.

After the successful implementation of SAP, the company has been exploring some cutting-edge technologies to improve supply chain. It has implemented a sophisticated smart-card based vehicle tracking system to improve operational efficiency in terms of cycle-time monitoring and fleet management. This has helped the company determine the exact cycle for vehicle carrying cement from the factory to a destination, and carrying raw material as a return load back to the factory. The information is dispatched to customers via SMS.

Source: *Dataquest*, February, 2009

Conversion Strategies

Once the ERP systems are designed and developed as per the organisation needs, it is important for the project team to implement it effectively. For effective implementation, one needs to convert the old systems and process to the new one. One may convert the old system to new using multiple conversion strategies, but one may not fit all kinds of organisations. Some of the popular conversion strategies being used are as follows:

- ***Phased implementation.*** The phased implementation strategy allows the organisations to implement the ERP in modules, as most of the ERP systems are available in modules. This implementation strategy is also known as 'Modular Implementation.' This is a widely used implementation strategy as it minimises the risk of failure. This strategy can also be used to implement independent modules of ERP systems location-wise, while integration of ERP modules is done at the later stage of the project. This implementation strategy is quite popular with those projects where the team is not very clear about the complete scope of the project, or there is a resistance to change among users. The successful implementation of one module can help in building clarity and confidence among the team members.
- ***Big-Bang implementation.*** In big-bang implementation strategy, the ERP team simultaneously starts implementation of multiple modules either at one location or at multiple locations. In this, the organisation is clear about the complete scope of the project and also has clear understanding of the priorities. The installation of various modules of ERP systems happens across the entire enterprise in one go. The big-bang approach helps the organisation in cutting down the implementation costs and time. It carries higher risk, if not tested properly, will leads to failure of ERP and also in turn failure of the organisation.
- ***Process oriented implementation.*** The process oriented implementation strategy helps organisations to focus on selected critical processes. This approach is quite similar to phased implementation approach. It is followed to minimise the risk associated with ERP implementation. It also helps in getting better clarity about the business processes and business objectives. This approach is primarily followed by small and medium enterprises (SME).
- ***Vanilla implementation.*** The vanilla implementation strategy allows organisations to implement ERP in the traditional manner with less or without any customisation. In this, most organisations tend to follow the offerings of the ERP vendor.

Why ERP Projects Fail?

The ERP implementation is considerably more difficult and politically charged in organisations structured into nearly independent business units, each responsible for their own profit and loss, because they will each have different processes, business rules, data semantics, authorisation hierarchies, and decision centres. The solutions include requirements coordination negotiated by local change management professionals or, if this is not possible, federated implementation using loosely integrated instances specifically configured and/or customised to meet local needs. The ERP projects fail because of many reasons. Some of the reasons for failure are:

- Poor technical methods
- Communication failures
- Poor leadership
- Poor initial evaluation of project
- Political structure of the organisation
- Customisations also make the software more unstable and difficult to maintain
- **Organisational factors**
  - Changes in scope
  - Sufficiency of resources
  - Magnitude of potential loss
  - Departmental conflicts
  - User experience
- **Management support**
  - Changing requirements and scope
  - Lack of commitment
- **Software design**
  - Developing wrong functions, wrong user interface
  - Problems with outsourced components
- **User involvement**
  - Lack of commitment
  - Ineffective communication
  - Conflicts
  - Inadequate familiarity with technologies
- **Project management**
  - Size and structure
  - Control functions
- **Project escalation**
  - Societal norms
  - Continue pouring resources into sinking ships

In order to make it successful one needs to link each current organisational process to the organisation's strategy; analysing the effectiveness of each process in light of its current related business capability; understanding the automated solutions currently implemented and take the people along as per the software needs. The internal users of the organisation need to adopt the work methods outlined in the software.

CUSTOMER RELATIONSHIP MANAGEMENT (CRM)

The CRM is an integrated information system solution that allows identification, acquisition, retention, and expansion of customers. By enabling organisations to manage and coordinate customer interactions across multiple channels, departments, lines of business, and geographies, CRM helps organisations maximise the value of every customer interaction and drive superior corporate performance. The organisations need to manage customer interactions across all touch points of customer like POS, Web, Call Center, Direct Sales, and through dealers and retailers (refer Figure 10.2). Many organisations also have multiple lines of business with many overlapping customers. The challenge is to make it easy for customers to do business with the organisation in any way they want—at any time, through any channel, in any language or currency.

The CRM is the process of getting and keeping customers and maximising their profitability, behavior, and satisfaction.

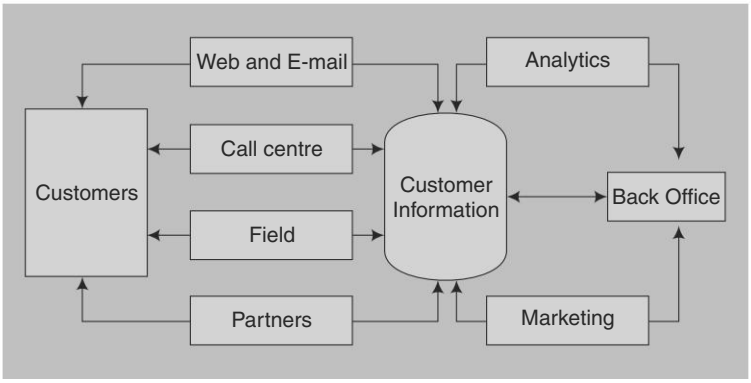

Figure 10.2 Customer Relationship Management

The successful CRM focuses on understanding the needs and desires of the customers and is achieved by placing these needs at the heart of the business by integrating them with the organisation's strategy, people, technology, and business processes. At its most basic CRM involves customers, organisations and relationships, and the combination creates the need for management. It is the rebirth of a belief that at the heart of all transactions is the creation of mutual value for all parties.

The CRM is about creating a competitive advantage by being the best at understanding, communicating, delivering, and developing existing customer relationships in addition to creating

and keeping new customers. The concept of product life cycle is giving way to the customer life cycle, focusing on developing products that anticipate the future needs of existing customers, and creating services that extend existing customer relationships beyond the merely transactional. The customer life cycle will focus on increasing the lifespan of the customer with the organisation rather than the continued existence of a particular product. A good CRM implements a paradigm shift from what ('product') to who ('customer').

A good CRM strategy will take the business vision and apply it to the customer base by asking the questions:

- What products and services are we offering now and in the future?
- In what markets and locations?
- What customer groups will these products and services appeal to?
- Which of these offer maximum value to the organisation?
  - In terms of spend?
  - In terms of reliability?
  - In terms of profitability?
  - In terms of growth potential?
- What are the additional needs in terms of products or services the most valuable customer groups have?
- What value will CRM deliver to the business?

For many years, organisations have endeavoured to understand the customers that buy their products. Despite this, many organisations fail to understand their customers. Typically, an organisation should be able to answer questions such as:

- What product did they bought last time?
- When did they call last time and for what?
- Which channel they used last time to buy their products?
  - Website?
  - E-mail?
  - Phone call?

In reality, many organisations do not even know their customers or, how many customers they have. Finding out the existing customers and their needs is very difficult. Despite all kinds of efforts, many will find that their customers still act indecisively, unpredictably, unproductively, and often find them dissatisfied and disappointed with the result of their transaction. The solution is to know our customer and its needs.

Extracting Diamond from CRM

The knowledge-based businesses collect data on their customers to provide them with a framework to build an understanding of the market. The improvements and innovations in technology, a key enabler of customer data collection, have provided organisations with the ability to store, share, analyse, and transfer large amounts of data at low costs. The growth in the use of sophisticated

databases, ERP, data warehouses, and data mining software applications make it possible for companies to analyse customers' behavioral patterns, individual levels of profitability, and the lifetime value of their customer. However, most businesses underestimate the wealth of customer knowledge within their own organisations. The integrated information systems that interconnect various functional systems in an organisation can provide valuable insight into the customers' behavioural patterns. Like a diamond, there are many perspectives that are in existence. The ERP is a technological solution that organisations must implement before implementing CRM, as over time, channels and operational systems are added to cater to changing customer demands. It results in several functional groups interacting with customers independently. The ERP offers the power of integrating data from all customer touch points.

The advanced data analysis techniques can produce statistically grounded behavioural models that more accurately project customer behaviour in a variety of situations:

- The likelihood of purchase of a specific product or service,
- The best next offer,
- The probability of defection.
- Customer retention:
  - (i) Model those customers who have defected (churn modelling)
  - (ii) Identify patterns that led them to defect (churn)
  - (iii) Apply model to current customers to identify who are likely to churn
- Sales and customer service:
  - (i) Market basket analysis finds sets of items that appear frequently together in a single purchase
  - (ii) Facilitates better point of purchase merchandising:
    - Floor and shelf layout
    - Web page catalogue design
- Marketing:
  - (i) Customer profiling
    - What type of customers buy what products
  - (ii) Direct marketing
    - What customers to target with what promotions
  - (iii) Market segmentation
  - (iv) Cross selling

Most of these models are specific to the organisation's existing customer base and are not based on assumptions about lifestyle characteristics or demographic profiles that account for the segmentation principles applied to the majority of direct marketing activities in organisations. As the CRM strategy progresses, considerable ongoing performance measurement is required. For more comprehensive analysis, these internal information sources will need to be coupled with external feeds, such as, customer surveys.

The measurements and analysis supported may include:

- Customer Segmentation
- Customer/Product/Channel profitability
- Demand Forecasting
- Campaign Analysis
- Channel Effectiveness
- Sales Analysis
- Cost-to-serve
- Revenue Optimisation
- Customer Lifetime Value (LTV)
- Customer Churn/Propensity to Churn
- Customer Satisfaction
- Customer Complaints

Creating Customer Value

The intelligent data analysis provides the mechanisms for managing meaningful relationships with our customers. The data analysis can direct the design of marketing communications, the management of quality service delivery, establish a basis for ongoing dialogue, the development of quality products, and a number of other outcomes that translate into long-term profitable relationships with the only source of sustainable customer revenues.

The management of customer value is a cyclical process that has four key steps as discussed below.

- ***Define Customers' Actions.*** The first stage in creating customer value is to understand the customer base. The analysis of existing data can provide information about segmentation, behavioural characteristics, and profitability, and churn rates that create an understanding of customers.
- ***Determine Customers' Expectations.*** The expectations while difficult to manage, are often the cause of dissonance that results in loss of customers. Understanding the needs and wants of customers with regard to the service delivery levels and product quality is essential if ongoing, mutual value relationships are to be established and endured.
- ***Design the Customer Value Model.*** The customer value model will help to deliver the combined understanding of customers' behaviour, and needs in the most cost-effective manner. Defining the customer journey, performance measurements, and product offerings will all be critical at this stage.
- ***Deliver Customer Value Model.*** The implementation of the integration of systems, processes, service providers, business technology, and infrastructure in addition to the creation of measurement systems to monitor the progress.

Media : Benchmarking with the Best

IT is gradually being adopted as a strategic tool in top media companies. The process excellence, multi-channel convergence, and innovation are keys to success.

Now, more than ever, traditional media like newspapers and magazines are under pressure to increase revenues and cut costs. The changing consumer behaviour and the rising tide of new media have fragmented traditional markets, making it increasingly difficult to win and retain customers. With pressure on circulation figures and advertising sales, media men are looking for new and better ways of generating business while maintaining their existing customer base. Similarly, on the editorial front, there is a continuous challenge to move from just being print centric to more content centric on account of huge shift in the way content is being consumed today. The content is increasingly getting more personalised, becoming collaborative and consumed on-demand across multiple channels.

IT in media has matured over a period during the last couple of years, and has come to play a significant role by moving up the value chain in almost all core processes in the set-up. IT is gradually being adopted as a strategic tool in top media organisations, more so if they are to remain both competitive and maintain leadership positions in these changing times.

Best Practices

It may be worthwhile to note that there is no single end-to-end solution that covers the entire media landscape and its processes, be it print, broadcast, or Internet. It is even more dangerous to look for one monolithic solution lest you may get stuck with inefficient, sub-standard solution for some of our key business needs. Hence, one has to acquire and integrate best-of-breed solutions from different vendors who specialise in some of your key core processes. The key point to note here is that the solutions should be transparent and open, to allow seamless integration.

In order to facilitate the transformation necessary for scalable digital business models, all IT solutions would require to be built using open standards, Web services, XML interchange methods, and a Service-Oriented Architecture (SOA) which in turn, helps to create a systems environment that supports interoperability. This framework will help promote agility and extensibility in the fast moving, constantly changing environments that define the current global media organisations.

In order to build support for multi-channel publishing, one would require separate content planning, procuring and packaging from the other processes in the editorial and advertising value chain, namely, content enhancing and publishing, delivering, or broadcasting. While the first set of processes may be managed centrally and in a media neutral way, the second set of processes will depend on the specific output channel.

The content management system should, therefore, be capable of managing each publishing channel through direct control or by integrating other publishing tools, such as for Web or broadcast channels.

Business Benefits

IT has been delivering and adding value to media business by streamlining the key processes, making them more efficient, scalable and agile. Today, solutions for enterprise resource planning, supplier relationship management, supply chain management, product life cycle management and customer relationship management along with industry specific solutions like ad-sales management, circulation sales, subscriptions and digital rights management provide strong support for core business processes in a media set-up.

Today, CRM solutions for media provide a comprehensive, real time solution that manages all customer interactions from marketing to sales to service. With complete customer life cycle management, marketing can now maximise every customer interaction, optimise their marketing spend, and develop long-term, profitable customer relationships. In print media business where subscription sales (or pre-paid business) provide a very stable revenue stream, the right marketing strategy holds the key to successful business.

Through the CRM platform, marketers are able to identify and measure the success of their marketing activities, know what offers are most successful, anticipate customer needs and preferences, and identify potential opportunities. Not only this, marketing is also able to track competitive schemes and promotional advertising. The CRM tools also facilitate content and cover analysis for providing valuable feedback to editorial on changing consumer tastes and preferences.

Thanks to the seamless end-to-end data flow, support for all Intellectual Property (IP) related processes have significantly helped media organisations to increase revenue from sales and licensing of all types of IP rights, and deliver accurate royalty accounting for both receipts and payments of royalties. The businesses can explore new revenue streams to target niche groups efficiently, realise opportunities for cross selling and up-selling, and develop new advertising and revenue-producing products.

Vendor Relationship

In an age where consolidation and acquisition/mergers are the norms of the day, and dynamics of the business, specifically, in media and entertainment, which is changing so rapidly, it is too risky to have a one-throat-to-choke approach for the vendor providing solutions for our business. Establishing multiple vendors for solutions makes more sense as long as solutions conform to an open standards framework (XML, Web services, SOA et al.). Justification for standardisation has been that integrating products from multiple vendors along with the data from multiple systems costs much more than standardising on fewer vendors. Unfortunately, few of us in IT compare the potential costs of integration with the costs of dependency on one vendor product or solution. With fewer vendors in the IT portfolio, we may even limit our negotiating leverage; vendors wont budge on terms if they do not think they have competition.

The vendors attempting to make their foray in media must know that processes, standards, and the business dynamics of this sector are quite different from some of the other sectors like BFSI and telecom where IT is perhaps at a much-matured level. But all that change is happening in this sector and happening very fast. The media organisations are rapidly embracing IT and benchmarking itself against the best of industries on IT adoption to remain both competitive and ready to take on challenges specifically from the new converging digital domain.

Source: *Dataquest*, 29 Feb, 2008, Vol. XXVI No. 04

Benefits of CRM

A clear understanding of the business and its operations is critical to the success of a CRM strategy. Even after accepting that CRM is wider than sales, many organisations are still unaware of its full impact across the organisation. The organisations are even not clear about where improvements can be made. There are numbers of research studies, which have proved that:

- It costs six times more to sell a new customer than to sell to an existing one.
- A typically dissatisfied customer will tell 8–10 people.
- By increasing the customer retention rate by 5 per cent, profits could increase by 85 per cent.

- A 5 per cent increase in retention rate can increase the profit by 60 per cent.
- Odds of selling to new customers is 15 per cent, as compared to those for existing customers which is 50 per cent.
- It is six times more expensive to service customers through a call centre as compared to Internet websites.
- The 70 per cent of the aggrieved customers will remain loyal if problem is solved.
- The 90 per cent of companies do not have the sales and service integration to support e-commerce.

As illustrated in the customer value management model, the organisational processes create the building blocks from successfully extending the customer's lifetime with an organisation, inherently and directly increasing their value and profitability. The organisations can implement the CRM solutions to get benefit in many of the processes like Product development; Channel management; Marketing planning; Sales; Inventory management; and Customer service etc.

Why CRM Projects Fail?

There could be many reasons why CRM projects fail. Some of the common mistakes that occur are:

- Project goals are not defined properly before the project commences.
- Trying to implement CRM solutions without analysing the underlying organisational and process changes needed to solve CRM problems.
- Lack of top management commitment.
- Misconception about the solution that it can create organisational change.
- Underestimating CRM costs by not including factors such as customisation, integration, internal resources, training costs, learning curves, ongoing maintenance (both internal and vendor licence), and opportunity costs.
- Not applying the knowledge gained from past project experience.
- Failing to closely monitor the project once it has commenced to discover deviations between actual and expected cost, benefit, and ROI.
- Underestimating the amount of integration needed between CRM projects and other organisational projects like ERP and BI both from process and technical perspective.

Other than the above mentioned generic problems, there could be many problems that are operational or process based which cannot be addressed using technology. The solution to these kinds of problems may lie in business process redesign, change management, training, or improving internal communications. Some of the symptoms of operational or process issues may include:

- Internal bottlenecks may be because of internal politics resulting in delays in fulfiling customer requests.
- Sales teams are not empowered enough to take decisions.
- Inadequate training and lack of knowledge about new systems and technologies.

- Business processes are not completely updated to leverage automated systems, thereby requiring redundant work and increasing turnaround times.

It is important to note that the improving processes or redefining processes, may cost less as compared to investing in new technology. The process solutions may require extensive change management plans, both upon implementation, and even afterwards. The alternatives for process changes may include:

- Reorganising staff and/or reporting relationships
- Introducing new metrics to measure processes and staff performance
- Restructuring processes to increase efficiency and reduce 'silo' communications
- Providing effective training

One has to remember that the technology is a tool used to empower, not replace, business strategy. It needs to be applied thoughtfully and purposefully in order to affect its intended return on investment. If the organisation has already or is in process of streamlining the operations may need to further improve access to information, speed of transaction processing, coordination of stand-alone processes, analysis of customer data and patterns, and/or understanding of sales modelling, they must integrate the technological solutions. The various symptoms of technology issues include:

- inability to access information easily or timely by sales and/or marketing staff,
- multiple product and service lines aimed at similar target markets but supported by independent, stand-alone systems,
- inability to centrally analyse sales forecast data and compare it to actual order records,
- inability to identify marketing targets from historic client data,
- inability of automated systems to support cross selling efforts,
- inadequate information to take decisions about customer preferences, and buying habits.

CRM Solutions

The CRM product solutions are automated applications that support the accomplishment of corporate goals related to customers, such as increased revenue and/or increased sales efficiency. These CRM technologies capture customer data from across the enterprise, then analyse, consolidate, and/or distribute it for use across the multiple customer interactive departments or processes within the organisation. The different CRM product solutions and possible business goals are summarised in Table 10.2.

1. **Customer/Partner Self-Service Systems:** It enables the organisational customers, suppliers, and/or partners to use the Internet to gain information that is directly relevant to them. This may include customised product selections, order status update, online order entry, or self guided query and response. The examples of these systems include e-mail response management systems, web personalisation systems, web-based order-entry, and web self help.

2. **Sales Force Automation Systems:** It provides tools for the organisational sales team to maintain their contacts, track sales prospects, provide sales forecasts, enter and track orders, and provide customised quotes for clients. The examples of these systems include online sales forecasting and order tracking.
3. **Call Centre Systems:** It provides support for employees that answer customer queries or respond to requests for dispatch services. The examples of these systems include web-based customer service, customer service call tracking, improved customer service representative (CSR) access to client information, and automated dispatch and tracking.
4. **Operational Billing/Order System Integration Systems:** It provides integration as well as migration between customer-interactive (front-end) application, and the production (back-end) order status and financial systems that contain the data that clients and partners may seek. These systems are not only CRM systems, but rather the components of larger software suites that may include CRM. The examples of these systems are packaged accounting and manufacturing systems that have CRM front ends or an ERP system with integrated CRM solution.
5. **Lead Generation Systems:** It enables targeted marketing based on client needs and/or past business trends. This lead generation could be dynamic or static. The dynamic lead generation means e-mail offers or customisation of web content. The static lead generation provides targeted databases of client by type. These systems include customer data mining, automated marketing campaigns, and customer personalisation tools.

Table 10.2 CRM Solutions and their Business Goals

CRM Solutions	*Business Goals*
Customer Self-service	Increase cross selling revenues and decreased cost of sales
Customer Service	Improve customer service
Sales Force Automation	Increase sales efficiency
	Reduce cost of sales
	Increase revenue
Call Centre	Decrease cost of customer support
	Increase customer service
Lead Generation	Increase quality leads
	Reduce cost of sales
	Increase revenue
Customer Service Integration	Increase customer service
	Process quality and/or efficiency
	Increase customer satisfaction
Enterprise Wide CRM	Any or all of the above

Figure 10.3 gives clarity between the front office and back office CRM applications and how these applications are integrated with each other. The figure also clearly defines that there are three types of CRM:

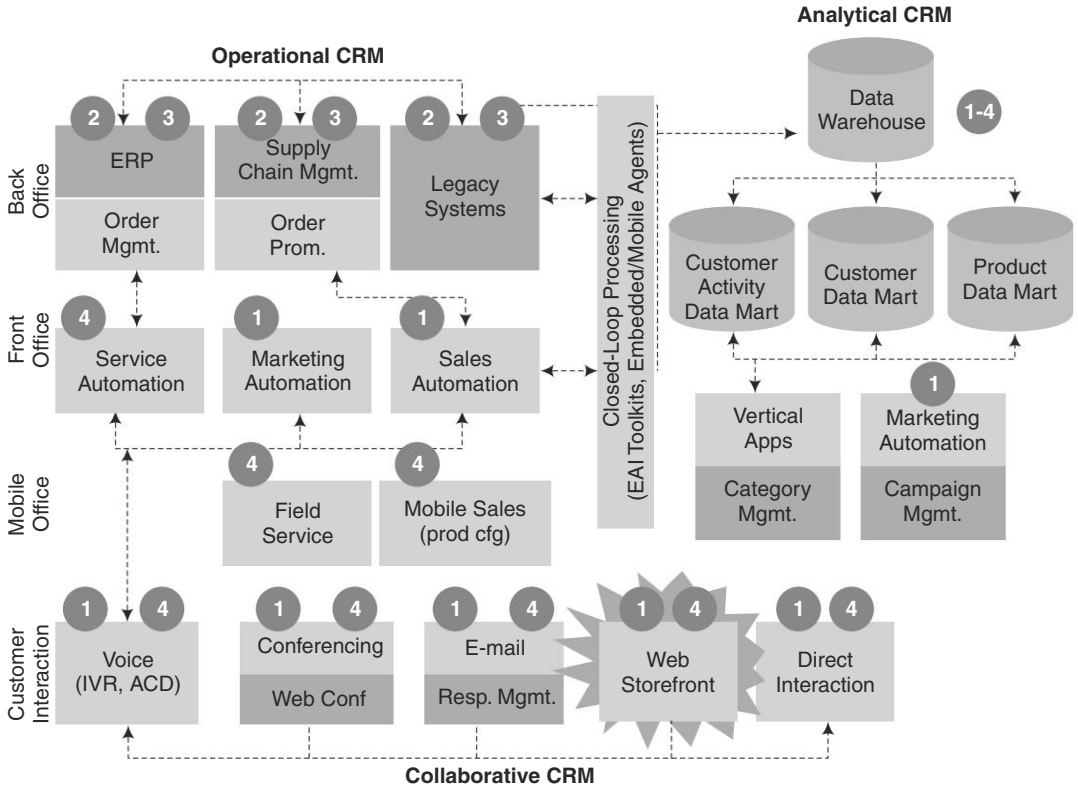

Figure 10.3 Integrated View of CRM Applications

- ***Operational CRM. This also known as front office CRM. The operational CRM involves areas where direct customer contact occurs—called customer touch points***. It enables and streamlines communication to and from the customers and does not necessarily imply optimisation of service. For example, a banking customer just checks account balance through a website touch point does not mean that they would not prefer a branch office touch point instead.
- ***Analytical CRM. This also known as back office CRM. It involves understanding the customer activities that were occurred in the front office using technological tools***. In analytical CRM, technology is used to compile and process customer data to facilitate analysis; to refine customer interactive practices; to increase loyalty, and profitability. The analytical CRM allows the organisation to provide differentiation in customer interaction—address individual customer needs rather than broad customer segmentation.
- **Collaborative CRM. It uses different communication tools like e-mail, voice mail, etc. for effective communication between different customer related activities.**

In the above figure (Figure 10.3), 1 refers to targeting, 2 refers to acquiring, 3 to retention and 4 to expansion. If one studies the figure, one may find the relationship between CRM activities and technological tools.

E-CRM

In a rapidly changing global business marketplace, organisation-customer relationships directly impact the brand equity, owing mainly to an unprecedented speed in information and communications technology like Internet. Also added to this is the customer's desire to move across media while expecting seamless consistent services. It is becoming challenging for organisations to attract, serve, and retain the customers and make profits. The Internet and mobile has become new channels for the organisation to reach out to their customers. In order to serve them better, it is becoming important for them to implement E-CRM. ***The E-CRM expands the traditional CRM techniques by integrating technologies of new electronic channels such as, web, wireless: and voice technologies***. Essentially, E-CRM helps in enabling a customer oriented organisation to deliver an extended infrastructure to customers and partners in new ways—to proactively learn customer needs, add value, gain new economies in scale/time/costs, reach out to new customers, and deploy innovative retention strategies.

The E-CRM integrates the traditional CRM applications on new media like mobile and Internet.

All customer interactions, regardless of origin, are seamlessly coordinated so that customers receive the same knowledgeable, personal service across the organisation's sales and service channels, regardless of the method of touch point communication. The E-CRM basically enables seamless 'integration and automation' of previously manual tasks and processes through the use of the Internet. The E-CRM enables organisations to leverage new technologies by integrating multiple communication channels, business processes, and people. The E-CRM essentially adopts a customer centric approach of doing business by putting the customer first. In short, E-CRM is all about discovering and delivering value to customers. Knowing clearly the needs of the customer that will help organisations in developing better and successful products.

The E-CRM can contribute incontrovertibly to organisational transformation into a real-time enterprise for customers, while harnessing the power of technology in a rapidly changing competitive landscape. The major benefits that accrue are new sales and account opportunities, smarter decision-making, and better efficiencies leading to significant improvement in customer service.

E-CRM allows to Create

- Extended customer relationships
- Competitive services, delivering high value
- Improved product and service delivery processes
- Better customer knowledge and insight
- Smooth, efficient customer service

Like traditional CRM, the market is confusing; in many cases, organisations have failed to come closer to the underlying business issues. Although, the early Internet based operations were largely centred on e-commerce, the bigger picture is, once again, enterprise wide e-business systems. It also includes Web self-service, where customers are able to access information for

PVR Cinemas: What Moves Movies

Technology has been a key enabler at PVR, helping them concentrate on their core job to offer a captivating movie watching experience

Right from the time we buy the movie ticket, till we step out of the multiplex movie watching is like an absolute experience: the great picture quality, sound, even the popcorn we pop in are all part of the package.

Things obviously haven't changed overnight. It's taken a whole decade to make the huge difference. And there is little doubt that one player has a huge role in bringing about this change to the world of entertainment PVR Cinemas.

The journey started with PVR giving India its very first multiplex in Delhi in 1997. The PVR now has an unmatched 101 screens across the country. Infact, technology has been a key enabler at PVR right from its inception. The inclusion of technology has always been key to PVR right from the day it was started. At present, all the existing cinemas at various locations are connected to each other by BI applications at the backend.

It has not only helped make all data automated at PVR but has also given a centralised control, which helps monitor the functioning of this network of halls. The management can see data across all the PVRs, which helps in having a better perspective on things.

CRM in Entertainment

With the introduction of online booking, which now constitutes 13% of PVRs ticket sales, and more competition from other players, there was an increasing need to be more customers driven.

The PVR receive a lot of complaints from people who were booking online. A lot of times payment was deducted from their credit cards but the ticket were not booked. So, all this needs to be checked manually at the backend, which was a difficult task.

The need for automation was felt to minimise this manual interface, and address faster solutions to customers problems. The other things that pressed PVR to go further with technology and continue to be a pioneer in the field of entertainment was the urgency to have speedy reaction time to customer mails, increased advanced online bookings, and customer feedback, which was many a times hushed up at the cinema manager level.

The management also wanted to check if there is a pattern in the customer feedback. They want to be sure about how and what is being done is being received well, and also the fact that they wanted to have snapshots of longer periods.

All this and much more prompted PVR to go live with its CRM program in April, 2008. The PVR zeroed in on Microsofts application, while an IT team internally handled the project. The company is also planning to make the bookings done at the box office automated, and launch RFID. Right now the footfall is so high, so they will take some more time to do that.

Meanwhile, currently the PVR is working on its new website with a fresh look, and planned a lot of things for online. The Website will also be collaborated with online networking sites Facebook and Orkut. The company has already launched its digital screens in Delhi and Mumbai. The new multiplex has 2k digital cinema, compliant with DCI technology, and advanced sound and picture quality. In these times of recession, which has not spared the entertainment industry, technology is helping them in get an edge over other players.

Source: *Dataquest*, February, 2009

themselves by interrogating intelligent automated systems on the Internet. As such, the Internet provides another infrastructure or channel for organisations to interact with their customers, in the same way that they currently deal on the telephone, fax or e-mail. However, treating the Internet as merely another channel to market is liable to leave the organisation exposed. The traditional CRM systems are effective only if they embrace back office operations, such as logistics and finance, so customer-interactive e-business operations must be built around strong back office functionality. Many of the early e-business sites fell apart because organisations focused too heavily on the front end website, rather than ensuring that the back end systems and processes were up to scratch. In some instances, the organisations failed to integrate the front and back office systems; as a result, they found themselves having to re-key data extracted from the website into their traditional order processing systems. Some organisations simply failed to take account of the different business imperatives of the Web environment. Several organisations, accustomed to selling in bulk, launched customer sites, only to find that the logistical costs of shipping individual customer orders destroyed their margins.

Every organisation now has to grapple with the impact of customer management over the Internet. Faced with a choice of suppliers with similar offerings, a customer will typically choose that organisation which is easiest to deal with. They may have a preference for dealing by telephone or e-mail, but they may be sufficiently Internet savvy to find out information for themselves and conduct transactions over the Web. In all probability, they will want to deal through different communications channels at different times—sometimes even simultaneously. This kind of multi channel customer management is becoming increasingly critical in developing a CRM strategy, particularly in customer service. As such, Internet capabilities are an essential factor when it comes to assessing offerings from CRM suppliers. Some of the simple applications of E-CRM include the following.

1. **Interactive voice response (IVR) systems:** The automated voice systems, which respond to telephone calls and offer callers key pad driven options form one method of routing and prioritising calls and can help to reduce the duration of calls. However, the process is criticised by many for being cumbersome and intrusive.
2. **Intelligent e-mail management:** The e-mail management is a fast growing area of CRM, and auto response technology has huge potential. The intelligent systems can search for key words in e-mails and suggest several possible responses, ranked in order of probable accuracy. Typically, an auto suggest facility routes the proposed answer to an agent who checks and forwards it. In basic cases, the response can go directly to the user (auto respond).
3. **Web base FAQs:** The Web offers large potential savings by encouraging visitors to find out answers for themselves. At a basic level, this consists of pages showing the answers to frequently asked questions (FAQs). The more intelligent systems can search vast knowledge bases for answers. While this process can filter out some queries, users must be able to assess live agents. This can be done indirectly by 'call-me' requests from the Web. The customers can also engage in live text-based discussions with agents ('chat') while online. Increasingly, voice-over-Internet protocol technology will allow users to talk while online.

SUPPLY CHAIN MANAGEMENT (SCM)

The supply chain is an important process that includes controlling and deciding the direction of resource movement in an organisation. It also includes all other sub process involved in coordinating them. The concept of supply chain and its management is not a new one. It has been in existence from many years. However, ERP has helped to reduce their inaccuracies and increased the performance of supply chain. It is important to know about ERP and supply chain management at length.

A supply chain is the stream of processes of moving goods from the supply of raw materials to production to distribution of products to the customer.

The supply chain is an integrated group of processes to 'source,' 'make,' and 'deliver' products (refer figure 10.4). All organisations have supply chains of varying degrees, depending upon the size of the organisation and the type of product manufactured. These networks obtain supplies and components, change these materials into finished products, and then distribute them to the customer.

What is Supply Chain Management?

- A set of approaches used to efficiently integrate
  - (i) Suppliers
  - (ii) Manufacturers
  - (iii) Warehouses
  - (iv) Distribution centers
- So that the product is produced and distributed
  - (i) In the right quantities
  - (ii) To the right locations
  - (iii) And at the right time
- System-wide costs are minimised.
- Service level requirements are satisfied.

Managing the chain of events in this process is what is known as supply chain management. The effective management must take into account coordinating all the different pieces of this chain as quickly as possible without losing any of the quality or customer satisfaction, while still keeping the costs manageable.

The first step is obtaining a customer order, followed by production, storage and distribution of products and supplies the order to the customer site. The customer satisfaction is paramount. Included in this supply chain process are customer orders, order processing, inventory, scheduling, transportation, storage, and customer service. A necessity in coordinating all these activities is the information service network.

In addition, key to the success of a supply chain is the speed at which these activities can be accomplished and the realisation that customer needs and customer satisfaction are the very

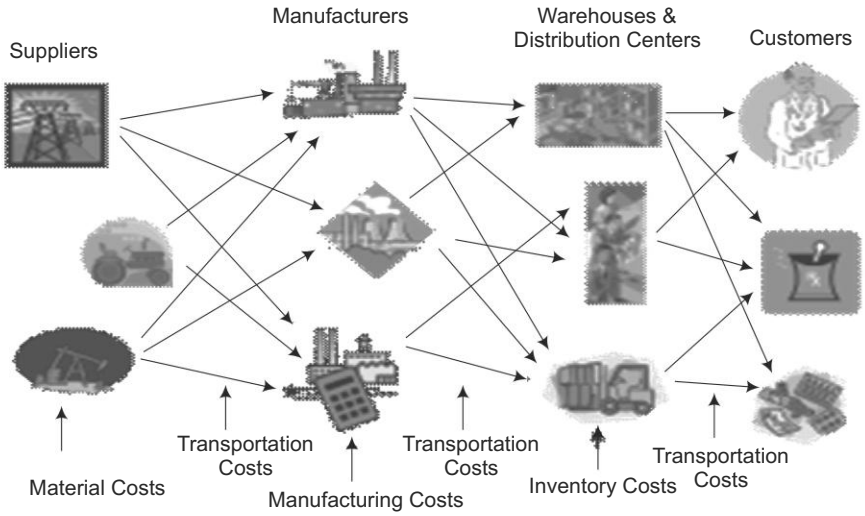

Figure 10.4 SCM Model

reasons for the network. The reduced inventories, lower operating costs, product availability, and customer satisfaction are all benefits, which grow out of effective supply chain management.

The decisions associated with supply chain management cover both the long-term and short-term objective. The strategic decisions deal with corporate policies, and look at overall design and supply chain structure. The operational decisions are those dealing with everyday activities and problems of an organisation. These decisions must take into account the strategic decisions already in place. Therefore, an organisation must structure the supply chain through long-term analysis and at the same time focus on the day to day activities.

Furthermore, market demands, customer service, transport considerations, and pricing constraints must all be understood in order to structure the supply chain effectively. These are the factors, which change constantly and sometimes unexpectedly, and an organisation must realise this fact and be prepared to structure the supply chain accordingly.

The structuring of the supply chain requires an understanding of the demand patterns, service level requirements, distance considerations, cost elements, and other related factors. It is easy to see that these factors are highly variable in nature and this variability needs to be considered during the supply chain analysis process. Moreover, the interplay of these complex considerations could have a significant bearing on the outcome of the supply chain analysis process.

Elements of a Supply Chain

There are six key elements to a supply chain, which are discussed below.

1. ***Production.*** The strategic decisions regarding production focus on what customers want and the market demands. This first stage in developing supply chain agility takes into consideration what and how many items to produce, and what, if any, parts or components

should be produced at which plants or outsourced to capable suppliers. The quality control and workload balancing are issues which are also needed to be considered with importance when making these decisions.

2. ***Supply.*** Next, an organisation must determine what their facilities are able to produce, both economically and efficiently, while keeping the quality high. An organisation needs to identify the source of supply required for production and also needs to take strategic decisions to determine the core capabilities of a facility and outsourcing partnerships.
3. ***Inventory.*** Further, strategic decisions focus on inventory and how much product should be available in house. The operational inventory decisions revolve around optimal levels of stock at each location to ensure customer satisfaction as the market demands fluctuate. The control policies must be looked at to determine correct levels of supplies at order and reorder points. These levels are critical for the day to day operations of organisations and to keep customer satisfaction levels high.
4. ***Location.*** The decision on locations depend on market demands and determination of customer satisfaction. The strategic decisions must focus on the placement of production plants, distribution, and stocking facilities, and placing them at prime locations to the market served. The decisions concerning location should also take into consideration tax and tariff issues, especially in interstate and worldwide distribution.
5. ***Transportation.*** The strategic transportation decisions are closely related to inventory decisions as well as meeting customer demands. The customer service levels must be met, and this often at times determines the mode of transport used. Often this may be an operational decision, but strategically, an organisation must have transport modes in place to ensure a smooth distribution of goods.
6. ***Information.*** The effective supply chain management requires obtaining information from the point of end use, and linking information resources throughout the chain for speed of exchange. Linking of the computers through networks and the Internet, and streamlining the information flow, consolidates knowledge, and facilitates velocity of products. The account management software, product configurators, enterprise resource planning systems, and global communications are key components of effective supply chain management strategy.

The supply chain has also been called the 'value chain' and the service chain. It is an operational strategy that, if implemented properly, will provide a new dimension to competing: quickly introducing new customised high quality products and delivering them with unprecedented lead times, swift decisions, and manufacturing products with high velocity.

The fast delivery is critical in most markets today. Many organisations address this market demand by carrying higher inventories. The inventory is a hedge against lead time. The higher levels of inventory are often maintained because an organisation is unable to produce the material within the time demanded by the market. Analysing the processes in the supply chain can identify the causes and facilitate solutions to reduce overall throughput time. The compressing time in the chain of events from the time a customer places an order until the order is satisfied can provide a competitive edge without the burden of carrying excessive inventory.

IT and Supply Chain Management

The information links all aspects of supply chain:

- E-business
  - Replacement of physical business processes with electronic ones
  - Cost savings and price reductions
  - Reduction or elimination of the role of intermediaries
  - Shortening supply chain response and transaction times
  - Gaining a wider presence and increased visibility for companies
  - Greater choices and more information for customers
  - Improved service as a result of instant accessibility to services
  - Collection and analysis of voluminous amounts of customer data and preferences
  - Creation of virtual companies
  - Leveling playing field for small companies
  - Gaining global access to markets, suppliers, and distribution channels
- Electronic data interchange (EDI)
  - A computer-to-computer exchange of business documents
  - Developed to reduce cost, delays, and errors inherent in the manual exchanges of documents such as: purchase orders, shipping documents, price lists, payments, and customer data
  - EDI differs from unstructured message because its messages are organised with distinct field for each of the important pieces of information
  - EDI industry committees define the structure and information fields of electronic documents for that industry
- Bar code and point-of-sale
  - The data creates an instantaneous computer record of a sale
  - One scanner can read multiple barcode symbologies
  - Symbologies can be used as data identifiers
  - Labels are very inexpensive to produce
  - Very high read reliability
  - Very fast read rate for conveyor applications
- Radio frequency identification (RFID)
  - The technology can send product data from an item to a reader via radio waves
  - RFID trials shows minimum 16% reduction in product stock outs
  - RFID equipped stores were 63% more effective in replenishing out-of-stock merchandise
  - Out-of-Stock items can be replenished three times faster with RFID

- Internet
  - Allows companies to communicate with suppliers, customers, shippers, and other businesses around the world, instantaneously
  - Introduces the management of virtual marketplaces like e-markets, net markets or exchanges, which are essentially Internet enabled markets, or intermediaries that connect disparate buyers with sellers within common vertical industries

With an objective to improve global supply chain performance, many organisations are outsourcing specific business functions to specialised companies like FedEx, DHL in order to manage their supplies, in terms of order management, inventory management, warehouse management, transportation management, distribution management, reverse logistics management, distribution centres, import/export management, and build to order management.

The companies like FedEx have the expertise and capabilities to help other companies execute a fully optimised, demand driven supply chain. Another example is of Dell Computers who sells made-to-order PCs online. Dell's supply chain model results in enviously thin inventory levels of typically less than 6 per cent of sales, when most of its competitor companies were holding more than five times. Another example is that of Cisco Systems, which maintains an Internet ecosystem that electronically links suppliers, customers, and manufacturers, processing over 80 per cent of customer orders via the web. Cisco has tried to develop a pure virtual distribution business model by partnering with FedEx.

IMPORTANCE OF ERP IN SCM

The ERP and supply chain management helps in coordination of resources. The organisation should manage the supply chain process. This remains true in any situation. The ERP acts as a tool that helps the companies to execute the things that are required for managing the supply chain in an effective manner. Any enterprise application be it MRP or MRP II or ERP is helpful for the organisation in planning and scheduling the required commodities. Since the function of supply chain is dependent on correct data, so ERP can certainly add value and meaning to the SCM process by way of rendering technical expertise not only in managing resources but also in handling crisis.

Comparison of SCM and ERP systems

	SCM System	*ERP System*
Objective	Integrating and optimising internal business processes of a single organisation as well as the interaction of the organisation with its business partners across the entire supply chain	Integrating and optimising internal business processes within the boundary of a single organisation
Focus	Optimising information flow, physical distribution flow, and cash flow over the entire supply chain	Optimising information flow and physical distribution flow within a single organisation
Goal	Constraint-based tool providing reasonable and feasible business plans based on the availability of the required key resources	Non-constraint-based tools providing business plans without the consider-ation of the availability of key resources

- The first generation systems tended to be closed (proprietary), monolithic and generally are not focused on enabling collaboration with suppliers and distributors.
- New ERP systems are Web-enabled, open, and component-based
- The ERPs become the facilitator, moving data from one function to another while managing the data centrally.
- It improves visibility and consistency of information by holding all data about sales, purchases, inventory, production, customers, suppliers, and accounts in one system.

The organisations, however, soon realised that although internal efficiency is important, its benefit would be limited unless complemented by increased efficiency across the supply chain. They also realised that, faultless flow of real-time information across the supply chain is the key to success in the emerging market scenario. Therefore, organisations started integrating ERP applications with SCM software. This ensures that the efficiency was achieved across the supply chain and there is a seamless flow of information. The ERP in such state of affairs, becomes a vital link in the integrated supply chain as it serves as the integrated planning and control system. The ERP enabled SCM system would include:

- Web-based procurement (e-procurement)
- Customer/Supplier Relationship Management (CRM)
- Collaborative planning, forecasting and replenishment (CPFR)
- Web-based Multi-location Advanced Planning & Scheduling (APS)
- Product life cycle collaboration
- Web-enabled order management
- Virtual fulfilment networks
- Web-based service and support
- Commit to Promise (CTP)
- Web EDI

ENTERPRISE WIDE INFORMATION PORTALS

A typical definition of an Enterprise Portal is a single gateway to an enterprise via corporate Intranet or the Internet, for access to relevant workflows, processes, application systems, and databases—integrated using common technologies and tailored to the specific job responsibilities of each individual.

In the past, finding the appropriate knowledge, or even being aware of all potential sources, was more a question of luck and intuition than anything else. Owing to this fundamental problem, portals are one of the most promising developments using Internet technology. The global industry leaders are deploying an enterprise wide corporate portal to deliver information and services from different business systems in a single, simple web destination that employees and partners from anywhere at anytime can use to build, sell, and support products faster.

The enterprise portal is a system that integrates information, people, and processes across organisational using technologies like internet.

The ERP and other business apps help TVS Logistics to expand three fold in just five years.

The technology plays a very important role in the logistics industry, but for long the industry has suffered from lack of domain specific solutions. However, the IT solutions market for logistics industry is getting more structured, owing to the advent of ERP vendors upping the ante in this space. One such company is Chennai based Ramco Systems which has created impressive proof points on successful deployments in the logistics vertical. A case in point is TVS Logistics Services (TVSLSL), a Chennai based third party logistics (3PL) player with 6 affiliate firms in India and abroad, and it has created a pro active IT backbone, and accrued defined benefits.

Overcoming Challenges

TVSLSL handles logistics for the automotive industry. The task involved in servicing one customer order is quite complicated as typically in a manufacturing facility, over 50,000 parts are required at any point of time of which about 5,000 are fast moving. A 3PL service provider has a tough role to play as the job involves dealing with multiple suppliers to service a single order for its clients. "The only way in which we can survive such a big and complex ecosystem, is by having access to real-time information. It is the only technology that can enable this," says Harinath Chakravarthy, CIO, TVS Logistics.

Today, despite these challenging requirements, TVSLSL ensures timely availability of parts and components for production with virtually bare minimum inventory, by deploying the necessary pieces of technology across its processes and locations. The entire process is orchestrated using different types of IT solutions. From sophisticated operations and supply chain automation solutions, to GPS and biometric devices, to a range of analytics and web-based solutions, to enable real-time access to information.

Tryst with IT

Maintaining automation of the supply chain, and visibility across each stage has always been crucial for TVSLSL. But the biggest transformation in the company came after its deployment of the ERP in 2005. Prior to this, the company was using home grown IT systems, and a specialised accounting package. But what led the company to switch over to the ERP system was driven by an aggressive growth in business, and hence the company felt the need to opt for a more sophisticated and integrated IT solution like ERP, and it finally zeroed in on Ramco Systems ERP solution.

Ramco has deployed its web architected enterprise application with functions catering to 3PL players, which includes modules like transportation management, warehousing operations, procurement, sales, financials, and human capital management. In addition to this, Ramco has also provided TVSLSL a powerful business intelligence solution.

One thing that TVSLSL cannot afford to go wrong with is managing its supply chain. Logistics companies have rather unique requirements and dynamics. Because of these complexities, most of the big players in the 3PL domain have opted for home grown systems. They usually never buy IT solutions off the shelf. Given these inherent challenges, the company decided to build a Supply Chain Management (SCM) application to handle domestic transportation, international transport, time-to-market warehousing, and material handling solution in collaboration with Ramco Systems.

In order to leverage the power of IT more effectively, TVSLSL has made 2 significant technological interventions after the ERP implementation. They have upgraded to a new GPS technology stack to track vehicles and consignments in transit, which has alert generating capabilities. This capability has been integrated with the Ramco ERP system, which also integrated the biometric devices.

Source: *Dataquest*, March 15, 2011

The mission of a corporate portal is not only to provide a library of information, but also to actively support the user in their day to day business activities. Typically, majority of enterprises' knowledge resources exists as unstructured data in documents, reports, e-mail, graphics, images, audio, and video files. These data sources are largely inaccessible from data warehouses and information systems. The collaborative portals have been developed to give access to these unstructured data sources.

The corporate portals integrate with existing document management systems, enterprise resource planning systems, and corporate legacy systems. The fully integrated portals can provide access to business intelligence, knowledge management, online analytical processing (OLAP), and other data warehouse decision support functions.

The corporate portals as these are also referred to, brings the following features and benefits to the modern organisation:

Integration. It integrates the hundreds of thousands of web pages into one enterprise-wide web destination. The portal brings together millions of documents on organisation networks and the Internet in a single, searchable directory of links to files, web pages and reports. The employees can draw on a common base of best practices, market news, product specifications, performance metrics, and policy and procedures for the information they need to make confident business decisions and act quickly on revenue opportunities, with no geographical restrictions.

Personalisation. Each user can tailor their portal experience to their her role by choosing from a menu of options. In order to assemble a complete view of the business, employees can select options including e-mail, real-time news, stock reports, sales histories, personnel directories, self-service travel booking, corporate expense reporting, and pay and benefits, from personalised portal pages. In addition to job needs, the portal is designed to address personal needs; employees can customise human resources needs and health care such as stress relief tools.

Collaboration. In portal pages, employees can embed web-based workplaces, that organisations may deploy by the hundreds enterprise wide, for drag and drop file sharing, multi threaded discussions, real-time messaging and polling.

Community. In order to encourage collaboration, managers can create community pages of content and services shared by the entire business units.

Scalability. Being dependent on Internet technologies, these systems are scalable with the increase in load.

Security. The system remains secured allowing the employees to see only the content and services that correspond to their specific roles.

The corporate portals also give a new meaning and dimension to business intelligence (BI), by enabling intelligence tools to analyse one pool of data instead of the disparate data sources of the past. The BI, by its nature, consolidates, and analyses raw business data and turns it into conclusive, actionable information. It enables companies to tap into disparate sources of customer, operational and market data, and then use this information to gain a competitive edge. The results generated from BI applications also provide companies with the intelligence data needed to spot trends, enhance relationships, reduce financial risk, and create new sales opportunities. In addition, BI helps transform customer and operational data into knowledge, allowing companies

to make better decisions, gain competitive advantage in the market, control cash flow, detect fraud, and reduce costs.

SUMMARY

- An integrated information system helps the organisation to integrate all the functional systems. This will allow the organisation to capture the data from source and share it across the organisation.
- The integrated information systems allow sharing of data across functional areas and also allow joint execution of business processes across departments, allowing the effective management of cross functional teams. The integrated information systems also allow organisations to extend their systems to their business partners like suppliers, distributors, retailers, and customers.
- The approach towards integrated enterprise systems started quite early with material resource planning (MRP) systems. The initial MRP systems allowed the organisations to start with a sales forecast and develop production and raw material plans. As competitive pressures increased and users became more sophisticated, advances in planning systems became more advanced and integrated financial accounting systems to become an integrated system for manufacturing execution. This was later known as 'MRP II.' The sharing of long range production schedules between manufacturers and suppliers was the beginning of the concept of Supply Chain Management (SCM). The integration of manufacturing with supply chain introduced the concept of Enterprise Resource Planning (ERP).
- The ERP systems can be understood as an extension of MRP II systems. The ERP systems are the integrated enterprise information system solutions that integrate modules for accounting, finance, sales and distribution, human resource, material management, and other business functions based on a common architecture that link the enterprise to both customers and suppliers.
- The initial phase of ERP integrated only the routine functions and offered solution to its internal users (cross-functional, across departments). In the second phase of ERP, the solution was extended to integrate the external users—organisations' suppliers and customers. The current phase of ERP includes the complete solution for its players in the value system. The current ERP systems are also known as 'Integrated Enterprise Systems,' which includes end-to-end ERP system with web integration, supply chain management (SCM), customer relationship management (CRM), knowledge management (KM), and business intelligence (BI).
- The ERP system has three basic properties. First, ERP systems are multifunctional, tracking a range of activities such as financial results, procurement, sales, manufacturing, and human resources. Second, they are integrated in nature, meaning that when data are entered into one of the functions, information in all related functions is also changed immediately. Third, they are modular in structure and usable in any combination of modules.
- One of the key characteristics of ERP is that it implements best practices. The best practices are the tested effective and efficient practices being followed across the world to accomplish a process. The best practices represent the way an ERP company feels a particular business transaction should be carried out to maximise efficiency.
- The ERP systems being complex integrated system need different implementation strategies. Some organisations use in house IT skills to integrate multiple software products, whereas some choose to implement only portions of an ERP system and develop an external interface to other ERP or stand-alone systems for their other application needs.
- The important guiding strategies for successful ERP implementation include: (i) ERP plans of the organisation must match with its business plan; (ii) ERP may lead to business process re-

engineering, which brings in structural changes, roles change, and process change; (iii) organisations need to select the balanced ERP team with strong commitment from the top management; (iv) need to provide effective training to its users; and (v) appropriate selection of implementation methodology with strong commitment to change.

- The CRM is an integrated information system solution that allows identification, acquisition, retention, and expansion of customers. By enabling organisations to manage and coordinate customer interactions across multiple channels, departments, lines of business, and geographies. CRM helps organisations maximise the value of every customer interaction and drive superior corporate performance. The successful CRM focuses on understanding the needs and desires of the customers and is achieved by placing these needs at the heart of the business by further integrating them with the organisation's strategy, people, technology, and business processes. A good CRM implements a paradigm shift from what ('product') to who ('customer').
- The management of customer value is a cyclical process that has four key steps: define the customer actions; determine customer expectations; design customer value model; and deliver customer value. There are two types of CRM—Operational CRM and Analytical CRM. The operational CRM is also known as front office CRM and analytical CRM is a back office CRM.
- The e-CRM expands the traditional CRM techniques by integrating technologies of new electronic channels such as web, wireless, and voice technologies. Essentially, e-CRM helps in enabling a customer oriented organisation to deliver an extended infrastructure to customers and partners in new ways—to proactively learn customer needs, add value, gain new economies in scale/time/costs, reach out to new customers, and deploy innovative retention strategies.
- The e-CRM basically enables seamless 'integration and automation' of previously manual tasks and processes through the use of the Internet. The e-CRM enables organisations to leverage off new technologies by integrating multiple communication channels, business processes (sales, marketing, and customer service/support) and people. The e-CRM essentially adopts a customer centric approach of doing business by putting the customer first. In short, the e-CRM is all about discovering and delivering value to customers.
- A supply chain is the stream of processes of moving goods from the customer order through the raw materials stage, supply, production, and distribution of products to the customer. All organisations have supply chains of varying degrees, depending upon the size of the organisation and the type of product manufactured. These networks obtain supplies and components, change these materials into finished products and then distribute them to the customer.
- The supply chain is an important process that includes controlling and deciding the direction of resource movement in an organisation. It also includes all other sub process involved in coordinating them. The concept of supply chain and its management is not a new one. It has been in existence for many years. However, ERP has helped to reduce their inaccuracies and increased the performance of supply chain. It is important to know about ERP and supply chain management
- The technology-driven supply chain management focuses on globalisation and information management tools, which integrate procurement, operations, and logistics from raw materials to customer satisfaction. It is also referred as e-SCM, that requires frictionless supply chain coordination of information, material, and financial flows, in order to deliver process optimisation levels, which was never before thought possible in the old economy. Once businesses have improved their internal e-SCM infrastructure at a technology level, they can then use the time savings to focus on streamlining and developing their supply chain partner relationships.
- The Enterprise Portal is a single gateway to an enterprise, via corporate Intranet or the Internet, for access to relevant workflows, processes, application systems, and databases—integrated using common technologies and tailored to the specific job responsibilities of each individual.

✦ The mission of a corporate portal is not only to provide a library of information, but also to actively support the user in their day-to-day business activities. Typically, majority of enterprises' knowledge resources exists as unstructured data in documents, reports, email, graphics, images, audio, and video files.

KEY TERMS

Accelerated Implementation
Analytical CRM
B2B
Best Practices
Big-bang Implementation
Business Intelligence (BI)
Call Centre
Collaborative CRM
Computer Integrated Mangufacturing (CIM)
Conversion Strategies
Customer Relationship Management (CRM)
Customer Value
Data Warehouse
E-business
E-CRM
EDI
Enterprise Resource Planning (ERP)
Enterprise Wide Information Portal
E-SCM
Finance and Accounting
Integrated Information Systems
Knowledge Management (KM)
Legacy Systems
Material Requirement Planning (MRP)
Materials Management
MRP II
OLAP
Operational CRM
Phased Implementation
Portal
Process Implementation
Production Planning
Sales and Distribution
Sales Force Automation (SFA)
Supply Chain Management (SCM)
Vanilla Implementation

SELF-STUDY QUESTIONS

1. The most important benefit of implementing a packaged ERP like SAP, Oracle is
   (a) Automation of business processes
   (b) Integration of business processes
   (c) Standardisation of business processes
   (d) Adoption of industry best practices
   (e) None of the above
2. The ERP implementation supports CRM applications by allowing
   (a) A salesperson to check inventory before taking an order
   (b) A sales person to check outstanding trouble tickets before a customer visit
   (c) Accounts receivable can put on hold collection from customers with outstanding trouble tickets
   (d) All of the above
3. Which of the following is the most efficient and effective way to carry out a particular business process in an Integrated Enterprise Wide system?
   (a) Enterprise Resource Planning
   (b) Customer Relationship Management
   (c) Best Practices
   (d) Access company's supply chain network

4. Which of the following is not the correct conversion strategy?
   (a) Phased (b) Big-Bang (c) Vanilla (d) BSP
5. Which of the following involves understanding the customer activities that were occurred in the front office using technological tools?
   (a) Operational CRM (b) Supply Chain Management
   (c) Analytical CRM (d) Enterprise Portal
6. Which of the following is an integrated group of processes to 'source,' 'make,' and 'deliver' products.
   (a) Operational CRM (b) Supply Chain Management
   (c) ERP (d) Enterprise Portal
7. Which of the following observations is not correct?
   (a) The ERP is an extension of MRP I and MRP II systems.
   (b) It is always possible to measure the financial benefits of deploying an ERP system.
   (c) It is possible to develop an ERP in-house.
8. Fill in the blanks:
   (i) _____ expands the traditional CRM techniques by integrating technologies of new electronic channels such as web, wireless, and voice technologies.
   (ii) In CRM, the paradigm shift is from _____ to who (customer).
   (iii) The four stages of CRM definition include Targeting, Acquiring, _____ and _____.

REVIEW QUESTIONS

1. Define Integrated Information Systems. Explain with examples.
2. Why organisations should implement ERP systems? Justify.
3. What are the strategies used for implementing ERP systems?
4. Explain with examples, how ERP systems have changed the work culture in an organisation?
5. List the complete historical framework of ERP. How these systems have evolved?
6. List the different ERP implementation strategies.
7. What do you mean by CRM and SCM?
8. How ERP is going to help the CRM implementation?
9. How has Supply Chain Management evolved? Is it necessary to implement ERP before implementing SCM?
10. What are Enterprise Information Portals? List the major components of EIP.

QUESTIONS FOR DISCUSSION

1. Explain with an example, how ERP, CRM, and SCM helps in business transformation.
2. Identify the key technologies that are required to implement the enterprise wide information solutions.

3. The enterprise wide information system solutions require organisational structural changes. Justify your answer.
4. Majority of organisations develop their solutions to cater to TPS and MIS needs. Where does the ERP system fits in the IS hierarchy? What happens if the organisation integrates the CRM and SCM systems also?
5. The SCM systems allow organisations to integrate their business partners to their information system to gain competitive advantage. Why all organisations do not implement these systems?

APPLICATION EXERCISES

1. Identify the examples of integrated information systems being implemented by some of the leading Indian organisations. Identify the technologies being used by these organisations.
2. Search computer journals and/or Internet to find information about:
   (a) Indian organisations using ERP systems and CRM solutions.
   (b) Indian organisations using ERP and SCM.
   (c) Indian organisations using enterprise wide information portals
   (d) Organisations using E-CRM and E-SCM solutions.
3. The enterprise systems are more concerned with the enterprise. The success of these systems is more dependent on the management, not on the project team. Study some of the leading ERP solutions and suggest the success factors.

GROUP PROJECTS

Use online library databases, trade publications and/or information published on the web to do the following projects:

1. Find out about the market for ERPs in India. Find how widespread is the usage of ERP in the small and medium enterprises (SME) segment in India. Identify main ERP vendors and how do they fare in this market. Also define the roadmap for the process modelling for the SME segment.
2. Identify any one Indian organisation that has derived benefits from the implementation of ERP systems. Explain the benefits derived by the organisation and any assessment of effectiveness or an ROI measure carried out by the company.
3. Pick up one Indian organisation that has implemented Customer Relationship Management (CRM) systems. Clearly explain the strategic nature of the project, objectives defined and benefits obtained.
4. Pick up one good example of an organisation that has implemented the Human Resources (HR) management module. Discuss how effective has the implementation been and what best practices were they able to imbibe.
5. Analyse ERP implementations in a few organisations and enumerate the main difficulties (classified into a few items) faced during implementation.

Caselets

1. Enterprise System at Asian Paints

Asian Paints is India's largest paint company, and it ranks among the top ten decorative coatings companies in the world. It operates in 22 countries and has 29 paint manufacturing facilities in the world, serving consumers in over 65 countries. Asian Paints expanded its business around the globe, in some cases acquiring companies. In ten markets it operates through its subsidiary, Beger International Limited; in Egypt through SCIB Chemical SAE; in the South Pacific as Apco Coatings; and in Fiji and Samoa as Taubmans.

SCENARIO-I

Each one of these subsidiaries initially had its own IT infrastructure, maintenance of which was a big issue for the corporate IT team. Each subsidiary using different systems and solutions led to issues such as high IT administrative costs and duplicated efforts in reporting. According to Aashish Kshetry, systems development manager, Asian Paints, there was a critical need to standardise operations in the international market.

With this objective in mind, Asian Paints decided to standardise on one platform, Microsoft Business Solutions Navision 3.7, now part of Microsoft Dynamics, for its operations in 22 countries outside India. The parent company in India runs a well-organised, efficient, and structured organisation, with an integrated supply chain management solution from i2 Technologies, and ERP solution from SAP in place. However, the general consensus was that the subsidiaries were not mature enough to use the SAP solution effectively, and that the cost of acquisition and deployment of the SAP solution throughout the enterprise would not be justified.

Consequently, Navision was selected over a six-month evaluation period to create a stable transaction system across all subsidiaries, that would last at least 7-10 years. Attention was also given to implement a solution that had built-in international modules on taxation and multilingual support, as the subsidiaries spanned geographies. "Navision had international modules for 40 countries, and it supported languages such as Chinese, Thai, and Arabic among others," elaborates Kshetry. Additionally, it offered a hub and spoke model which was ideal for Asian Paints; while the parent hub was running on SAP, the subsidiaries (spokes) ran on Navision.

Asian Paints roped in All e-Technolgies, a Microsoft Gold Certified Partner, to help with the implementation process. Each country's implementation was on a separate Microsoft Navision installation on its own server. Once the initial installation was completed according to requirements, the company set an aggressive plan of implementing Microsoft Business Solutions Navision in ten countries, in just eight months.

The SAP Navision hub and spoke model has enabled Asian Paints subsidiaries to interact with the parent organisation easily and effectively, removing the need for generating multiple reports. With a worldwide edition of Microsoft Navision that supports multiple languages and the tax and legal structures of various counties, Asian Paints did not have to implement local solutions to support local taxation and legal requirements. 'Our key objective—to standardise technology platforms and business processes across subsidiaries and regions—has been fulfilled,' evinces a satisfied Kshetry.

The subsidiaries are now all on a single platform using the same applications and processes. This uniformity greatly reduces the IT intervention that was required earlier in a heterogeneous environment. The consolidated financial statements from the subsidiaries can now be transferred from different accounting structures into the standard requirements of the parent organisation. To top it all, with each subsidiary on the same technology platform, the same business processes are being followed globally. This removes redundancies and improves business processes that have benefitted all.

SCENARIO-II

A big IT challenge that the company was faced with recently was the implementation of the Product Life-

cycle Management (PLM) platform. According to Manish Choksi, CIO, Asian Paints, the company has essentially been involved in formulation management. The solution to manage these formulations was developed a long time ago and was built on the Foxpro platform which was getting outdated. Though the IT team had a large centralised pool of information through ERP and SCM solutions on a new platform, the core R&D information —how the products should be manufactured was still on the legacy platform.

The processes involved were ISO compliant but to a certain extent were manual in nature, which meant data on formulations had to be transmitted physically by taking several copies of the printouts as per the ISO records and then transmitted to the plants. The problem lay in the fact that there was no capture of information on how the formula was developed; there was no documentation on what processes went into approving formulae; and post approval that formulation had to be transferred manually which was time consuming and led to higher expenses. When the product information was transmitted to the other IT systems, there was a manual interface which took into account all the information being transferred. So, there was a need to eliminate the manual interface and completely automate the process.

Choksi took a holistic look at the challenge around the management of formulations and processes in the development arena. The team then went on a search for a process for the right PLM platform and partnered with some large vendors such as SAP and specialist companies in the space such as Optiva (Inforink) and ASD Software, etc, to integrate the processes and software.

Questions for Discussion

1. What are the key challenges that Asian Paints has faced?
2. List the management strategies that were adopted.
3. What is the enterprise solution that the company has implemented with respect to the two scenarios?
4. List the benefits that they have achieved, because of the implementation.
5. Visit the company site to update your facts and present.

Source: Adapted from Various issues of *Dataquest*

2. SAP System at Barista Coffee

Barista Coffee Company (BCCL), established in February 2000 to recreate the ambience and experience of the typical Italian neighbourhood Espresso Bars in India, is one of the largest and fastest growing retailer of fine coffee with 120 outlets in the country. Despite stiff competition Barista continues to remain the pioneering name amongst Indian café chains.

It was however becoming obvious that to reach out to its stated goal of 1,200 outlets by 2010, Barista needed a solution that would improve operations through effective control of processes across the organisation. More importantly, the solution had to integrate information flow between the Point of Sale (POS) system at the stores and the main system at the head office in Delhi. Barista also realised that real-time data would enable quicker decision-making. The technologically superior system had to be scalable and flexible to support the company's business expansion plans as well.

In consequence, SAP was chosen as the vendor while TCS was selected as the SI. Subsequently, TCS implemented SAP IS-Retail mySAP 2004 as the ERP backbone in BCCL and SAP IS-Retail to support the retail business processes of the chain.

In order to support these aggressive expansion plans, Barista deployed SAP NetWeaver platform with the help of TCS. This ensured a seamless information flow between TCS' custom developed POS solution across Barista stores and the SAP ERP system at the head office in New Delhi. This was the first SAP XI implementation in India on the NetWeaver platform. TCS' SAP specialists configured specific business scenarios in the POS and SAP system, such that data transfer would happen automatically between the two systems. The business warehouse was also integrated with the POS such that real-time data would be available.

"In a very dynamic retail environment, Barista is now equipped with latest technology to execute its innovative ideas and strategic plans through informed

and planned decision-making," asserts Rajesh Malhotra, CFO, BCCL. Thanks to the SAP deployment, Barista is now able to manage store inventory replenishment through innovative in-store approach.

In terms of more concrete benefits the solution helped improve Barista's financial reconciliation capability and eliminated data entry duplication thereby facilitating faster decision-making. The NetWeaver platform helped shorten closing cycles, lower the inventory costs thereby leading to quicker communication between the stores and the head office. Last but not the least, the IT deployment has improved customer experience at Barista outlets by getting timely information on stock outages and deploying strategic promotions within a very short time.

"It is the start of a new phase in Barista history wherein our operations team working at outlets under limited support from regional and head office would be made informative within a very short time. The level of transparency within operations and support systems at HO and RO will automatically improve manifold," believes Rajesh Rustagi, Project Manager and Finance Controller, BCCL. Thanks to SAP, Barista is now ready to take anybody head on.

Questions for Discussion

1. What are the key challenges that the company has faced? List the management strategies that were adopted.
2. What is the enterprise solution that the company has implemented?
3. List the benefits that they have achieved, because of the implementation.
4. Visit the company site to update your facts and present.

Source: Dataquest, February 28, 2007, Vol. XXV No. 04

Answers to Self-Study Questions

1. (d) 2. (d) 3. (c) 4. (d)
5. (c) 6. (b) 7. (b)
8. (i) E-CRM, (ii) What (product), (iii) Retention, Expansion

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Section V

Building Intelligent Systems for Businesses

CASE V: Smart Knowledge Management Means Quick Money

Accessing data faster and taking quicker decisions creates opportunities for making money.

The global capital markets industry is experiencing dynamic changes. The profitability in this business is at times determined by decisions taken in milli-seconds by ultra low latency applications. Reacting to market events faster than the competition to increase profitability of trades is one of the key challenges that technologists in this industry are constantly working on.

The faster access to market information and events (market, economic and political events) leads to quicker trading decisions, which impact the bottom line of the organisation. In such a fast paced environment the focus till now has been on trade processing applications, market data applications, risk analysis applications, and all back-office applications. These technology components help reduce latency, process volumes of data, and help in faster and accurate decision making.

While a lot of work has been going on to achieve the above objectives of reducing latency and enhancing scalability, there is a second dimension to this challenge of addressing the needs of this fast paced business environment. The effective and efficient knowledge sharing among individuals, groups, and geographies to enhance the overall productivity is another aspect, which will lead to faster and more efficient operations. However, not much progress has been made on this.

Going forward, in such a fiercely competitive and dynamic business environment, differentiation among banks would be achieved by reducing the time required to retrieve relevant knowledge that is stored within the organisation. Retrieving knowledge stored within the organisation in the form of structured data (data stored in organisational databases), semi-structured data (data stored in a template format, i.e., following a metadata), and completely unstructured data (data without any templates, for example, e-mails, non-standard format documents, etc.), and even tacit knowledge (stored in the minds of employees) would help create the differentiation.

In this industry, this competitive edge is directly derived from the knowledge base within the organisation. The effective knowledge sharing in this industry is thus even more critical than in others. Retaining clients in this industry requires an organisation to be a step ahead in the product offering and technology deployment to cater to those product offerings. The technology support to cater to the ever evolving products and servicing the clients through technology to keep the clients ahead in their business is very challenging.

Let's analyse the importance of effective knowledge management in the capital markets space.

INTERNAL KNOWLEDGE SHARING

All aspects of this business rely on the knowledge of individuals and collective knowledge of the organisation. The different individuals from different groups have to bring in their knowledge together to come up with an offering, which will keep clients ahead of the curve. The quants, for instance, may come up with models and strategies which would make more money. This in turn requires the technology team to come up with applications, which can make these models available for pricing and trading of these instruments. The sales team should be able to share these offerings with their clients. In addition to such cross-group interactions required for launching any offering, we have the complexity added by the dynamically changing business environment in this space.

In order to bring the organisation together to share the knowledge on such competitive offerings requires effective knowledge sharing. It would not be a hyperbole to say that effective collaboration and knowledge sharing between functions is not just critical for success, rather an imperative for survival.

The technology applications in the capital markets industry require a front to back integration for the trade to complete its life cycle. The trader would interact with a front-office trade input application. This would go to a middle office application for allocations, etc., and then finally to the back-office for settlements. Each of these technology components are big islands by themselves and in large organisations, typically, the teams to develop and support these

applications are scattered across the globe. Being geographically distant in an environment which requires a tight integration of applications is itself a challenge.

The sharing of knowledge in this environment has to circumvent the following 3 challenges:

- Cross-group knowledge sharing: This could be across technology teams, e.g., a trading application team which needs to hand-off the trade and position data to the risk technology team.
- Cross-region knowledge sharing: The global investment banks today operate in all the major markets and invariably have a huge technology and operations teams in India.
- Knowledge sharing in limited time to keep pace with the dynamic environment: It is evident that time to market in this dynamic business environment is highly limited as a result the efficiency with which knowledge goes to the right people at the right time is critical.

EXTERNAL KNOWLEDGE SHARING

We just talked about the need to share knowledge between the various groups within the organisation with the objective of enhancing operational efficiency.

The struggle to stay ahead of the competition is forcing banks to involve and engage with the clients in a manner in which they derive tangible value on multiple fronts.

The trend in the industry is to move towards helping the clients to benefit from the research knowledge base within the organisation. The exposing of the research knowledge base to the clients, not just in terms of research tools as explained above, would be extremely useful if there is an effective knowledge retrieval mechanism. The Research knowledge base comprises research reports and tacit knowledge stored in the minds of the researchers. An effective knowledge retrieval medium has to be context sensitive to understand the jargon of capital markets. It has to have the artificial intelligence built-in to understand that equities, common stock, and stock are related in some manner. Such intelligence is dynamic in nature and as a result this has to be intelligently built over time.

The banks are taking their engagement with clients to the next level where they are thinking of creating a professional network which, would allow the clients to engage with the research knowledge base. This would allow clients to access specialised knowledge stored as structured, semi-structured, unstructured or even tacit knowledge within the bank and make better decisions. For instance, if a client wants to understand the outlook on Chinese Yuan the retrieval solution should be able to fetch relevant reports by doing a context sensitive search and also bring the relevant researchers (based on the profile of the researcher) to the client. In this globalised world, it may so happen that the research report on the outlook of Chinese Yuan maybe residing on a server in New York and the researcher who specialises in Asian currency markets is in Tokyo while the client searching for this information maybe in UK. It would be interesting if the medium is able to create a professional network of sorts where the client is able to chat with the researcher suggested by the solution.

NEED FOR AN EFFECTIVE SOLUTION

It had been observed that till now most i-banks have focused on the internal mechanisms for sharing knowledge. This poses a limitation as it is highly person dependent. At best knowledge sharing has meant effective use of a collaboration tool. These are all static mechanisms and are not fast paced.

The need of the hour is a technology solution which will be an effective medium to seamlessly integrate the knowledge in the minds of people and structured/un-structured information stored in various forms. For this medium to be effective it should be the following:

- An easily accessible medium such as an online medium for knowledge sharing within the organisation, which is integrated with the documentation repositories, relevant databases, people profile etc.
- A context sensitive knowledge sharing medium. For example, a query on securitisation may also look at data on Mortgage Backed Securities (MBS) or maybe even Asset Backed Security (ABS) depending on the context of the query.

- An efficient medium which would build the associations in an intelligent manner depending on the usage over time.

All these factors require an intelligent technology platform, which is designed for global banks operating in the capital markets space. The technology solution providers should understand the subject matter of capital markets domain to design an effective context sensitive medium for sharing and retrieving knowledge.

Questions to Think About

1. Identify the role of Business Intelligence and Knowledge Management in building effective information system solution.
2. In a competitive business environment would KM plays a role of differentiator? Justify.

Source: Adapted from *Dataquest*, February, 2011

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Chapter 11

Decision Support Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- Different decision theories that exist;
- Different decision models that decision makers apply to take decisions;
- The technological tools that help the decision-maker to support decision process;
- The various decision support systems and also the group based decision processes;
- The concept about the data warehouse and data mining technologies;
- Building managerial decision-making models using everyday technological tools.

INTRODUCTION

Everyone makes decisions of varying importance every day, so the idea that decision-making can be a rather sophisticated. However, studies have shown that most people are much poorer at decision-making than they think. An understanding of what decision-making involves, together with a few effective techniques, will help produce better decisions. For a business manager to lead effectively, one needs to be able to make good decisions. If one can learn to do this in a timely and well-considered manner, then one can lead the team to spectacular and well-deserved success.

The decision-making process is a systematic means of arriving at a decision. The number of decision theories are available that support different types of decision processes that a decision-maker tends to follow. The researchers and information technology specialists have developed various kinds of IT and non-IT based systems that help these decisions-makers to take effective decisions. The technologists have built Decision Support Systems (DSS) for the purpose.

These systems became so popular among the decision-makers. Thus, the technology providers developed various functionalities and came up with number of alternatives like group decision support systems, data warehouse, data mining, executive information systems, and many more.

Today's tech-savvy managers have been using different kinds of decision models. Some use quantitative decision models, some use qualitative, and some use their own intuition to take decisions. It is the comfort level of each decision-maker and also the situation under which the decision is being taken. All kinds of decision theories exist which have evolved over a period of time. The technology driven decision process tends to use more of quantitative modelling for decision-making, as it helps to generate more alternatives. The decision-making is about generating alternatives and evaluating them to select the best decision. While acknowledging the benefits of quantitative models, decision-makers have often viewed the modelling process itself as a difficult process, which is meant to be practiced only by statisticians, highly skilled or computer specialists. Unfortunately, the decision-maker needs to delegate the modelling process to experts. This delegation of modelling to experts removes the manager from the process, a step that often leads to deviation from the application. In order to overcome this, organisations have developed Decision Support Systems (DSS).

The computerised decision support systems became possible with the development of computers, timeshare operating systems, and distributed computing. The history of the implementation of such systems began in the mid-1960s. The different people perceive the field of Decision Support Systems from various vantage points and report the different accounts of what happened and what was important. As technology evolved, new computerised decision support applications were developed and studied. The researchers used multiple frameworks to help build and understand these systems. Armed with this computerised evolution, today one can organise the history of DSS into five broad DSS categories: communications driven, data driven, document driven, knowledge driven and model driven decision support systems.

This hyper–text document is a starting point in explaining the origins of the various technology threads that are converging to provide integrated support for managers working alone, in teams and in organisation hierarchies to manage organisations and make more rational decisions. The historical facts can be sorted out and better understood, but more information gathering is necessary. This web page is a starting point in collecting first hand data used in building a more complete mosaic of what was occurring in the organisations to build and use DSS.

The study of decision support systems is an applied discipline that uses knowledge and special theories from other disciplines. For this reason, many DSS research questions have been examined because they were of concern to people who were building and using specific DSS. Hence, much of the broad DSS knowledge base provides generalisations and directions for building more effective DSS.

Along with the above advancement, the dramatic advances in data capture, processing power, data transmission, storage capabilities and decision models are enabling organisations to integrate their various databases into data warehouses. The data warehousing is defined as a process of centralised data management and retrieval. The data warehousing represents an ideal vision of maintaining a central repository of all organisational data. An equally dramatic advances in data

analysis software are allowing users to access this data freely. The data analysis software is what supports data mining.

Generally, data mining is the process of analysing data from different perspectives and summarising it into useful information—information that can be used to increase revenue, cuts costs, or both. It allows users to analyse data from many different dimensions or angles, categorise it, and summarise the relationships identified. Technically, data mining is the process of finding correlations, or patterns among dozens of fields in large relational databases.

Most organisations today collect and refine massive quantities of data. The data mining techniques can be implemented rapidly on existing software and hardware platforms to enhance the value of existing information resources, and can be integrated with new products and systems as they are brought online. When implemented on high performance client/server or parallel processing computers, data mining tools can analyse massive databases.

This chapter traces decision support applications related to model and data oriented systems, management expert systems, multi–dimensional data analysis, query and reporting tools, online analytical processing (OLAP), business intelligence, group DSS, conferencing and groupware, document management, spatial DSS and executive information systems as the technologies emerge, converge, and diverge. The chapter also covers basic introduction to the basic technological tools like data warehousing and data mining. All of these technologies have been used to support decision-making.

DECISION-MAKING

The decision-making is the study of identifying and choosing alternatives based on the values and preferences of the decision-maker. The decision-making is the process of sufficiently reducing uncertainty and doubt about alternatives to allow a reasonable choice to be made. Making a decision implies that there are alternative choices to be considered, and in such a case one wants to identify the maximum number of alternatives and choose the best one. Very few decisions are made with absolute certainty because complete knowledge about all the alternatives is seldom possible. Thus, every decision involves a certain amount of risk.

The decision-making is a cognitive process of reaching a decision.

The decision-making is a nonlinear, recursive process, meaning most decisions are made by moving back and forth between the choice of criteria and the identification of alternatives. The alternatives available influence the criteria that are applied to them, and similarly the criteria that influence the alternatives are considered. Every decision is taken within an environment and we need to understand that.

THE DECISION ENVIRONMENT

A decision environment is defined as the collection of information, alternatives, values, and preferences available at the time of the decision. An ideal decision environment would include all possible information, all of it accurate, and every possible alternative. However, both

information and alternatives are constrained because the time and effort to gain information or identify alternatives are limited. The time constraint simply means that a decision must be made within a certain time. The effort constraint reflects the limits of manpower, money, and priorities. Since decisions must be made within this constrained environment, one can say that the major challenge of decision-making is uncertainty, and a major goal of decision analysis is to reduce uncertainty. One can almost never have all information needed to make a decision with certainty, so most decisions involve an undeniable amount of risk.

Many decision-makers have a tendency to seek more information than required to make a good decision. When too much information is sought and obtained, one or more of several problems can arise.

1. A delay in the decision occurs because of the time required to obtain and process the extra information.
2. Information overload will occur.
3. Selective use of the information will occur.

The quantity of information that can be processed by the human mind is limited. Unless information is consciously selected, processing will be biased towards the first part of the information received. The decision-makers have started using the computer based decision techniques to handle large amount of information to support their decision processes. The quality of a decision can be judged if the decision meets the stated objectives in the most effective and efficient manner.

APPROACHES TO DECISION-MAKING

There are two major approaches to decision-making in an organisation; the **authoritarian method** in which an executive head makes a decision for the group and the **group method** in which the group decides what to do. Within these two broader approaches, decision-makers follow their own style of generating alternatives and taking decisions. Some of the common styles of decision-making include:

Optimising

This helps in selecting the best possible alternative for a decision problem. This style involves:

- Identification of a problem
- Generating alternatives
- Selecting the best alternative
- Implementing the best alternative
- Feedback

This is the ideal method of taking decision, but many a times the decision-maker is constrained because of information availability, time, money, and resources. Given a choice one would always prefer to use the optimising style of decision-making.

Satisficing

In this strategy, the first satisfactory alternative is chosen rather than the best alternative. Most of the decision makers tend to follow the satisficing decision strategy.

Organisational

In this method, the decision-maker tends to follow the organisation policies and procedures to take decision. The organisation view of decision-making is primarily based on Standard Operating Procedures (SOPs) or the rule book.

Political

It is a more authoritarian style of decision-making. In this, the decision-maker takes the decision as per his/her thought process with or without following any systematic method for decision-making.

Maximax

This stands for 'maximise the maximums'. This strategy focuses on evaluating and then choosing the alternatives based on their maximum possible payoff. This is sometimes described as the strategy of the optimist, because favourable outcomes and high potentials are the areas of concern. It is a good strategy for use when risk taking is most acceptable.

Maximin

This stands for 'maximise the minimums'. This is the strategy of a pessimist as the worst possible outcome of each decision is considered and the decision with the minimum possibility of adversity is chosen. The maximin orientation is good when the consequences of a failed decision are particularly harmful or undesirable. The maximin concentrates on the salvage value of a decision, or of the guaranteed return of the decision.

DECISION-MAKING PROCEDURE

If one wants to automate the decision-making process, one would always try to pick the best strategy of decision-making. If one tries to understand the different styles of decision-making, one will find that all the styles like satisficing, organisational, maximax and maximin are subsets of optimisation. Except for the political view of decision-making, one can automate all the remaining styles of decision process. The steps involved are:

Problem Identification

Defining the problem and determining the scope and limitations under which decision is to be taken. What are the possible parameters? All decisions needs to be taken while keeping in mind the Goal.

Collect the Facts

Collection of the as many facts as possible about a decision keeping the time limitations in mind. Most of the decisions are made in partial ignorance. Lack of complete information should not be taken as a limiting factor for decision. A decision based on partial knowledge is usually better than not making the decision, when a decision is really needed. While collecting the facts, one must list the feelings, hunches, and intuitive urges. Many decisions must ultimately rely on or be influenced by intuition because of the remaining degree of uncertainty involved in the situation.

Generate Alternatives

Making a list of all the possible choices one has, including the choice of doing nothing. Not choosing one of the alternatives is in itself a decision. But sometimes the decision to do nothing is useful or at least better than the alternatives, so it should always be consciously included in the decision-making process. Also one needs to be sure to think about not just identifying available alternatives but creating alternatives that do not yet exist.

Evaluate each Alternative

This is the evaluation of the value of each alternative. While evaluating the alternatives, one may also consider factors like cost, consequences, constraints, time required, money saved, time saved, innovations, and creativity. In decision-making, however, there is always some degree of uncertainty in any choice. It is important to measure the risk with each of the alternatives. These risks can be rated as percentages, ratios, rankings, grades or in any other form that allows them to be compared.

Make the Decision

If it is an individual decision, one needs to apply individual preferences. One has to choose the path to follow, whether it includes one of the alternatives, more than one of them or the decision to choose none. And of course, one does not forget to implement the decision and then evaluate the implementation.

DECISION MODELS

With the enhancement increase in business complexities, decision-making process has also become unbelievable complex. The decision-maker needs to take effective decisions on real time using large amount of data. So the decision-making has become information oriented. The number of alternatives that needs to be considered has increased. Most decisions are to be made under time pressures; and for good effective decisions one needs to analyse the information based on some decision models. The decision models selectively describe the managerial situations; decision models designate decision variables; and decision models designate performance measures that reflect objectives.

The decision modelling refers to the use of mathematical or scientific methods of decision-making, which allows determining an allocation of scarce resources, which improves or optimises the performance of a system. The terms operations research and management science are also used to refer to decision modelling. The current information technology solutions have revolutionised modelling by allowing managers to construct and analyse models for themselves. These technologies have made the modelling process simple and allowed the manager to use decision modelling for decision-making.

The decision modelling is a scientific approach to managerial decision making, which allows the development of a mathematical model of a real-world scenario.

The examples of systems to which decision models have been applied include:

- Financial systems: The portfolio optimisation, security pricing, pension planning and bond refunding. There are numbers of organisations who are using Spreadsheet based optimisation models to manage financial decision models.
- Production systems: Oil, steel, chemical, and many other industries are using linear programming based decision models to improve their production decisions.
- Distribution systems: Airlines, paper, university/school systems are using linear programming to optimise their distribution systems.
- Marketing systems: There are number of organisations worldwide who are using various decision modelling tools for sales force design, forecasting new product sales, telecommunications strategies, brand management, merchandising strategies etc.

The Modelling Process

Understanding management situations, taking decision, implementing decision, and reviewing the decision are the major steps of managerial decision-making. When faced with a situation involving conflicting or competing alternatives, the situation is analysed by the managers; decisions are reached to resolve the conflicts; the decisions are implemented; and the organisation receives the consequences in the form of payoffs, not all of which are monetary.

Figure 11.1 defines the modelling process. As per the process, the management situation is converted into the model, which is analysed to generate a result, which is then interpreted by the decision manager to take a decision. The complete process is dependent on abstraction, intuition, analysis, and interpretation. Historically, managers relied almost exclusively on their own intuition for making decisions. A manager practicing intuition alone for decision-making learns only from the feedback of final outcomes, which is an expensive process.

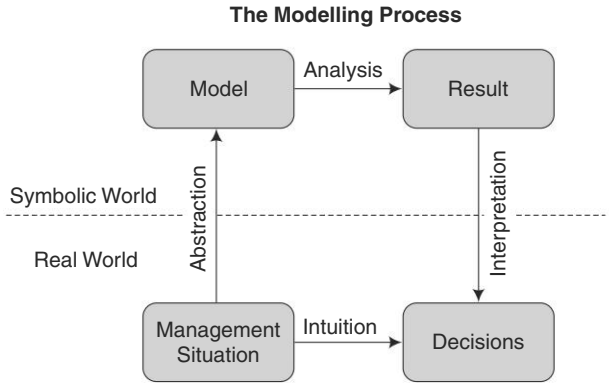

Figure 11.1 Decision Modelling Process

After building the model, it is analysed to generate some results or conclusions that emanate from the model alone; that is, without regard to the abstractions previously made. Next, interpretation of the model based result back to the real world situation occurs, taking into account what was left out during the earlier abstraction phase. When augmented by the manager's intuition and experience, this modelling process leads to better decisions and insights that affect learning.

Steps in Decision Modelling Process are Summarised as

1. Formulation: This means translating a problem from real-world to a mathematical model—define the problem, develop a model, and collect input data.
2. Solution: This means solving the model to obtain the optimal solution by developing a solution and testing the solution.
3. Interpretation and Sensitivity Analysis: This involves analysing results and implementing a solution.

MODELLING CHARACTERISTICS

A model is a simplified representation of a real-world situation. It can be regarded as a substitute for the real system, reducing the large amount of complexity to leave only essential, relevant details. A model is used to facilitate understanding of a real object or situation. A decision-maker is better able to evaluate the consequences of alternative actions by analysing the model's behaviour. The advantages of a model are:

- The cost of modelling is less.
- The models enable compression of time.
- The manipulation of model is much simpler and easier.
- The testing of a model is easier.
- It is easy for the decision-maker to understand.
- There is less risk when experimenting with a model than with the real. system.
- The mathematical models enable testing of large data sets.

The different types of models that are being used by decision-makers are given in Table 11.1 below. The three types of models that are popularly being used by decision-makers include physical, analog, and symbolic. The models created by architects about a new building are referred to as a physical model. The physical models are three-dimensional representations of real world objects. There are also scaled down versions of the models more suited to computers which include (i) analog or graphical models, which use lines, curves, and other symbols to produce flow charts, pie charts, bar charts, scatter diagrams, etc. and (ii) symbolic or mathematical models which use formulae and algorithms to represent real world situations. All of the models that we are going to discuss are either graphical or mathematical.

Table 11.1 Types of Decision Models

Model Type	*Characteristics*	*Examples*
Physical Model	Tangible Easy to Comprehend Difficult to Duplicate and Share Difficult to Modify and Manipulate Limited Scope of Use	Car or Aeroplane or House or Building Models
Analog Model	Intangible Tough to Comprehend Easy to Duplicate and Share Easy to Modify and Manipulate Wider Scope of Use	Road Map, Speedometer, Bar or Pie Chart
Symbolic Model	Intangible Tough to Comprehend Easy to Duplicate and Share Easy to Modify and Manipulate Widest Scope of Use	Simulation Model, Algebraic Model, Spreadsheet Model

Since a model is not an exact representation, it cannot contain all aspects of a problem. This models involve a large number of assumptions about the environment in which the system operates, about the operating characteristics of its functions, and the way people behave. ***These environmental assumptions are called uncontrollable variables because they are outside the decision maker's control,*** e.g., interest rates, consumer trends, currency fluctuations, etc. On the other hand, ***controllable variables are those inputs that influence a model's outcome and are within the decision-maker's control.*** The examples of control variables are product price, the level of output, or acceptable profit levels.

The validity of a model's results will depend on how accurately the model represents the real situation. The ideal model is one which is neither too trivial in its representation of reality nor too complex to implement. There are three main steps in building symbolic models.

1. The first step of problem formulation requires that the decision-maker adopt a systematic and rigorous approach to the selection of variables. One of the main sources of errors in model building is the exclusion of important variables, either to an oversight or a lack of understanding of the model's underlying logic. In either case, the results will be meaningless or at best, dubious.
2. The second step in model building is the identification of the relationships among the variables. In many cases well-known formulae may already exist.
3. The final step is to set up the model using the technology tool like spreadsheet. Spreadsheets like Microsoft Excel are power decision tools that help the decision-maker in model creation, generating alternatives, and selecting the best alternative.

TYPES OF DECISION-MAKING

If a decision-maker knows the exact values of all uncontrollable variables, then the model is said to be **deterministic**, i.e., the outcome is already determined because all variables—both controllable and uncontrollable—are known. The best decision is thus made under condition of certainty, i.e., there is no element of doubt associated with the outcome. A payroll system, income tax calculation are typical examples of a deterministic application because all inputs are already quantified. The linear programming (LP) techniques, including integer and goal programming, are the most widely used tools for solving deterministic models. Table 11.2, list out the various characteristics associated with three types of business decision making, which are:

Decisions Taken Under Conditions of Certainty (Structured Decisions)

Under conditions of certainty, the decision taken is always the best one. In many managerial decisions, however, there is an element of risk attached to future events because the uncontrollable variables are not known completely or with certainty. The decision-makers should therefore be aware that in a risky environment where they do not have complete control over all inputs, bad outcomes will sometimes occur. While the outcome is not known with certainty, the decision is an informed one, based on an analysis of previous events.

Decisions Taken Under Conditions of Risk (Semi-structured Decisions)

While 'decisions under risk' can have more than one outcome, it is assumed that decision-makers have some knowledge of how matters will turn out, i.e., they know the probability of events occurring. The decision-maker tries to make a good decision, which will result in a good outcome by taking into account the probabilities associated with the uncontrollable inputs. In this situation, a model is said to be '**probabilistic**'. The decision is an informed one because there is sufficient information available to allow probabilities to be assigned to the uncontrollable variables. The statistical techniques, involving probabilities and probability distributions, are the main tools used in solving problems which have an element of risk attached to them. The simulation is another model building tool which is used to analyse problems containing uncontrollable variables represented by probability distributions.

Decisions Taken Under Conditions of Uncertainty (Un-structured Decisions)

This moves into the area of guesswork where very little information if any, exists on which to base a decision. While probabilities can be assigned to uncontrollable variables in decisions under risk, the decision-maker is unable or lacks confidence to specify since probabilities still cannot be assigned to uncontrollable inputs because of the levels of uncertainty. For this reason, models, which operate under conditions of uncertainty are called non-probabilistic models.

Table 11.2 Characteristics of Decision Making

	The decision-making environment		
Characteristics	*Certainty*	*Risk*	*Uncertainty*
Controllable variables	Known	Known	Known
Uncontrollable variable	Known	Probabilistic	Unknown
Type of model	Deterministic	Probabilistic	Non-probabilistic
Type of decision	Best	Informed	Uncertain
Information type	Quantitative	Quantitative and Qualitative	Qualitative
Mathematical tools	Linear Programming	Statistical methods; Simulation	Decision analysis; Simulation

DECISION SUPPORT SYSTEMS (DSS)

The Decision Support Systems (DSS) are a class of computerised information system that supports decision-making activities.

The Decision Support System (DSS) is an interactive computer-based information system that supports a decision. The primary function of a DSS is to assist managers in solving unstructured, semi-structured, and structured decision problems. The DSS primarily supports analytical, quantitative type of work using modelling techniques. The decision Support System is a general term for any computer application that enhances a person or group's ability to make decisions.

In the 1960s, researchers began systematically studying the use of computerised quantitative models to assist in decision-making and planning. The first experimental study using a computer-aided decision system was investigation of a production scheduling application. In 1967, another DSS was developed which involved building, implementing and then testing an interactive, model driven management decision system. The concept of decision support systems was first articulated by Scott Morton in February 1964 in a basement office, in the Harvard Business School. During 1966, Scott Morton studied how computers and analytical models could help managers make a recurring key business planning decision. He conducted an experiment in which managers actually used a Management Decision System (MDS). The marketing and production managers used an MDS to coordinate production planning for laundry equipment. In the mid-1960s, the first hypermedia—groupware system called NLS (Online System) was developed. The NLS facilitated the creation of digital libraries and the storage and retrieval of electronic documents using hypertext. The NLS also provided for on screen video teleconferencing and was a forerunner to group decision support systems. The Semi-Automatic Ground Environment (SAGE) is probably the first computerised data driven DSS.

The early MIS focused on providing managers with structured, periodic reports, and the information was primarily from accounting and transaction processing systems, but the systems did not provide interactive support to assist managers in decision-making. Around 1970, business journals started to publish articles on management decision systems, strategic planning systems and decision support systems. Since the Management, Information Systems primarily focused on structured decisions, it was suggested that the supporting information systems for semi-structured and unstructured decisions should be termed 'Decision Support Systems'.

Beginning in 1980, many activities associated with building and studying DSS occurred in universities and organisations that resulted in expanding the scope of DSS applications. These actions also expanded the field of decision support systems beyond the initial business and management application domain. These diverse systems were all called Decision Support Systems. From those early days, it was recognised that DSS could be designed to support decision-makers at any level in an organisation. Also, DSS could support operational decision-making, financial, and strategic decision-making.,

The organisations have already started using the DSS for manipulating quantitative models, accessing, and analysing large data bases, and supporting group decision-making. Much of the model driven DSS research emphasised use of the systems by individuals, i.e., personal DSS, while data driven DSS were usually institutional, ad hoc or organisational DSS. The group DSS research emphasised impacts on decision process structuring and especially brainstorming.

Characteristics of DSS

The major characteristics of DSS would include:

- For semi-structured and unstructured decisions
- For managers at different levels
- For groups and individuals
- For adaptable and flexible decisions
- Effectiveness, not efficiency the focus
- Humans control the machine
- Modelling and knowledge based
- The major components that a DSS system would include:
  - User Interface
  - DSS Database
  - DSS Model Base
  - Knowledge Base

Types of DSS

Broadly there are six types of decision support systems that are being used by the industry. These include:

1. **Communication driven DSS:** Most communications driven DSSs are targeted at internal teams, including partners. Its purpose is to help conduct a meeting, or for users to collaborate. The most common technology used to deploy the DSS is a web or client server. The examples include chats and instant messaging softwares, online collaboration, and net-meeting systems. The communications driven DSS use network and communications technologies to facilitate decision-relevant collaboration and communication. In these systems, communication technologies are the dominant architectural component. The tools used include groupware, video, conferencing and computer-based bulletin boards.

2. **Data driven DSS:** Most data driven DSSs are targeted at managers, staff, and also product/service suppliers. It is used to query a database or data warehouse to seek specific answers for specific purposes. The examples include computer based databases that have a query system to check including the incorporation of data to add value to existing databases. In general, a data driven DSS emphasises access to and manipulation of a time series data of the organisation. The data driven DSS with online analytical processing provide the highest level of functionality and decision support that is linked to analysis of large collections of historical data. The executive information systems are examples of data driven DSS. The initial examples of these systems were called data oriented DSS. The data warehousing and online analytical processing (OLAP) began broadening the realm of EIS and defined a broader category of data driven DSS.
3. **Document driven DSS:** The document driven DSSs are more common, targeted at a broad base of user groups. The purpose of such a DSS is to search web pages and find documents on a specific set of keywords or search terms. The usual technologies used to set up such DSSs are via the web or a client server system. A search engine is a primary decision aiding tool associated with a document driven DSS. These systems have also been called text oriented DSS.
4. **Knowledge driven DSS:** The knowledge-driven DSSs or 'knowledge base' as they are also known, are a catch-all category covering a broad range of systems covering users within the organisation, but may also include others interacting with the organisation—for example, consumers of a business. It is essentially used to provide management advice, or to choose products/services. The knowledge driven DSS can suggest or recommend actions to managers. These DSS are personal computer systems with specialised problem solving expertise. The 'expertise' consists of knowledge about a particular domain, understanding of problems within that domain, and 'skill' at solving some of these problems. These systems have been called suggestion DSS and knowledge based DSS. Some of these systems are based on Artificial Intelligence (AI) technology.
5. **Model driven DSS:** The model driven DSSs are complex systems that help analyse decisions, or choose between different options. These are used by managers and staff members of a business, or people who interact with the organisation, for a number of purposes depending on how the model is set up—scheduling, decision analyses, etc. A model driven DSS emphasises access to and manipulation of financial, optimisation and/or simulation models. The model-driven DSS use limited data and parameters provided by decision-makers to aid decision-makers in analysing a situation, but in general large databases are not needed for model driven DSS. The early versions of model driven DSS were called model oriented DSS or computationally oriented DSS or sometimes spreadsheet oriented and solver oriented DSS.
6. **Web based DSS:** The World Wide Web and global Internet provided a technology platform for further extending the capabilities and deployment of computerised decision support. The release of the HTML specifications with form tags and tables was a turning point in the development of web based DSS. In addition to web based, model driven DSS, researchers were reporting Web access to data warehouses. The goal was to provide a useful starting

point for accessing web based material related to the design, development, evaluation, and implementation of Decision Support Systems. ***A Web based decision support system is defined as a computerised system that delivers decision support information or decision support tools to a manager or business analyst using a 'thin-client' Web browser like Internet Explorer.***

Doctor at the Doorstep

Max Healthcare boasts of a patient health database, wherein patient related information is available at the point of care, regardless of location.

One of the fundamental indicators of economic progress is affordable, assessable, and responsive healthcare. At Max, the endeavor has always been to provide quality healthcare services, with the desired patient touch points at the optimised cost. "Our vision is to increase the penetration of quality healthcare similar to that of providing ATMs for healthcare, and enable doctor anywhere at the most favorable costs, with the help of technology," says Dr Neena Pahuja, CIO, Max Healthcare Institute Ltd.

In the last couple of years, there have been end-to-end productivity, and business process changes in a number of industries. The Max Healthcare wants to be the leader to bring-in similar changes in the healthcare industry. Dr Pahuja explains by quoting an oft-repeated scenario of rushing a patient to the hospital for urgent treatment. Even before a patient arrives at the hospital, complete patients health record is pulled from the on-line repository, and presented to the response team of the doctors, nurses, and para-medicals. The care starts in the ambulance and as the patient reaches the emergency ward of the hospital, the response team is aware of the patients history and present condition along with a working stabilisation plan, which is immediately put to action. A simple business like this requires a connected healthcare environment, which has the patients history, some simple decision support systems to guide the para-medicals and over and above the details of the patients health records, his current medications, allergies, previous procedures, etc.

A First Step

In order to enable this vision at Max, as a first step, the required IT infrastructure backbone for the hospitals has already been created. Dell Services is the chosen partner for IT support and development, both for infrastructure and application. This redundancy in the network infrastructure has been created to enable higher reliability, and the servers have been moved to the Dell data center where they are monitored, and supported $24 \times 7 \times 365$.

Dr Pahuja further adds that we are ready with systems for disaster recovery, and have created processes for business continuity, and have also changed our architecture of applications to allow scalability to be ready for the growth of our hospitals planned this year. Together with this, an environment of higher compliance with connectivity everywhere was created. The doctors across Max hospitals have already started using the newer collaboration tools, to conduct meetings/trainings and also discuss patients cases. Besides, Web 2.0 is being used to increase the reach to the customers at nominal costs.

Next Step: Integrated Care

On the next step, which is going to be the capture and retrieval of electronic clinical data, she says, this will bring in the much needed standardisation, practice, and monitoring of evidence based medicine, culture of safety and improvements, and preparing a ground for the next set of tools to build on.

"We are also working on Electronic Health Records (EHR) system, wherein we have used an open source product and configured that to capture the patients records. We are currently working on the training, and change management to incorporate the new processes associated with EHR. With the standardisation, it will also help in the faster discharge of the patient, reduce wastage of medicines, and will also support faster TPA approvals", Dr Pahuja adds.

Within the organisation, Dr Pahuja has successfully leveraged technology to support economies of scale and is using IT to improve clinical outcomes, efficiency, productivity, and effectiveness by enabling Integrated Care, which should improve the patients quality and safety.

Source: *Dataquest*, March, 2011

GROUP DECISION SUPPORT SYSTEM (GDSS)

The organisations' decision-making process is individual or group driven. The most of the strategic decisions are taken by group of experts or as part of business meetings. These meetings are people dependent, place dependent, and time dependent. It is always a challenge to collect all the decision-makers at the same date, time and at the same place. In the early 1980s, academic researchers developed a new category of software to support decision-making at group level called Group Decision Support Systems abbreviated as GDSS. There are two levels of GDSS. The level 1 GDSS are systems with tools to reduce communication barriers, such as large screens for display of ideas, voting mechanisms, and anonymous input of ideas and preferences. These are communications driven DSS. The level 2 GDSS provide problem structuring techniques, such as planning and modelling tools. These are model driven group DSS. Most companies have commercialised model driven group DSS and groupware.

The GDSS is an interactive computer based system that facilitates solution of decision problems by decision makers working as a group.

In 1989, Lotus introduced a groupware product called Notes and broadened the focus of GDSS to include enhancing communication, collaboration, and coordination among groups of people. In general, groupware, bulletin boards, audio and videoconferencing are the primary technologies for communications driven decision support. In the past few years, voice and video delivered system using the Internet protocol have greatly expanded the possibilities for synchronous communications driven DSS.

Advantages and Disadvantages of Group Decision processes

Advantages	*Disadvantages*
• Increased participation	• Time-consuming and slow process
• Improved pre-planning	• Lack of coordination
• Open, collaborative atmosphere	• Poor planning of meetings
• Idea generation free of criticism	• Inappropriate influence of group dynamics like fear to speak
• Groups are better than individuals at understanding problems	• Tendency towards compromised solutions of poor quality
• People are accountable for decisions in which they participate	• Tendency to repeat what already was said

Contd...

Contd...

- Group has more information (knowledge) than individual
- Group members will have their egos embedded in the decision
- Better and easy implementation
- Larger cost of making decision
- Inappropriate representation in the group

However, it is important to realise that one is not therefore trying to say that small meetings do not have some of these problems; these problems mentioned exist in any kind of meetings, but one is just trying to stress that they are more commonly found in large meetings. The small meetings tend to be more easily controlled than large meetings.

In a GDSS environment, there is usually a large electronic meeting room. Each of the decision-maker is provided with a computer connected to a network with special GDSS software. Some of these solutions use Nominal Group Technique, which includes:

- Silent generation of ideas in writing
- Round-robin listing of ideas
- Serial discussion of ideas
- Listing and ranking of priorities
- Discussion of priorities
- Re-ranking and rating of priorities

The GDSS enables participants to simultaneously discuss, when the computer sorts and sends ideas to each of the terminal, all at the same time. That saves tremendous amount of time, because all these are done electronically instead of manually, and the time saved will enable participants to spend more time manipulating and expressing their ideas. This can consequently increase the productivity and efficiency of the group. Besides this, no one can dominate the meeting. The GDSS provides an anonymous scheme, so that whatever one types in the terminal will be protected. Under this circumstance, no one really knows who is typing what. Because of this, no single person can dominate the meetings. In the worst case, one might find 'some ideas' are dominating the meeting, but this is perfectly fine because this is as a matter of fact an aim of the GDSS: to help participants voice their opinions from an idea oriented mindset.

Besides, this anonymity scheme will also help those team members who are shy to voice opinions. And with the anonymity, people are likely to be more honest. However, whether this anonymity is good or not can be very controversial. The success of meetings supported by GDSS depends largely on the conduct of the participants. If people are taking advantage of the anonymity system by typing obscene words or foul languages, this system may be banned for the good of the organisation.

Some of the GDSS technologies that are used by different organisations include:

- Special purpose decision room: It is an electronic meeting as explained above. It allows face to face meetings using computer network coordinated by the facilitator.
- Multiple use facility: It is an effective low cost general purpose computer lab. The group leader structures meeting with facilitators using the technology network.

- Web based groupware with clients: It is anytime/anyplace meeting with deadlines established. It requires no special facilities. One can use the traditional internet based network with GDSS software. It is a cheaper and flexible solution for global meetings.

Some of the common technologies that support The GDSS are: Lotus Notes/Domino; Microsoft Net meeting; Groove Workspace; Group Systems Meeting Room, and CISCO WebEx.

THE DATA WAREHOUSE

A data warehouse is an important data repository used for data-driven DSS. The data warehousing provides architectures and tools for business executives to systematically organise, understand, and use their data to make strategic decisions.

> A data warehouse is a subject oriented, integrated, time-variant and non-volatile collection of data in support of management's decision-making process.

Components of Data Warehouse

A large number of organisations have found data warehouse systems to be a competitive tool as it given single view of data. In order to understand the definition better, let us explain the components of data warehouse:

Subject Oriented

The functional systems and the legacy systems that the organisation has developed have an application orientation. For example, an accounts payable system will manage the data required for supplier payments. In data warehouse, data are arranged and optimised to provide answers to questions from diverse functional areas within an organisation. Therefore, the data warehouse contains data organised and summarised by subjects, such as sales, marketing, finance, distribution, and transportation. For each one of these topics, the data warehouse contains specific subjects of interest—products, customers, departments, regions, promotions, and so on. One can note that this form of data organisation is quite different from the more functional or process oriented organisation of typical transaction systems.

Integrated

The data warehouse is a centralised, consolidated database that integrates data derived from the entire organisation as well from external sources. The data warehouse helps to consolidate the data captured from various legacy systems, enterprise systems, and external databases, and also the market research data. The data integration helps in providing a unified view of the overall organisation data. The data integration also ensures the data quality by standardising the data.

Time variant

The DSS data include a time element. In contrast to the operational data that focus on current transactions, the warehouse data represents the flow of data through our time frame. The data warehouse consists of data from the inception of the organisation. The data warehouse can even contain projected data generated through statistical and other decision models. It is also time variant in the sense that, once data are periodically uploaded to the data warehouse, all time dependent aggregations are recomputed.

Non-volatile

Once data is entered into the data warehouse, they are never deleted or updated. This is because the data warehouse consists of organisation's transaction history data. The data warehouse always grows exponentially, because data is never deleted but added. The DSS DBMS must be able to support multi-terabyte database and multi-processing.

The subject orientation, integration, time variant, and non-volatility constitute the key elements of a DSS data repository. If the DSS database is to function properly, the data warehouse data must conform to these four requirements. The data warehouse data must be integrated to provide a consistent view for all organisational components. The data integration implies that all business entities, data elements, data characteristics, and business metrics are described in the same way throughout the enterprise. In order to avoid the potential formal tangle, the data in the data warehouse must conform to a common format acceptable throughout the organisation.

The basic objective of operational systems is to maintain functionality, that is, it is designed to capture and modify data related to operational transaction. In contrast, the data warehouse has a subject orientation. The subject refers to the data entities or data elements found within the operational data that concern the data analyst, or the organisation. Therefore, instead of storing an invoice, the data warehouse stores its product and customer components, because decision support activities require the retrieval of sales summaries by product or customers.

As data in a data warehouse constitute a snapshot of the company history as measured by its variables, the time component is crucial. Therefore, the data warehouse contains a time that places the data within a time framework. This time is also used to generate appropriate summaries and aggregations. In other words, the time element allows the data analyst to add a time dimension to decision analysis, thus permitting the examination of any component by week, month, quarter, and year. Once the data enter the data warehouse, the time that is assigned to the data cannot be changed.

In a nutshell, the data warehouse is usually a read only database optimised for data analysis and query processing. Typically, data are extracted from various sources and are then transformed and integrated—in other words, passed through a data filter—before being loaded into the data warehouse. The users access the data warehouse via front end tools and/or end user application software to extract the data in usable form. Some of the important characteristics of a warehouse include:

- Historical foundation for BI
- Granular data
- Integrated
- Nonvolatile
- Application neutral

Creating Data Warehouse

Creating a good data warehouse is seldom simple, because its data are typically derived from a variety of different sources that use different data formats and structures. As shown in Figure 11.2,

different operational databases, external databases, and other distributed databases feed data to the data warehouse. As the data might be extracted from different types of files and databases, these might also be in different platforms. Therefore, integrating the sources, data types, and formats into a homogeneous data warehouse framework can be a real challenge.

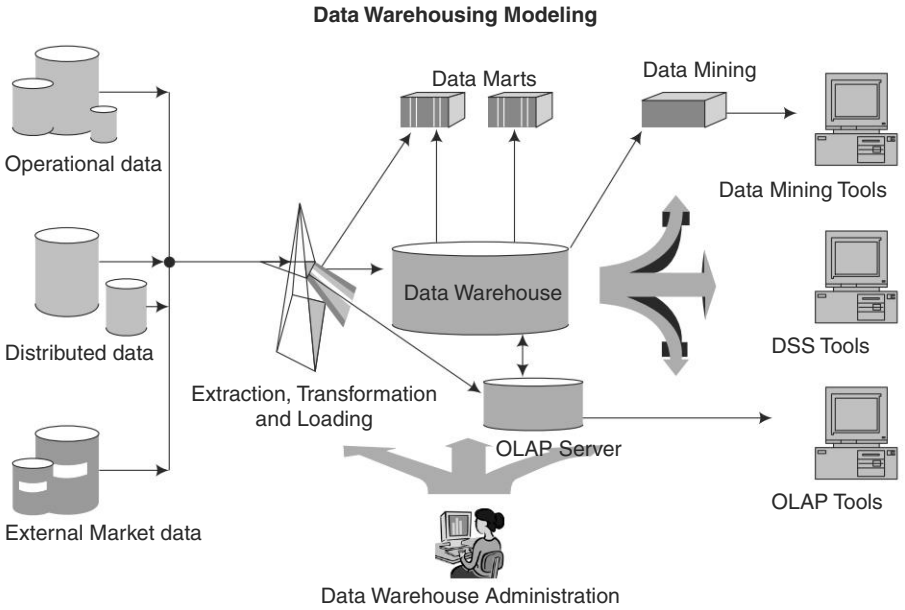

Figure 11.2 Data Warehouse Model

A data mart is a subset of an organisational data warehouse, usually oriented to a specific function or department to support decision-making.

The data warehouse creation requires time, money, and considerable managerial effort. Therefore, some of the organisations begin their effort of creating data warehousing by focusing on more manageable data sets that are targeted to meet the special needs of small groups within the organisation. These small data stores are called data marts. ***A data mart is a small, single subject data warehouse subset that provides decision support to a small group of people.***

Some organisations are attracted to data marts not only because of the lower cost and shorter implementation time, but also because of current technological advances and inevitable 'people issues' make data marts attractive. A powerful computer allows providing a customised DSS to small groups in ways that a centralised system may not be able to do. In addition, people at different organisational levels are likely to require data with different summarisation, aggregation, and presentation formats. The data marts can serve as a test vehicle for companies exploring the potential benefits of data warehouses. By following this gradual data mart-to-data warehouse migration, managers can solve a specific department's decision support needs within a reasonable time frame, as compared to the time usually required to implement a data warehouse.

Process of Data Warehousing

The data warehousing is the process of creating, populating, and then querying a data warehouse and can involve a number of discrete steps such as:

1. ***Source Data/System Identification.*** In order to build the data warehouse, the appropriate data must be located. Typically, this will involve both the current Online Transaction Processing (OLTP) system where the 'day-to-day' information about the business resides and historical data for prior periods, which may be contained in some form of 'legacy' system. Often these legacy systems are not relational databases; much effort is required to extract the appropriate data. The external databases are also used to extract the relevant data.
2. ***Data Warehouse Design and Creation.*** This step describes the process of designing the warehouse, with care taken to ensure that the design supports the types of queries the warehouse will be used for. This is a serious effort that requires thorough understanding of the database scheme to be created keeping user requirements in mind. The design is often an iterative process. A great care must be taken at this stage, because once the model is populated with large amounts of data, the model can not be changed. The data warehouse structure in the following section explains the concept in more details.
3. ***Data Acquisition.*** In this stage, the data is acquired from the source data systems like OLTP systems and other external databases. It is the most time consuming and costly effort in the data warehousing project, and is performed with software products known as ETL (Extract/Transform/Load) tools. The data acquisition is then an ongoing, scheduled process, which is executed to keep the warehouse relevant to a predetermined period in time. The ETL tool is used to extract data as per the warehouse subject from all data sources, the data is cleaned, and is transformed as per the data warehouse structure for loading into the warehouse.
4. ***Data Cleansing.*** This is typically performed in conjunction with data acquisition as part of transformation stage of ETL. A data warehouse that contains incorrect data is not only useless, but also very dangerous. The whole idea behind a data warehouse is to enable decision-making. The objective of data warehouse is to take strategic decisions, and if it is based on incorrect data, it will lead to failure of an organisation. The data cleansing is a complicated process that validates and, if necessary, corrects the data before it is inserted into the warehouse. This process is also referred to as 'data scrubbing', or 'data quality assurance'. It can be an extremely complex process, especially if some of the warehouse inputs are from older mainframe file systems.
5. ***Data Aggregation.*** The data warehouses can be designed to store data at the detail level, at some aggregate level, or a combination of both. The advantage of summarised data is that typical queries run faster. The disadvantage is that information, which may be needed to answer a query, is lost during aggregation. The trade off must be carefully weighed, because the decision can not be undone without rebuilding and repopulating the warehouse. The safest decision is to build the warehouse with a high level of detail, but the cost in storage can be extreme.

Data Warehouse Structure

The data warehouse usually are created using the star schema as a data modelling technique. It is also used to map multidimensional decision support data into a relational database. The reason for the star schema's development is that existing relational modelling techniques, E-R and normalisation, did not yield a database structure that served the advanced data analysis requirements well. *The* ***star schema's yield an easily implemented model for multidimensional data analysis while still preserving the relational structures on which the operational database is built.*** The basic star schema has four components: facts, dimensions, attributes, and attribute hierarchies.

1. ***Facts.*** The facts are numeric measurements (values) that represent a specific business aspect or activity. For example, sales figures are numeric measurements that represent product and/or service sales. The facts that are commonly used in business data analysis are units, costs, prices, and revenues. The facts are normally stored in a fact table that is the centre of the star schema. The fact table contains facts that are linked through their dimensions. Figure 11.3 depicts the example of a star schema with sales amount, unit price and quantity as facts.

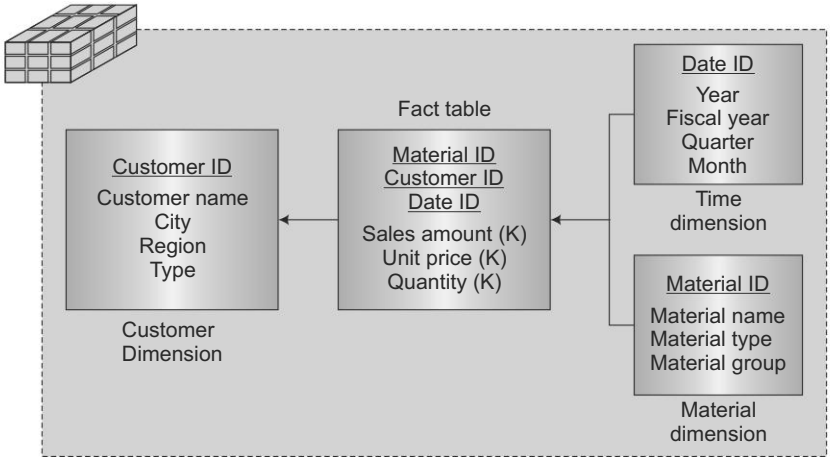

Figure 11.3 Star Schema Example

2. ***Dimensions.*** The dimensions are qualifying characteristics that provide additional perspectives to a given fact. It was stated that the dimensions are of interest to us because DSS data are almost always viewed in relation to other data. For instance, sales might be compared by product from region to region, and from one time period to the next. So sales have product, location, and time dimensions. Such dimensions are normally stored in dimension tables. Figure 11.3 depicts the example of a star schema with customer, material and time deminesions.
3. ***Attributes.*** Each dimension table contains attributes. The attributes are often used to search, filter, or classify facts. The dimensions provide descriptive characteristics about

the facts through their attributes. Therefore, the data warehouse designer must define common business attributes that will be used by the data analyst to narrow a search, group information, or describe dimensions. Each of the dimensions in the star schema depicted in Figure 11.3 has appropriate attributes.

4. ***Attribute Hierarchies.*** The attributes within dimensions can be ordered in a well-defined attribute hierarchy. The attribute hierarchy provides a top-down data organisation that is used for two main purposes: aggregation and drill down/roll up data analysis. For example, Figure 11.4 shows how the location dimension attributes can be organised in a hierarchy by region, state, city, and store.

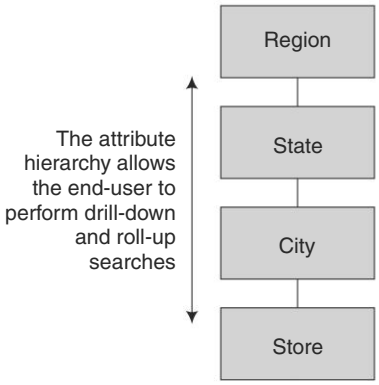

Figure 11.4 Attribute Hierarchy

5. ***Metadata Management.*** Throughout the entire process of identifying, acquiring, and querying the data, metadata management takes place. *The metadata is defined as 'data about data'*. An example is a column in a table. The data type, for instance, a string or integer of the column is one piece of metadata. The name of the column is another. The actual value in the column for a particular row is not metadata—it is data. The metadata is stored in a metadata repository and provides extremely useful information to all of the tools mentioned previously. metadata management has developed into an exacting science that can provide huge returns to an organisation. It can assist companies in analysing the impact of changes to database tables, tracking owners of individual data elements, and much more. It is also required to build the warehouse, since the ETL tool needs to know the metadata attributes of the sources and targets in order to 'map' the data properly. The BI tools need the metadata for similar reasons.

> The metadata is data about data - data that is the information about the contents and uses of the data warehouse.

Data Analysis using Data Warehouse

Once the warehouse has been built and populated, it becomes possible to extract meaningful information from it that will provide a competitive advantage and a return on investment. This is done using business intelligence (BI) tools. The BI is a very broad field, which contains technologies such as Decision Support Systems (DSS), Executive Information Systems (EIS), Online Analytical Processing (OLAP), Relational OLAP (ROLAP), Multidimensional OLAP (MOLAP), Hybrid OLAP (HOLAP, a combination of MOLAP and ROLAP), and more. The BI can be broken down into four broad fields:

- ***Multidimensional Analysis Tools.*** The tools that allow the user to look at the data from a number of different 'angles'. It helps the user to have a 360 degree view of data. These tools often use a multi-dimensional database referred to as a 'cube'.

- ***Query Tools.*** The tools that allow the user to use SQL (Structured Query Language) queries against the warehouse and get a result.
- ***Data Mining Tools.*** The tools that automatically search for patterns in data. These tools are usually driven by complex statistical formulas. The easiest way to distinguish data mining from the various forms of OLAP is that OLAP can only answer questions one know to ask; data mining answers questions that one may not be aware of.
- ***Data Visualisation Tools.*** The tools that show graphical representations of data, including complex three dimensional data pictures. The theory is that the user can 'see' trends more effectively in this manner than when looking at complex statistical graphs.

ONLINE ANALYTICAL PROCESSING (OLAP)

The Online Analytical Processing (OLAP) create an advanced data analysis environment that supports decision making, business modelling, and operations research activities. The OLAP systems share the following characteristics:

- Use multi-dimensional data analysis techniques
- Provide advanced database support
- Provide easy to use end user interfaces
- Support client/server architecture.

The multi-dimensional data analysis refers to the processing of data such that data are viewed as part of a multi-dimensional structure. The interest in the multi-dimensional aspect of data analysis stems from the fact that business decision-makers usually view data from a business perspective. That is, they tend to view business data as they relate to other business data. The OLAP architecture consists of the following modules:

- OLAP graphical user interface
- OLAP analytical processing logic
- OLAP data-processing logic

These three OLAP modules, residing in the client/server environment, make it possible to use OLAP's three defining characteristics: multi-dimensional data analysis, advanced database support, and easy to use interface. Figure 11.5 illustrates the OLAP components and attributes.

OLAP is a class of multi-dimensional applications that facilitates the discovery of patterns and relationships in data.

Relational OLAP

The relational online analytical processing (ROLAP) provides OLAP functionality by using relational databases and familiar relational query tools to store and analyse multi-dimensional data. This approach builds on existing relational technologies and represents a natural extension to all those organisations that already use relational database management systems within their organisations.

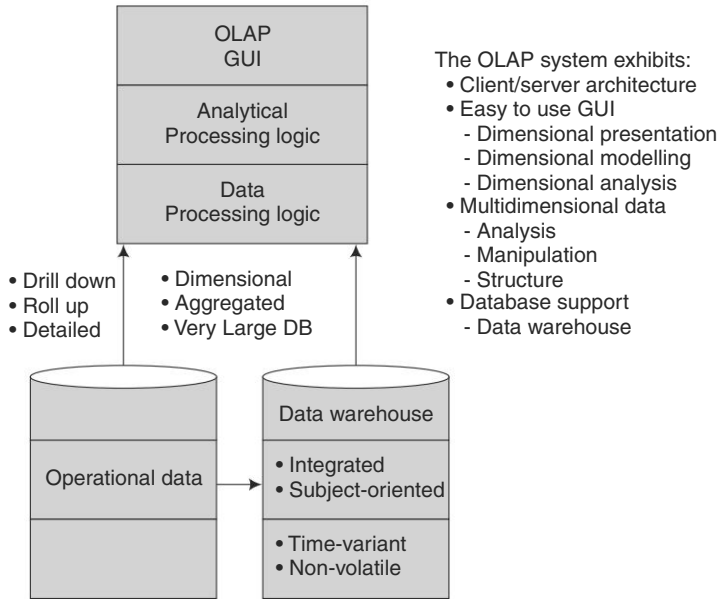

Figure 11.5 OLAP System Architecture

Multi-dimensional OLAP

The multi-dimensional online analytical processing (MOLAP) extends OLAP functionality to multi-dimensional database management systems. A multi-dimensional database management system uses special proprietary techniques to store data in matrix like n-dimensional arrays. MOLAP's premise is that multi-dimensional databases are best suited to manage, store, and analyse multi-dimensional data. Most of the proprietary techniques in MDBMs are derived from engineering fields such as computer-aided design/computer-aided manufacturing (CAD/CAM), and geographic information system (GIS). Conceptually, MDBMS end users visualise the stored data as a three-dimensional cube known as a data cube. The location of each data value in the data cube is a function of the x, y, and z axes in a three-dimensional space. The x, y, and z axes represent the dimensions of the data value. The data cubes can grow to n-number of dimensions, thus becoming hyper cubes. The data cubes are created by extracting data from the operational databases or from the data warehouse. One important characteristic of data cubes is that they are static; that is, they are not subject to change and must be created before they can be used. In other words, data cubes cannot be created by ad hoc queries. Instead, query pre-created cubes with defined axes; for example a cube for sales will have the product, location, and time dimensions and one can only be allowed to query those dimensions. Therefore, the data cube creation process is critical and requires in depth front end design work. This front end design work may be well justified by the fact that MOLAP databases are known to be much faster than their ROLAP counterparts, especially when dealing with small to medium data sets. In order to speed data access, data cubes are normally held in memory, in what is called the cube cache. Table 11.3 depicts comparison between ROLAP and MOLAP on various characteristics.

Table 11.3 Comparison between ROLAP and MOLAP

Characteristic	*ROLAP*	*MOLAP*
Schema	Uses star schema Additional dimensions can be added dynamically	Uses data cubes Additional dimensions require recreation of the data cube
Database size	Medium to large	Small to medium
Architecture	Client/server Standards-based Open	Client/server Proprietary
Access	Supports ad hoc requests Unlimited dimensions	Limited to pre-defined dimensions
Resources	High	Very high
Flexibility	High	Low
Scalability	High	Low
Speed	Good with small data sets; average for medium to large data sets	Faster for small to medium data sets; average for large data sets

DATA MINING

The data mining is a powerful technological tool that helps organisations in extracting hidden predictive information from large databases. The data mining tools predict future trends and behaviours, allowing businesses to make proactive, knowledge driven decisions. The automated, prospective analyses offered by data mining move beyond the analyses of past events provided by retrospective tools typical of decision support systems. The data mining tools can answer business questions that traditionally were time consuming to resolve. They use databases for hidden patterns, finding predictive information that experts may miss because it lies outside their expectations.

The data mining is the process of extracting hidden patterns from databases.

The purpose of data mining is to discover previously unknown data characteristics, relationships, dependencies, or trends. Such discoveries then become part of the information framework on which decisions are built. A typical data analysis tool relies on the end-users to define the problem, select the data, and initiate the appropriate data analyses to generate the information that helps model and solve problems uncovered by them. If the end-user fails to detect a problem, no action is taken. Given this limitation, some DSS now support various types of automated alerts. These alerts are software agents that constantly monitor certain parameters, such as sales indicator levels, and then perform specified actions like sending e-mail or alert messages, when such parameters reach pre-defined levels.

In contrast to the traditional DSS tools, the data mining premise is proactive. That is, instead of having the end-user define the problem, select the data, and select the tools to analyse such data, the data mining tools automatically search the data for anomalies and possible relationships, thereby identifying problems that have not yet been identified by the end user. In other words,

data mining tools analyse the data, uncover problems, or opportunities hidden in the data relationships, form computer models based on their finding, and then use the models to predict business behaviour—requiring minimal end user intervention. The end-user is, therefore, able to use the system's findings to gain knowledge that may yield competitive advantages.

The data mining is described as a methodology designed to perform knowledge discovery expeditions over the database data with minimal end user intervention during the actual knowledge discovery phase. Refer to Figure 11.6 which represents three states: data, information, and knowledge. The data is the base of the complete concept and represent organisation's data collected from different operational databases. The information represents the processed data and acts as the basis for decision-making and business understanding. The knowledge is found at the top and represents highly specialised information that helps in taking decision.

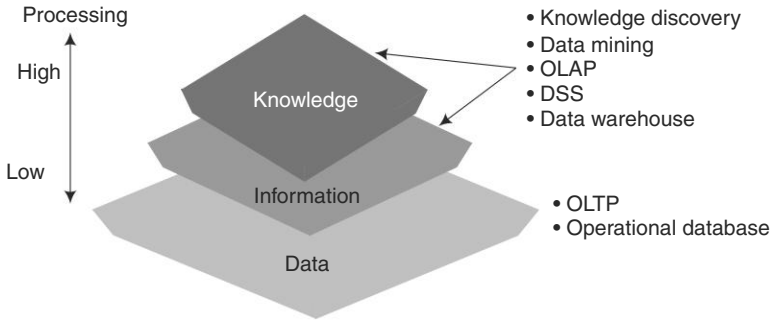

Figure 11.6 Knowledge Discovery Stages

Most organisations already collect and refine massive quantities of data. The data mining techniques can be implemented rapidly on existing software and hardware platforms to enhance the value of existing information resources, and can be integrated with new products and systems as they are brought online. When implemented on high performance client/server or parallel processing computers, data mining tools can analyse massive databases. The data mining tools use advanced techniques from knowledge discovery, artificial intelligence, and other fields to obtain 'knowledge'. One can apply these techniques to business needs. The knowledge is then used to make predictions of events or forecasts of values such as sales returns, etc. Several OLAP tools have integrated at least some of these data mining features in their products.

The Scope of Data Mining

The data mining derives its name from the mining analogy—searching for valuable business information from a large database. The processes require either sifting through an immense amount of material, or intelligently probing it to find exactly where the value resides. The given databases of sufficient size and quality, data mining technology can generate new business opportunities by providing these capabilities.

- ***Automated prediction of trends and behaviours.*** The data mining automates the process of finding predictive information from large databases. The questions that

traditionally required extensive hands on analysis can now be answered directly from the data—quickly. A typical example of a predictive problem is targeted marketing. The other predictive examples include forecasting bankruptcy and other forms of default, and identifying segments of a population likely to respond similarly to given events.

- ***Automated discovery of previously unknown patterns.*** The data mining tools sweep through databases and identify previously hidden patterns in one step. An example of pattern discovery is the analysis of retail sales data to identify seemingly unrelated products that are often purchased together. The other pattern discovery problems include detecting fraudulent credit card transactions and identifying anomalous data that could represent data entry keying errors.

The larger databases, yield improved predictions. The databases can be larger in both depth and breadth:

- ***More columns.*** The analysts must often limit the number of variables they examine when doing hands on analysis due to time constraints. Yet variables that are discarded because they seem unimportant may carry information about unknown patterns. The high performance data mining allows users to explore the full depth of a database, without selecting a subset of variables.
- ***More rows.*** The larger samples yield lower estimation errors and variance, and allow users to make inferences about small but important segments of a population.

Madura Garments (DM)

The right retail solution led to better in-stock movement and sell-through, as well as a better understanding of the consumer buying pattern.

As a part of Aditya Birla Nuvo, an AV Birla Group company, Madura Garments is the name behind leading fashion brands like Louis Philippe, Van Heusen, Allen Solly, Peter England, Byford, Elements, and SF Jeans. And if that's not enough, the company is also a preferred global supplier of international brands like Marks & Spencer, Tommy Hilfiger, Polo, and Ralph Lauren. The group is also involved on the retail front, distributing the brands through its retail chain Planet Fashion and Trouser Town.

"Last year, the company decided to bifurcate its business into two divisions—retail and trade (where large orders are booked directly by customers). It was looking for a comprehensive retail solution. and decided to implement Oracles Retek, in November last year. What is especially significant and unique is that for the first time in the world, Retek, and SAP (used in the wholesale business) have been interfaced with each other," says NP Singh, senior vice president and CIO, textiles and apparel business, Aditya Birla Group.

For deploying Retek, a team of fifteen members from various departments was formed. Retek has been rolled out in forty Allen Solly stores with plans to deploy the solution in all Louis Philippe and Van Heusen stores by March end this year. The Retek solution assists retail merchandise management, allocation of stock to store, setting up promotion, and merchandise, item, and demand planning.

What's important to note is that Retek is being interfaced with SAP for financial transaction posting as Retek does not have a financial module. Therefore, what's happening is that at the end of the day, data pertaining to sales and stocks get transferred to SAP for financial analysis and report generation. All expenses pertaining to stores are also directly entered in the SAP system, says Singh.

Challenges

Considering that Retek has not been deployed in Indian retail businesses so far, finding a system integrator partner equipped with the right skills to implement the solution was a challenge. Moreover, without a finance module for Retek, interfacing with SAP was also a tough task.

"The most critical challenge for the company was dealing with change management in terms of processes, user training and ownership. Since the trade business was accounted for in SAP, the retail business was now being done in Retek. Thus, the users had to learn to adopt and own the new ERP solution", says Singh.

While Retek has been implemented at the back-end, it has been interfaced with Shoper from Tally Solutions in the front-end. For Peter England People stores, Retek has been interfaced with a front-end called 360 Commerce. For retail analytics, Madura is using Retek which has a data warehouse called RDW and a presentation layer known as Micro Strategy. Meanwhile, the financial analytics is being done out of SAP by using Business Information Warehouse (BIW).

In the future, "we plan to use Cognos which would extract data from RDW and BIW," adds Singh.

The post deployment of Retek, retail data is easily available in real-time allowing users to take informed and faster decisions. The real-time visibility of data ensures that users plan and set up promotions online, thereby helping increase sales. Since data comes at the end of the day, data collation and analysis leading to report generation could only be done the next day. "With Retek, data is available immediately, helping stock movement and sell-through as it enables the people to see the buying patterns, meaning what's in demand and what's not," says Singh.

Source: *Dataquest*, February, 2009

Extracting Knowledge

It is difficult to give a comprehensive list of data mining tools. These tools have evolved over a period; most of these seem to be governed by a different approach and focus of the end-user needs. Within a given niche, data-mining tools can use certain algorithms, and those algorithms can be implemented in different ways and/or applied over different data. There are no standards that are available, but to build a data mining tool, one needs to do:

- Data preparation
- Data analysis and classification
- Knowledge acquisition
- Prognosis

In the data preparation phase, the main data sets to be used by the data-mining operation are identified and cleansed of any data impurities. If one is accessing the data from the data warehouse, these issues are already addressed.

The data analysis and classification phase studies the data to identify common data characteristics or patterns. During this phase the data-mining tool applies specific algorithms to find: data groupings, classifications, clusters, or sequences; data dependencies, links, or relationships; and data patterns, trends, and deviation.

The knowledge acquisition phase uses the results of the data analysis and classification phase. During this phase, the data-mining tool selects the appropriate modelling or knowledge

acquisition algorithms. The most typical algorithms used in data-mining are based on neural networks, decision trees, rules, induction, genetic algorithms, classification and regression trees, memory based reasoning, or nearest neighbour, and data visualisation. A data-mining tool may use many of these algorithms in any combination to generate a computer model that reflects the behaviour of the target data set.

Although many data-mining tools stop at the knowledge acquisition phase, others continue to the prognosis phase. In this phase, the data-mining findings are used to predict future behaviour and forecast business outcomes.

The complete set of findings can be represented in a decision tree, a neural net, a forecasting model, or a visual presentation interface that is then used to project future events or results. For example, the prognosis phase might project the likely outcome of a new product rollout or a new marketing promotion. Figure 11.7 illustrates the different phases of the data mining techniques.

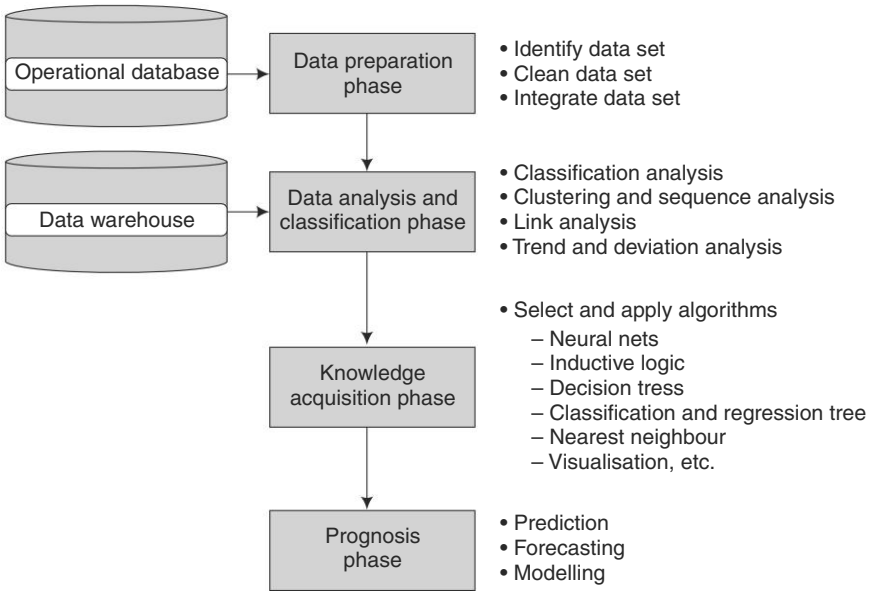

Figure 11.7 Data Mining Phases

Data Mining Tools

The information technology has been evolving transaction and analytical systems, and data mining is providing the link between the two. The data mining software analyses relationships and patterns in stored transaction data based on open ended user queries. Several types of analytical software are available: statistical, machine learning, and neural networks, etc. Generally, while mining the data one or more of four types of relationships are sought:

- ***Classes.*** The stored data is used to locate data in predetermined groups. For example, a retail chain could mine customer purchase data to determine when customers visit and

what they typically buy. This information could be used to increase traffic by having special offers for the day.

- ***Clusters.*** The data items are grouped according to logical relationships or customer preferences. For example, data can be mined to identify market segments or customer affinities.
- ***Associations.*** The data can be mined to identify associations between the buying patterns. The bread-butter or beer-nuts are examples of associative mining. This helps in doing market basket analysis.
- ***Sequential patterns.*** The data is mined to anticipate behaviour patterns and trends. It helps in identifying the sequence of purchase. For example, if a customer buys a pen what probability that he/she is going to buy a notebook as its next item.

The data mining is to be done on integrated, consistent data. The organisations have already created data warehouses, which addresses the issue of data integration, consistency, consolidation from various sources, and transformation of data for analysis. There are different levels of analysis that can be done to mine the data are:

- ***Decision trees.*** A structure that can be used to divide a large collection of records into successively smaller sets of records by applying a sequence of simple decision rules. A decision tree model consists of a set of rules for dividing a large heterogeneous population into smaller, more homogeneous groups with respect to a particular target variable. It is a tree-shaped structure that represents sets of decisions. These decisions generate rules for the classification of a dataset. The example of decision tree is given in Figure 11.8. The decision tree can be a binary tree or n-tree.

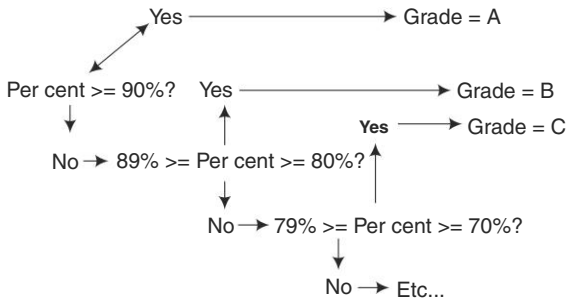

Figure 11.8 Example of Decision Tree

- ***Artificial Neural Networks (ANN).*** The non-linear predictive models that learn through training and resemble biological neural networks in structure. When applied in well-defined domains, their ability to generalise and learn from data 'mimics' a human's ability to learn from experience. A very useful technique in finding patterns. The drawback of ANN is training a neural network, results in internal weights distributed throughout the network making it difficult to understand why a solution is valid. An example of Neural network is given in Figure 11.9.

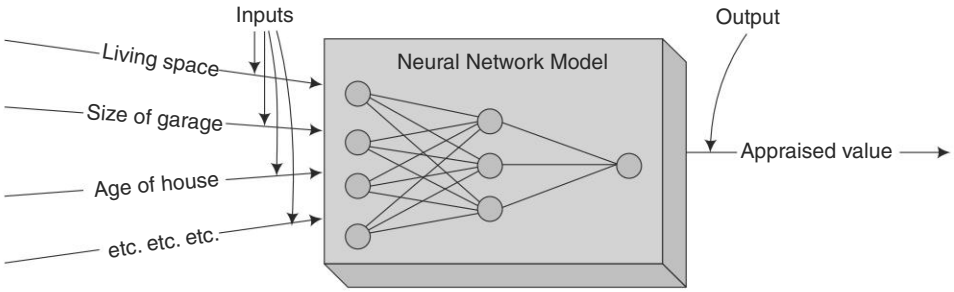

Figure 11.9 Neural Network Model

- ***Nearest neighbour method.*** In order to forecast the prediction value for an unclassified record is to look for similar records and use the prediction value of the record that is nearest to the unclassified record. The records that are close to each other will have similar prediction values. If one knows the prediction value of one record, one can predict the corresponding value for its nearest neighbours. It is a technique that classifies each record in a data set based on a combination of the classes of the *k* record (s), most similar to it in a historical dataset. Sometimes called the *k*-nearest neighbour technique.
- ***Clustering.*** It is used to segment a database into clusters based on a set of attributes. The clustering is governed by measurement of proximity. The members belong to a cluster if they have proximity to each other. It is the process of grouping data into clusters so that records within a cluster have high similarity in comparison to one another. The clusters do not need to have equal number of records and can do grouping according to one or more attributes. The clustering can help marketers discover distinct groups in their customer databases and characterise them based on the customer segmentation done. The K-means clustering algorithm is one of the popular clustering techniques, which is similar to nearest neighbour techniques and depends on a geometric interpretation of the data. The K-means clustering example is given in Figure 11.10.

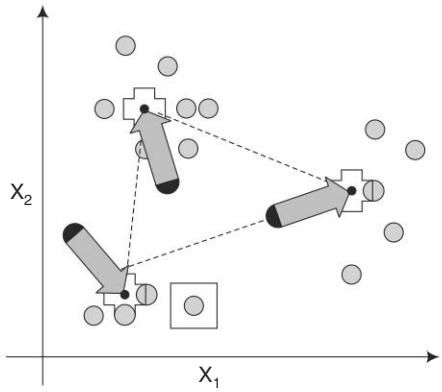

Figure 11.10 K-means clustering example where K = 3

- ***Genetic algorithms.*** The optimisation techniques that use process such as genetic combination, mutation, and natural selection in a design based on the concepts of natural evolution.
- ***Rule induction.*** The extraction of if-then rules from data based on statistical significance.

- ***Data visualisation.*** The visual interpretation of complex relationships in multidimensional data. The graphics tools are used to illustrate data relationships.

How exactly is data-mining able to tell you important things that you did not know or what is going to happen next? The technique that is used to perform these feats in data mining is called modelling. The modelling is simply the act of building a model in one situation where one knows the answer and then applying it to another situation that one does not. This act of model building is thus something that people have been doing for a long time, certainly before the advent of computers or data mining technology. The computers are loaded with lots of information about a variety of situations where an answer is known and then the data-mining software on the computer must run through that data and distill the characteristics of the data that should go into the model. Once the model is built, it can then be used in similar situations where one does not know the answer.

SUMMARY

- The decision-making process is a systematic means of arriving at a decision. It is a way of organising data with the purpose of presenting or displaying it to the decision-maker in such a way which is more obvious than simply making a list of the alternatives. The models are created from a decision-making process, which is a series of interrelated steps and follow a specific methodology to ensure that one or more viewpoints are taken in collecting and depicting the data.
- There are two major approaches to decision-making in an organisation; the authoritarian method in which an executive head makes a decision for the group and the group method in which the group decides what to do. Within these two broader approaches, decision-makers follow their own style of generating alternatives and taking decisions.
- The common styles of decision-making include: Optimising; Satisficing, Organisational, Political, Maximax, and Maximin. The optimising way of taking decision is the best approach as it helps the decision-maker to take the decision in a structured manner. The steps involved are: identify the problem; get the facts; develop the alternatives; evaluate each alternative, rate the risk associated with each alternative; and take the decision.
- A model is a simplified representation of a real world situation. It can be regarded as a substitute for the real system, stripping away a large amount of complexity to leave only essential, relevant details. A model is used to facilitate understanding of a real object, or situation. A decision-maker is better able to evaluate the consequences of alternative actions by analysing the model's behaviour.
- The three types of models that are popularly being used by decision-makers include: physical; analog; and symbolic. The models created by architects about a new building is referred to as a 'physical' model. The physical models are three-dimensional representations of real world objects. There are also scaled down versions of the models more suited to computers which include (i) analog or graphical models, which use lines, curves, and other symbols to produce flow charts, pie charts, bar charts, scatter diagrams, etc. and (ii) symbolic or mathematical models, which use formulae and algorithms to represent real world situations. All of the models that we are going to discuss are either graphical or mathematical.
- The business decision-making is mainly of three types: decisions taken under conditions of certainty (Structured Decisions); decisions taken under conditions of risk (Semi-Structured Decisions);

and decisions taken under conditions of uncertainty (Unstructured Decisions). There are various characteristics associated with each of these three types of decision-making. The decision analysis—also called decision theory—is the chief model building tool used in an environment of uncertainty. In decision analysis, uncontrollable variables are called 'events'. These events may result from economic, social, and political factors beyond the control of the decision-maker.

- The decision Support System (DSS) is an interactive computer based information system that supports a decision. The primary function of a DSS is to assist managers in solving unstructured, semi-structured, and structured decision problems. The DSS primarily supports analytical, quantitative type of work using modelling techniques. The Decision Support System is a general term for any computer application that enhances a person or group's ability to make decisions.
- The typical information that a decision support application might gather and present would be (a) accessing all information assets, including legacy and relational data sources; (b) comparative data figures; (c) projected figures based on new data or assumptions; (d) consequences of different decision alternatives, given past experience in a specific context. The major components that a DSS system would include are User-interface; DSS Database; DSS Model Base; and Knowledge Base.
- The trends suggest that data driven DSS will use faster, real time access to larger, better integrated databases. The model driven DSS will be more complex, yet understandable, and systems built using simulations and their accompanying visual displays will be increasingly realistic. The communications driven DSS will provide more real time video communications support. The document driven DSS will access larger repositories of unstructured data and the systems will present appropriate documents in more useable formats. Finally, knowledge driven DSS will likely be more sophisticated and more comprehensive.
- The GDSS is an interactive computer based system that facilitates solution of unstructured decision problems by decision-makers working as group. The organisations' decision-making process is either individual or group driven. The DSS systems are widely used by individuals and the GDSS is meant to be used by the group decision processes.
- A data warehouse is a subject oriented, integrated, time variant and non-volatile collection of data in support of management's decision-making process. The data warehousing provides architectures and tools for business executives to systematically organise, understand, and use their data to make strategic decisions. A large number of organisations have found data warehouse systems to be a competitive tool. The subject orientation, integration, time variant, and non-volatility constitute the key elements of a DSS data repository. If the DSS database is to function properly, the data warehouse data must conform to these four requirements.
- Once the warehouse has been built and populated, it becomes possible to extract meaningful information from it that will provide a competitive advantage and a return on investment. This is done using Business Intelligence (BI) tools. The BI is a very broad field, which contains technologies such as Decision Support Systems (DSS), Executive Information Systems (EIS), Online Analytical Processing (OLAP), Relational OLAP (ROLAP), Multidimensional OLAP (MOLAP), Hybrid OLAP (HOLAP, a combination of MOLAP and ROLAP), and more.
- The data warehouse uses the star schema as a data modelling technique. It is also used to map multidimensional decision support data into a relational database. The reason for the star schema's development is that existing relational modelling techniques, E-R and normalisation, did not yield a database structure that served the advanced data analysis requirements well. The star schemas yield an easily implemented model for multi-dimensional data analysis while still preserving the relational structures on which the operational database is built. The basic star schema has four components: facts, dimensions, attributes, and attribute hierarchies.
- The Online Analytical Processing (OLAP), create an advanced data analysis environment that supports decision-making, business modelling, and operations research activities. The OLAP

systems share the following characteristics: use multidimensional data analysis techniques; provide advanced database support; provide easy to use end user interfaces; and support client/server architecture. The multi-dimensional data analysis refers to the processing of data such that data are viewed as part of a multi-dimensional structure.

- The data mining is a powerful technological tool that helps organisation in extracting hidden predictive information from large databases. The data mining tools predict future trends and behaviours, allowing businesses to make proactive, knowledge driven decisions. The automated, prospective analyses offered by data mining move beyond the analyses of past events provided by retrospective tools typical of decision support systems. The data mining tools can answer business questions that traditionally were time-consuming to resolve. They use databases for hidden patterns, finding predictive information that experts may miss because it lies outside their expectations.
- The data mining software analyses relationships and patterns in stored transaction data based on open ended user queries. Where are several types of analytical software are available: statistical, machine learning, and neural networks, etc. Generally, while mining the data one or more of four types of relationships are sought: classes; clusters; association; and sequencing. different kind of tools that are popularly being used are: decision tree; artificial neural network; nearest neighbour; cluster analysis; genetic algorithm; rule induction; and data visualisation.

KEY TERMS

Analog Models
Association
Business Intelligence (BI)
Certainty
Classification
Clustering
Communication DSS
Data Cleansing
Data Driven DSS
Data Mining
Data Visualisation
Data Warehouse
Databases
Decision-making
Decision Models
Decision Support Systems (DSS)
Decision Tree
Dimensional Table
Document Driven DSS
ETL
Extraction
Fact Table
Functional Systems
Genetic Algorithm
Group Decision Support System (GDSS)
Integrated
Knowledge Discovery
Knowledge Driven DSS
Load
Maximax
Maximin
Metadata
Model Driven DSS
Multi-dimensional OLAP
Multi-dimensional Analysis
Nearest Neighbour
Neural Networks
Non-volatile
OLAP
OLTP
Optimising
Organisational View
Physical Models
Political View
Relational OLAP
Risky
Rule Induction
Satisficing
Semi-structured Decisions
Sequencing
Star Schema
Structured Decisions
Subject Oriented
Symbolic Models
Time Variant
Transformation
Types of DSS
Unstructured Decisions
Web Based DSS

SELF-STUDY QUESTIONS

1. _____ is the process of sufficiently reducing uncertainty and doubt about alternatives to allow a reasonable choice to be made.
2. _____ and _____ are two major approaches to decision-making in an organisation.
3. Which on the following is not the common style of decision-making?
   (a) Optimising (b) Satisficing
   (c) Knowledge Management (d) Maximin
4. The terms operations research and management science are also used to refer to _____.
5. The primary function of a _____ is to assist managers in solving unstructured, semi-structured and structured decision problems.
   (a) Management Information Systems (b) Expert Systems
   (c) Data Warehouse (d) Decision Support Systems
6. _____ is an interactive computer based system that facilitates solution of decision problems by decision makers working as a group.
   (a) Group DSS (b) Knowledge DSS
   (c) Expert Systems (d) Business Intelligence
7. A Data Warehouse is an important data repository used for _____ DSS.
   (a) Web Based (b) Model Driven (c) Data Driven (d) Collaborative
8. The _____ tool is used to extract data as per the warehouse subject from all data sources, the data is cleaned, and is transformed as per the data warehouse structure for loading into the warehouse.
9. Which of the following is not a component of STAR Schema?
   (a) Fact Table (b) Dimension (c) Attribute (d) Master Data
10. _____ tool predict future trends and behaviours, allowing businesses to make proactive, knowledge driven decisions.
    (a) Data Mining (b) Data Warehousing
    (c) Knowledge Management (d) OLTP

REVIEW QUESTIONS

1. Define decision models? Why are they used?
2. List different decision styles being followed by decision-makers.
3. List the steps involved in decision-making. How are they different from computer-based decision process?
4. List different types of decision-making. Which type of decision-making does DSS support?
5. Define DSS and GDSS. List the tools to implement GDSS.
6. How communication based DSS is different from GDSS?
7. List different types of DSS system and explain them.
8. List the characteristics of a data warehouse.

9. Define the ETL process.
10. What do you understand by the term data mining? How is it different from business intelligence?
11. List some of the data mining techniques.
12. How data marts are different from data warehouse?

QUESTIONS FOR DISCUSSION

1. Organisations that need to create data warehouse must consolidate their data from all sources including external data. Justify.
2. How model base DSS is different from data mining techniques?
3. Why organisation use models to build DSS? One can create the DSS systems without creating decision models. Justify.
4. List some of the probabilistic and non-probabilistic decision techniques.
5. Identify the difference between data driven and document driven DSS. Justify your answer with examples.
6. How can one ensure the data quality while creating data warehouse?
7. An organisation can create as many data warehouses as they can create any number of data marts. Justify.

APPLICATION EXERCISES

1. The Xylo Ltd. is considering to introduce three new models of its popular car, specified as prototypes Xylo 1, Xylo 2, and Xylo 3. However, the company has capacity to manufacture one model only. A payoff table has been prepared showing the estimated profits that can be expected on the basis of the prototypes' popularity. The company's management will use the table below to find which is the most profitable model to manufacture.

Payoff table for new models of car

Model Popularity	*Expected profits (Rs. '000s)*		
	Xylo-1	Xylo-2	Xylo-3
Excellent	120	100	60
Moderate	80	60	50
Poor	– 30	– 20	0

2. Cease Infotech is a small manufacturer of microcomputers. Its board of directors is faced with the problem of evaluating four proposals and deciding which, if any, of the alternatives are acceptable. The table shows the expected annual cash flows and available capital (Rs.'000s) over the next four years. The cash inflows are shown as positive values while outflows are negative. The cost of capital is taken to be 15 per cent per annum. Management's objective is to maximise the rate of return.

Annual Cash Flows

Proposals	*Year 1*	*Year 2*	*Year 3*	*Year 4*
1	– 60	0	40	70
2	– 50	– 30	50	100
3	– 40	– 80	100	90
4		– 35	110	– 50
Capital available each year	100	100	50	50

3. Biggy has recently inherited some money, which he would like to invest in stock. Biggy already holds stock in company A, and over the past ten years he has received an average annual return of 7.48 per cent on his investment. He would like to improve on this figure and has informed his bank that an annual return of at least 12 per cent is his desired objective. The bank's funds investment manager has forwarded details (Table below) of two suitable companies B and C, whose stock performances meet Biggy's requirements.

   From the table, it is clear that there is a wide variation between the annual returns for each stock. On the basis of return fluctuations, stocks A, B, and C can be classified as medium, low, and high risk, giving average annual returns of 7.48 per cent, 13.45 per cent, and 14.65 per cent respectively. The investment manager's problem is to determine the best percentage of the total funds that should be invested in each stock. His main objective is to achieve an optimal balance between three criteria: (i) minimise risk; (ii) maximise returns; (iii) ensure that returns are not less than 12 per cent.

Percentage annual return (over 10 years)

Company	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
A	8.5	15.3	11.5	– 1.6	– 3.6	8.4	6.8	11.9	6.1	11.5
B	6.7	9.2	11.3	17.7	7.4	13.0	19.5	15.1	19.4	15.2
C	15.1	27.8	38.6	– 12.0	– 5.9	– 2.7	– 2.1	12.8	36.8	22.7

4. The CaRent Company is reviewing its policy on cars used by its salesforce. The company regularly supplements its own car fleet by hiring extra vehicles from a local leasing company at a cost of Rs. 400 per car per day. The cost to the company of hiring out few number of cars is Rs. 5,000 per car per day—the average income lost when a salesperson is unable to visit customers. If too many cars are hired, then the CaRent Company has still to pay the leasing company for the unused cars.

   Past Records have been Examined and the Following Table of Car Usage Data Produced.

No. of cars hired	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Usage probability	0.40	0.25	0.13	0.11	0.05	0.04	0.01	0.01

   The CaRent would like to find the optimal number of cars to hire that will balance the cost of oversupply and shortages.

5. The Pizza Company is introducing a new product and plans to increase its advertising campaign both on television and print magazines. However, the two media are not equally effective in reaching potential (high income) buyers. The company plans to spend a maximum of Rs. 5,00,000 on promoting the new product. The table below gives the advertising costs and potential audiences (in thousands) for every Rs. 1,000 spent in each advertising medium.

The company has prioritised its three goals as follows:

1. Reach an audience of at least three million.
2. Spend around 40 per cent of the advertising budget on magazines.
3. Reach a high income audience of approximately 5,00,000.

GROUP PROJECTS

1. Search the library or the Internet to find the popular DSS solutions. Prepare a report stating the purpose of the DSS, kind of questions it asks, variables it collects, kind of user interface being used, and the output generated.
2. Search the library or Internet and prepare a paper for each of the data-mining techniques stating the business applications of each one.

Caselets

1. Retail Industry

The retail is among the oldest business activities known, and today it is one of the most high growth sectors in India. Over the last few decades, organised (modern) retail has gained momentum and has transformed retail from a supply driven model, where the consumer had to take what he got, to one offering a choice and catering to demands of the consumer, and in many cases creating a market too.

The growing economy and disposable incomes of Indians have offered an opportunity to local and global retailers, who are attempting to attract and retain the customer with attractive and luring offers, among other things.

In India, maximum shopping takes place around weekends and festive seasons. This puts tremendous pressure on the IT infrastructure and requires infrastructure resilience to minimise outages, which may result in adverse customer experiences. The billing failure during rush hours causes abandoned shopping carts and irate customers.

The retail industry offers many opportunities for technology intervention as compared to some other industries. As consumers embrace modern retail formats and begin to leverage multiple channels to shop, technology will play an important role in creating an experience for the shopper as well as for the retailer in creating a competitive edge based on defined focus areas.

The use of effective IT provides efficiency in supply chain, warehousing, and replenishment from vendors to distribution centres to stores. The ordering and replenishment systems can help in reducing operational cost, which may translate into benefitting the consumer by offering lower prices.

The retailers are experimenting with blue casting, self service kiosks, SMS based interactions, digital signage, and self checkout counters. Thus, the IT organisation has to be agile enough to address the rising expectations, and move up on the adoption curve.

The Indian retailer has an advantage over many global competitors with no legacy systems and technologies to manage. The global retailers, however, score high with their process maturity and knowledge of the customer derived out of many years of data capture and mining. The future needs are converging as Indian retailers too are striving to create technology led supply chain efficiencies, optimising revenue opportunities, and customer intimacy. Within two three years, we believe, the Indian retailers IT sophistication and usage will be at par with, or better than, the current industry leaders.

One of the biggest stories in the retail industry has been the adoption (or lack) of RFID tags. The attempt by Wal-Mart to pressurise its suppliers to tag each item with an RFID label did not provide the enumerated benefits to either Wal-Mart, or vendors.

Most of the recent experiments focus on pallet tagging and warehouse efficiencies and not on shelf level replenishment of items. The cost of RFID tag, in comparison to that of barcode, in India does not provide a viable business case for larger adoption.

Most retailers seek the loyalty of their customers by offering some kind of loyalty card or co-branded credit cards, which provide them with spending patterns. This provides real insights and can be a key differentiator in retaining and attracting the consumer with focused offers and communication. The upcoming retailers should focus on few basic principles of technology adoption. It is assumed that merchandise systems and point of sales (POS) will be the basic part of the operations. Depending on the size of the warehouse and the number of SKUs (stock keeping unit), a good supply chain system, and replenishment model will start driving basic operational activities. The efficiency is created with POS to warehouse to supplier integration with dynamic allocation and replenishment of stock based on sale data.

Questions from discussion

1. Analyse the case and identify the key decisions that are taken by the top management.
2. Identify the decision for which the organisations can implement DSS solutions.
3. Is it a good idea to implement the mining tools? Justify.

Source: *Dataquest*, 29 Feb. 2008, Vol. XXVI No. 04

2. ICICI Prudential

ICICI Prudential, one of the largest insurance companies in the private sector, has been relying heavily on technology for all its needs. Right since its inception, about nine years ago, as a part of the mammoth ICICI Group, IT was adopted in full scale. And there were very few hurdles to IT adoption, as the group company was already ahead of the curve in adopting some of the best IT infrastructure and applications in the industry.

ICICI Prudential Life Insurance has adopted IT as an essential part of its operations and customer service. Not only robust CRM tools, ICICI has also invested in a very nimble HRMS system that has automated almost 99% of the employee processes on the platform. Apart from that ICICI Prudential has also recently deployed a Sybase data warehousing application and a claims processing system using the ACORD models.

Based on the BizRules engine, the internal IT team has also built a customised underwriting system. The fact that the company has set up a project management office comprising senior officials from all departments of the company, to ensure that all projects are completed in time has enabled faster adoption of technology. Now, the company plans to focus on delivering services on the mobile and as part of its customer self service models.

One IT project that has provided maximum benefits to the company has been the Health Claims Management System (CAPS). The project was conceived to build a robust, scalable web based integrated system that will serve as a single application to be used by all third parties. The system would be accessed by the entire ecosystem of health insurance domain nation wide comprising payers (insurance companies), providers (hospitals and clinics), TPA, and branch offices.

The project was innovative in many respects. It was a pure SOA based health claims solution; it was the first successful usage of ACORD (international insurance data model standard) for health insurance claim system, in india. It provided pure acord XML driven integration with third party system which facilitated real-time hospital access to provided claims decision within hours instead of days. it also featured a flexible claim benefit calculation engine built primarily on actuate engine.

The project has been implemented with best of breed design patterns by using spring and hibernate framework. The solution is compliant with international health insurance standards such as HIPAA and ACORD. It also has inbuilt fraud rules for alerting blacklisted customers and hospitals. The system is completed integrated at the back end. The claims solution is integrated in real-time with SMS, e-mail and document management engine for customer and hospital communication at various stages of claims processing.

The project has reduced the turnaround time for cashless claims decisions from 8 hours to 3 hours. providing anywhere and everywhere access, Thus it allows real time information for analytics that reduces the fraudulent claims. it also allows the executives to track per customer wise claims that helps in up-selling the portfolio of products.

The claims management system also features hospital credential ratings to help take right cost decisions and communicates with the customer at all stages of the claims lifecycle as all processes are integrated at the back end and made available through e-mail and SMS. The system has also improved employee productivity as it auto allocates the claims cases to respective assessors.

Questions for Discussion

1. Identify the key challenges that are being faced by ICICI Prudential.
2. Does the implementation of new integrated information system solution help the comapny?
3. What are the data management and analytic techniques they could use?

Source: *Dataquest*, January, 2010

Answers to Self-Study Questions

1. Decision-Making	2. Authoritarian and Group Method		3. (c)
4. Decision modelling	5. (d)	6. (a)	7. (c)
8. ETL	9. (d)	10. (a)	

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Chapter 12

Knowledge Management and Intelligent Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- What are intelligent systems?
- What are business applications of artificial intelligence?
- What are knowledge management and its applications in business?
- What are business intelligence and its applications in business?
- What is competitive intelligence?

INTRODUCTION

With advances in Information Technology, organisational information systems have also grown from simple text processing based to object processing systems; from dumb computing to intelligent computing. The product offerring has changed from mechanical to electromechanical to intelligent-mechanical. This happened because of the popularity of not so new stream of computer sciences called Artificial Intelligence (AI). The artificial Intelligence is concerned with the studying of thought processes of humans and representing those processes via machines. Most of the information system solutions like word processors, spreadsheets, etc. have some built in intelligence. In the industrial side, CNC machines, robotics, sensory devices, all have a component of intelligence built in. It is important to understand the concept of intelligent systems.

The intelligent system found its applications in business areas like financial services, customer satisfaction, and material management. It is also being widely adopted in diagnostics and testing. The diagnostic systems are used to examine networks, aircraft engines, manufacturing, and other types of equipment, energy pipelines, hazardous materials, and so on. Similarly, in the

transportation industry, which is also fast catching up with the trend, AI is being used for traffic management systems, aircraft maintenance operations, airport gate scheduling, railroad planning, and forecasting assignments.

Another area that has evolved over the last one decade is of knowledge management. The knowledge management is the distribution, access and retrieval of human experiences, and relevant information between related individuals or workgroups. In an organisational context, data represents facts or values of results, and relations between data and other relations have the capacity to represent information. The patterns of relations of data and information and other patterns have the capacity to represent knowledge. For the representation to be of any utility it must be understood, and when understood the representation is knowledge to the person who understands. It is the area which deals with capturing and storing the knowledge for acquisition of the key decision-makers of the organisation.

The intelligent business is another development in business IS applications, which is a fundamental shift in thinking for the world of data warehousing and business intelligence. For years organisations used operational systems and analytical ones as per need. There has been a 'great divide' between the two camps with IT people, who work on either side of the divide not even communicating with each other, let alone knowing what the other is working on or communicating with business. The intelligent business is also about placing it at the very heart of the enterprise. This idea is about 'traditional' data warehousing and business intelligence continues as normal but in addition, operational applications, and portals can ask for trusted business intelligence on demand. It is like saying that BI underpins operations or that operations encapsulate BI so that we have 'intelligence inside'.

An intelligent system is one that learns from the environment and its past actions. A person is called intelligent if with change in environment, the person reacts. Today's scientists tried replicating the intelligent behaviour of human beings to dumb machines using a stream of computer sciences called Artificial Intelligence. The Artificial Intelligence (AI) has been used in business applications for decades. The AI initially generated much interest, but failed to live up to the hype. However, with the advent of web enabled infrastructure and rapid strides made by the AI development community, the application of AI techniques in real-time business applications has picked up substantially in the recent past.

Infact, the AI is a broad discipline that simulates number of human skills such as case based reasoning, neural networks, decision making, expert systems, fuzzy logic, natural language processing, pattern recognition, and speech recognition, etc. The AI technologies bring more complex data analysis features to existing applications. The business applications utilise the specific technologies to try and make better sense of business environment. The business applicability of AI techniques is spread across functions ranging from finance management to forecasting and production.

The success of Artificial Neural Networks (ANN) and expert systems has helped the AI gain widespread adoption in enterprise business applications. The neural networks have become a well-established technique for pattern recognition, particularly of images, data streams, and complex data sources and, in turn, have emerged as a modelling backbone for a majority of data mining

tools available in the market. Some of the key business applications include fraud detection, cross selling, customer relationship management analytics, demand prediction, failure prediction, and non-linear control.

The AI has found its applications in the field of financial services. The AI has been widely adopted in such areas of risk management, compliance, and securities trading and monitoring, with an extension into customer relationship management (CRM), supplier relationship management (SRM) and business intelligence (BI). The tangible benefits of AI adoption include reduced risk of fraud, increased revenues from existing customers due to newer opportunities, avoidance of fines stemming from non-compliance, and averted securities trade exceptions that could result in delayed settlement.

In the fiercely competitive and dynamic market scenario, decision-making has become fairly complex and latency is inherent in many processes. In addition, the amount of data to be analysed has increased substantially. The AI technologies help enterprises reduce latency in making business decisions, minimise fraud, and enhance revenue opportunities. Additionally, autonomic computing concepts derived from the AI technologies, which facilitate self-healing systems, have generated a lot of hype in the recent past. Autonomic systems auto-configure for changing conditions, continuously monitor the constituent system parts, and fine tune workflow to achieve predetermined system goals.

The modern enterprises that utilise AI enhanced applications are expected to become more diverse, as the needs for the ability to analyse data across multiple variables, fraud detection and customer relationship management emerge as key business drivers to gain competitive advantage. Though the financial services sector is an evangelist in the implementation of AI technologies, other sectors such as manufacturing, transportation, logistics, and health care have fast caught on.

INTELLIGENT SYSTEMS

There are many definitions of intelligence. A person who learns fast or one that has a vast amount of experience may be called 'intelligent'. The ***Intelligent systems are those, which learn from their environment and past actions.*** However, for our purposes the most useful definition is: the systems comparative level of performance in reaching its objectives. This implies having experiences where the system learned which actions are necessary to achieve its objectives.

An intelligent system is a system that learns during its existence.

An intelligent system learns how to act so that it can reach its objectives. The main processes occurring within the intelligent systems include the following:

- The intelligent system has a temporary objective which is derived from its main objective.
- It senses its environment using its faculties.
- The system then stores these sense impressions as elementary concepts.

- Concepts are a material way of storing information.
- By working on concepts, it creates new ones and stores relationships to other total, part, abstract and concrete concepts.

The intelligent system continually records the present situation and the action that follows as a response rule. The very first response rules are due to chance actions and to teaching. When the system is externally inactive, that it sleeps, it reviews the response rules stored in its memory and performs some generalisations. It makes abstractions of concepts and creates the corresponding response rules, including these abstractions. Further, comparisons are between the situation and action of a series or recently learned response rules as well as comparisons between situations of different response rules and between actions of different response rules. By all these activities, starting with very concrete response rules, it creates response rules that are applicable to several different but similar situations. After some time, its memory is full and it forgets the least used concepts and response rules.

Some of the key characteristics of intelligent systems include:

- Capability to extract and store knowledge
- Human like reasoning process
- Learning from experience (or training)
- Dealing with imprecise expressions of facts
- Finding solutions through processes similar to natural evolution

One can create intelligent systems by embedding the intelligence artificially into the machine, so that the machine starts behaving intelligently. The Artificial Intelligence is a branch of computer sciences that helps to create intelligent systems. The Artificial intelligence (AI) encompasses a diverse number of computer applications, or components within applications, that use sets of rules and knowledge to make inferences. In business applications, Al capabilities are often integrated with systems that serve the day-to-day needs of the enterprise, such as inventory tracking, manufacturing process controls, and customer service databases.

The artificial intelligence (AI) is the key technology of today's business applications, ranging from banking systems that detect attempted credit card fraud, to telephone systems that understand human voice, to software systems that anticipate a problem and offer solutions.

ARTIFICIAL INTELLIGENCE

AI is difficult to define with any precision. But in short as its definition we can tell that ***artificial intelligence is the science of making machines, which does things that would require intelligence.*** The artificial intelligence (AI) is concerned with two basic ideas—

1. it involves studying the thought processes of humans;
2. it deals with representing those processes via machines

The AI is concerned with the studying of thought processes of humans and representing those processes via machines. The AI is behaviour of a machine that, if performed by a human being, would be called intelligent. The AI's ultimate goal is to build machines that will replicate human intelligence.

Artificial Intelligence is about making the machines intelligent.

The AI's scientific goal is to understand intelligence by building computer programs that exhibit intelligent behaviour. It is concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how the knowledge used to make those inferences will be represented inside the machine. The term *intelligence* covers many cognitive skills, including the ability to solve problems, learn, and understand language; AI addresses all of those. But most progress to date in AI has been made in the area of problem solving—concepts and methods for building programs that *reason* about problems rather than calculate a solution.

The AI does not produce stand-alone systems, but instead adds knowledge and reasoning to existing applications, databases, and environments, to make them friendlier, smarter, and more sensitive to user behaviour and changes in their environments. Some of the common applications of AI include: Autonomous vehicles; Computer chess Deep Blue; Advanced user interfaces like PEGASUS, which is a spoken language interface connected to the American Airlines EAASY SABRE reservation system, which allows subscribers to obtain flight information and make flight reservations via a large, online, dynamic database, accessed through their personal computer over the telephone.

Intellectually, AI has a broad interdependence with computing disciplines and with fields like logic, psychology, linguistics, philosophy, neuroscience, mechanical engineering, statistics, economics, and control theory, among others. This breadth has been necessitated by the magnificence of the dual challenges faced by AI—creating mechanical intelligence and understanding the information basis of its human counterpart.

Applications of AI

The AI is a vast area of sciences and number applications have been developed over decades like Expert Systems, Fuzzy Logic, Artificial Neural Network, Genetic Algorithm, and many more.

Expert Systems

The expert systems (ES) are computer-based systems that apply the substantial knowledge of a specialist—be it in medicine, law, insurance, or any other field—to help in solving complex problems without little or no human interventions. The objective of expert system is to transfer expertise from an expert to a computer and then on to other humans. In developing such systems, designers usually work with experts to determine the information and decision rules (heuristics) that the experts use to solve particular types of problems. An expert system is a form of artificial intelligence that uses a knowledge base (KB) and inference engine to make decisions. The input for the knowledge base is gathered through a user interface. The inference engine uses a series of IF-THEN statements to derive intelligence from the knowledge base. The expert systems tend to focus on narrow area of expertise.

An Expert System is an AI based system that is designed to hold the accumulated knowledge of one or more domain experts.

The expert systems are also referred to as knowledge based systems. Often, the term expert systems is reserved for programs whose knowledge base contains the knowledge used by human

experts, in contrast to knowledge gathered from textbooks or non-experts. The area of human intellectual endeavour to be captured in an expert system is called the task domain. The task refers to some goal oriented, problem solving activity. And the domain refers to the area within which the task is being performed. The typical tasks are diagnosis, planning, scheduling, configuration, and design.

The building of an expert system is known as knowledge engineering and its practitioners are called knowledge engineers. The knowledge engineer must make sure that the computer has all the knowledge needed to solve a problem. The knowledge engineer must choose one or more forms to represent the required knowledge as symbol patterns in the memory of the computer—that is, he (or she) must choose a knowledge representation. He/she must also ensure that the computer can use the knowledge efficiently by selecting from a handful of reasoning methods.

The expert systems can be used to accomplish many business tasks: decision management; diagnostic and troubleshooting; maintenance and scheduling; design or configuration; process monitoring, etc. The expert systems provide a business with faster, consistent expertise. They also help preserve organisational knowledge. However, they are not without limitations. The ES are not suitable for every problem situation. They excel only in solving specific types of problems in a limited domain of knowledge. They fail to solve problems requiring a broad knowledge base. The expert systems are also difficult and costly to develop and maintain.

Examples of Expert Systems

- MYCIN: The medical system for diagnosing blood disorders. First used in 1979.
- DESIGN ADVISOR: It gives advice to designers of processor chips.
- DENDRAL: It is used to identify the structure of chemical compounds. First used in 1965.
- LITHIAN: It gives advice to archaeologists examining stone tools.
- Banking and finance for credit assessment & project viability.
- Maintenance for diagnosis of machine faults.
- Law for application of law in complex scenarios.

Components of Expert Systems

Every expert system consists of following components:

1. Knowledge Base. The knowledge base of expert systems contains both factual and heuristic knowledge. The factual knowledge is that knowledge of the task domain which is widely shared, typically found in textbooks or journals, and commonly agreed upon by those knowledgeable experts in the particular field. The heuristic knowledge is the less rigorous, more experiential, more judgmental knowledge of performance. In contrast to factual knowledge, heuristic knowledge is rarely discussed, and is largely individualistic. It is the knowledge of good practice, good judgment, and plausible reasoning in the field. The knowledge representation formalises and organises the knowledge. One widely used representation is the production rule, or simply rule. A rule consists of an IF-THEN part (also called a condition and an action). The IF part lists a set of conditions in some logical combination. The THEN part can be concluded, or its problem solving

action taken. The expert systems whose knowledge is represented in rule form are called rule based systems. Another widely used representation, called the frame, or schema is based upon a more passive view of knowledge.

2. Inference Engine. The problem solving methods are built into program modules called **inference engines** or inference procedures that manipulate and use knowledge in the knowledge base to form a line of reasoning.

3. Blackboard. It is another component of the expert systems, which is a temporary storage area. It is the area of working memory for current problems and recording intermediate results. The blackboard is a kind of database used while the interaction between the user and the expert system is going on.

4. User Interface. This component is used by the user to interact with the ES.

5. Justifier. This is an important component of ES, which is an explanation system. Like when one interacts with an human expert, one can always demand for an explanation relating to a decision, similarly one can also seek explanation (justification) relating to the decision.

6. Knowledge acquisition refers to the task of endowing expert systems with knowledge, a task currently performed by knowledge engineers. The choice of reasoning method is important, but it is not as important as the accumulation of high-quality knowledge. The power of an expert system lies in its store of knowledge about the task domain—the more knowledge a system is given, the more competent it becomes.

7. Knowledge engineering is the art of designing and building expert systems, and knowledge engineers are its practitioners. Theoretically, a knowledge engineer is a computer scientist who knows how to design and implement programs that incorporate artificial intelligence techniques. The nature of knowledge engineering is changing, however, and a new breed of knowledge engineers is emerging. Though different styles and methods of knowledge engineering exist, the basic approach is the same: a knowledge engineer interviews and observes a human expert or a group of experts and learns what the experts know, and how they reason with their knowledge. The engineer then translates the knowledge into a computer usable language, and designs an inference engine, a reasoning structure, that uses the knowledge appropriately. They also determine how to integrate the use of uncertain knowledge in the reasoning process, and the kinds of explanation that would be useful to the end user. Next, the inference engine and facilities for representing knowledge and explaining are programmed, and the domain knowledge is entered into the program piece by piece.

Fuzzy Logic

The knowledge is almost always incomplete and uncertain. To deal with uncertain knowledge, a rule may have associated with it a confidence factor or a weight. The set of methods for using uncertain knowledge in combination with uncertain data in the reasoning process is called reasoning with uncertainty. An important subclass of methods for reasoning with uncertainty is called 'fuzzy logic,' and the systems that use them are known as 'fuzzy systems.'

The ***fuzzy logic is an AI technique that deals with uncertainties by simulating the process of human reasoning, allowing the computer to behave less precisely and logically than***

conventional computers do. The computers are digital machines, which work only on binary concept. The computers are not been able to recognise 'maybe', or 'slightly'. The concept is based on feeding the computer 'fuzzy sets,' or groupings of concrete information and relative concepts. The fuzzy means "not clear, distinct, or precise; blurred".

The fuzzy logic is a rule based AI, which deals with imprecise, uncertain and unreliable type of situations. It uses rules that are approximate or subjective and can handle incomplete or ambiguous data. The fuzzy logic incorporates a simple, rule-based 'IF X AND Y THEN Z' approach to a solving control problem rather than attempting to model a system mathematically. The Fuzzy Logic model is empirically based, relying on an operator's experience rather than their technical understanding of the system. It uses imprecise and yet very descriptive terms of what must actually happen. One has to consider what to do in the shower if the temperature is too cold: one will make the water comfortable very quickly with little trouble. The fuzzy logic is capable of mimicking this type of behaviour but at very high rate.

The Fuzzy Logic is a form of knowledge representation suitable for notions that cannot be defined precisely, but which depend upon their contexts.

Applications of Fuzzy Systems

- Control of manufacturing processes.
- The appliances such as air conditioners, washing machines, and video cameras.
- It is also used in combination with other intelligent system methodologies to develop hybrid fuzzy-expert, neuro-fuzzy, or fuzzy-Genetic Alogarithm systems.

Neural Networks

The ***Neural Networks are intelligent systems with architecture and processing capabilities that mimic certain processing capabilities of the human brain.*** The knowledge representation is based on massive parallel processing, fast retrieval of large information, and ability to recognise patterns based on experience is called neural computing.

The Neural Networks are AI based systems that are modeled on the human brain and nervous system.

The neural networks go one step further than expert systems in bringing stored knowledge to bear on practical problems. Instead of just leading the user to the appropriate piece of knowledge that has been captured in the system, neural networks process patterns of information to arrive at new abilities they are not equipped with. In a sense, neural networks learn to do things for the user based on special preparation that involves feeding the system data which it then analyses for patterns. This approach has effective applications in the fields of finance, information technology management, and health care, etc.

Artificial Neural Networks (ANN)

The ***ANN attempts to emulate the processing patterns of the biological brains.*** It uses the concept by implementing the software simulation of massive parallel processing that involves Processing Elements (PE), which is interconnected in a network. The human brain is a biological neural

network, containing 100 billion nerve cells called neurons. Each neuron contains dendrites that receive input and axons that send output. The synapses separate axons from dendrites, and are used to transfer information between neurons. Each neuron can connect upto tens of thousands of other neurons, and all neurons form one million new connections in the human brain each second. Large clusters of interconnected neurons can process large amounts of complex information.

The Artificial Neural Networks (ANN) simulates neural networks found in nature, such as the human brain. The term artificial is used to distinguish ANNs from their biological counterparts. The nodes as referred for artificial neuron receive input and fire output if a certain weight is exceeded. The ANNs might be used to make decisions based on input from large and complex data sets. An ANN is trained through a learning process, and knowledge is retained through synaptic weights. The synaptic weights between nodes are adjusted based on the desired output.

Figure 12.1 shows a simplified ANN designed for loan approval. The network contains input nodes (artificial neurons), a layer of hidden nodes, and an output node. The hidden nodes add complexity, which allows representation of complex relationships. The nodes are connected by synapses, each given a weight. A node fires if a threshold weight is exceeded. If the final output node fires, desired output is achieved. When that process is complete, the ANN is trained and can be used on new live data to identify future decisions.

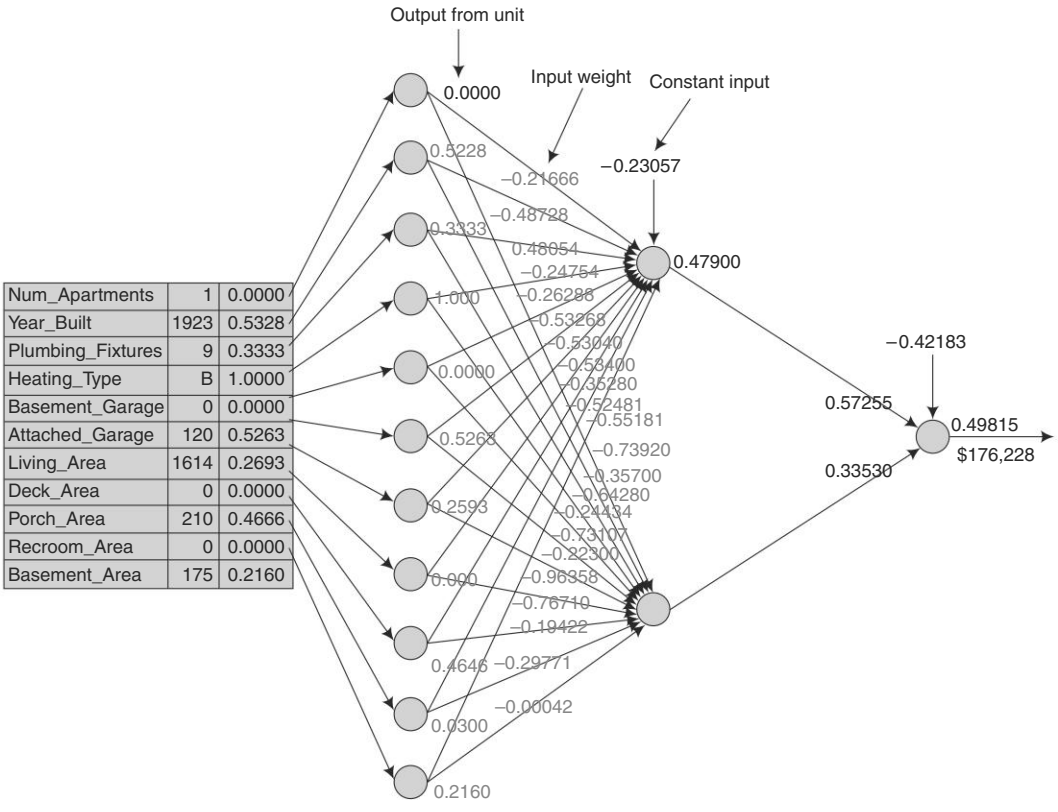

Figure 12.1 ANN Example

Genetic Algorithms

A genetic algorithm is a type of search algorithm that takes input and computes an output, where multiple paths might be taken. The ***genetic algorithms are a part of evolutionary computation that use concepts borrowed from nature to conduct the search, including selection, mutation, and crossover rate.*** The genetic algorithms use strings to represent a genome also called a 'chromosome'. The genetic algorithms are used in information security for tasks such as misuse detection, intrusion detection, data mining and analysis, and related tasks. Following terms are used in genetic algorithms:

- Genome: An individual, made up of a string of genes.
- Gene: A specific function.
- Allele: The value returned by the gene/function (the action to be taken).
- Fitness score: The process by which a genome's fitness is evaluated.
- Selection: The process by which a genome is selected for cross-breeding.
- Crossover: The process by which two genomes cross-breed to produce children.
- Mutation: The random changes to a child genome that might have positive or negative impact.

Business Applications of AI

The AI is being used extensively by businesses worldwide, despite the fact that the discipline itself is still evolving. Its applications cross a wide spectrum. For example, AI is being applied in management, administration, science, engineering, manufacturing, financial and legal areas, military, space endeavours, medicine, and diagnostics. Some AI implementations include natural language processing, database retrieval, expert consulting systems, theorem proving, robotics, automatic programming, scheduling, and solving perceptual problems. The management is relying more and more on knowledge work systems, which are systems used to aid professionals such as architects, engineers, and medical technicians in the creation and dissemination of new knowledge and information.

The managers in many organisations use AI based strategic planning systems to assist in functions like competitive analysis, technology deployment, and resource allocation. They also use programs to assist in equipment configuration design, product distribution, regulatory compliance advisory, and personnel assessment. The AI is also contributing heavily to management's organisation, planning, and controlling operations, and will continue to do so with more frequency as programs are refined.

The AI is also influential in science and engineering. The applications developed were used to organise and manipulate the ever increasing amounts of information available to scientists and engineers. The AI has been used in complex processes such as mass spectrometry analysis, biological classifications, and the creation of semiconductor circuits and automobile components. The AI has been used with increasing frequency in diffraction and image analysis; power plant and space station design; and robot sensing, control, and programming. It is the increased use of robotics in business that is alarming many critics of artificial intelligence.

The robots are being utilised more frequently in the business world. The experts predict that by the year 2025 robots could potentially replace humans in almost all manufacturing jobs. This includes not only the mundane tasks, but also those requiring specialised skills. They will be performing jobs such as shearing sheep, scraping barnacles from the bottoms of ships, and sandblasting walls. However, there are jobs that robots will never be able to perform, such as surgery. Of course, there will still be a need for individuals to design, build, and maintain robots. Yet, once scientists develop robots that can think, as well as act, there may be less of a need for human intervention. Thus, the social ramifications of AI are of major concern to people today.

The Artificial Intelligence in the form of expert systems and neural networks have applications in every field of human endeavor. They combine precision and computational power with pure logic, to solve problems and reduce error in operation. Already, robot expert systems are taking over many jobs in industries that are dangerous for or beyond human ability. Some of the applications of AI are as follows:

- **Authorising Financial Transactions:** The credit card providers, telephone companies, loan providers, banks, and the government organisations employ AI systems to detect fraud and expedite financial transactions. This kind of systems first uses learning algorithms to construct profiles of customer usage patterns, and then use the resulting profiles to detect unusual patterns and take the appropriate action.
- **Configuring Hardware and Software:** The AI systems configure custom computer, communications, and manufacturing systems, guaranteeing the buyer maximum efficiency and minimum set-up time, while providing the seller with expertise in tracking the rapid technological evolution of system components and specifications. These systems detect order incompleteness and inconsistencies, employing large bodies of knowledge that describe the complex interactions of system components.
- **Diagnosing and Treating Problems:** The systems that diagnose and treat problems—whether illnesses in people or problems in hardware and software—are now in widespread use. The diagnostic systems based on AI technology are being built into photocopiers, computer operating systems, and office automation tools to reduce service calls. The stand-alone units are being used to monitor and control operations in factories and office buildings. The AI based systems assist physicians in many kinds of medical diagnosis, in prescribing treatments, and in monitoring patient responses.
- **Scheduling for Manufacturing:** In order to gain competitive advantage organisations have started automating their manufacturing operations. The AI technology, supports rapid rescheduling up and down the 'supply chain' to respond to changing orders, changing markets, and unexpected events—has shown itself superior to less adaptable systems based on older technology. This same technology has proven highly effective in other commercial tasks, including job shop scheduling, and assigning airport gates and railway crews.
- **Heavy Industries and Space:** An entire manufacturing process is now totally automated, controlled, and maintained by a computer system in car manufacture, machine tool production, computer chip production, and almost every high-tech process. They carry

out dangerous tasks like handling hazardous radioactive materials. The robotic pilots carry out complex maneuvering techniques of unmanned spacecrafts sent in space. Japan is the leading country in the world in terms of robotics research and use.

- **Finance:** The banks use intelligent software applications to screen and analyse financial data. The software programs that can predict trends in the stock market have been created which have been known to beat humans in predictive power.
- **Computer Science:** The researchers in quest of artificial intelligence have created spin offs like dynamic programming, object oriented programming, symbolic programming, intelligent storage management systems, and many more such tools. The primary goal of creating an artificial intelligence still remains a distant dream but people are getting an idea of the ultimate path which could lead to it.
- **Aviation:** The air lines use expert systems in planes to monitor atmospheric conditions and system status. The plane can be put on auto pilot once a course is set for the destination.

Enterprise Intelligence: Innovative Aiding Tools for BI

The enterprises exploiting the Big Data would gain new ability to identify insights that were previously difficult to infer. The business insights bring out new product/service predictions, next generation trends, and the areas of tailoring the service offerings.

The business today requires better, faster decisions backed by key facts and insights. The service providers are forced to bring in recommendations beyond traditional BI solutions for their customers to take the information delivery to the next level. There are many recent ground-breaking innovations, including Big Data, Information Retrieval Management (IRM), Social Analytics, In-memory Analytics, and BI Mobility, that go beyond the ability of commonly used BI tools, through more powerful data management systems and capacities of speed and processing optimisation. Each of them empowers the business in accessing the data and insights that they need to make faster and reliable decisions. This article covers about Big Data and IRM complementing conventional BI.

Big Data

The experts acknowledge the recent needs of an enterprise to deal with massive volume, diversity, complexity, and kinds of data that are exponentially generated and consumed in its business systems. This includes unstructured, structured, people and machine-generated data encompassing social network, internet texts, emails, images, documents, videos, call detail records, military surveillance, medical records, large-scale e-commerce data, and log files of IT systems.

It is mandated to look beyond the traditional warehouse technologies to handle them and switch to new age solutions for handling Big Data. This should include new people roles (e.g., data scientists) and new massive processing abilities (e.g., MPP databases, data mining grids, distributed data, cloud computing platforms, and scalable storage systems). They would now be exponentially increasing the ability to load, monitor, backup, and optimise the use of the large data repositories and its integration across heterogenous data resources.

Schemas would be modeled on a flexible, non-relational, and parallel-relational model. The software frameworks like Open Source Hadoop, Googles MapReduce, Microsofts Dryad, or Yahoos S4 provide the platforms with schema-less design and processing frameworks to provide a sub-second response to

queries. The traditional players, including Informatica and IBM Infosphere, work towards exploiting these frameworks.

Information Retrieval to Complement BI

The blending of search based information discovery to go along with conventional BI system enables users asking the better questions and reaching out to the final discovery through continuous refining of questions and tool provided clues. The IRM easily adds the capabilities to consume and analyse non-traditional data sources (unstructured data sources) through semantics and text analytics. The IRM tools along with BI reports enable self-service discovery by business users. With predefined/ad hoc search feature, users can do sophisticated searches and keep adjusting their queries to narrow down on exactly what they are looking for. Whether the IRM engine is drawing information from a structured GL system or from an unstructured social media is transparent to the user, who simply sees the integrated results.

The IRM engines, such as Autonomy, Endeca, and Exalead, work in opposite to the conventional data-resides-in-a-schema but that all the data goes into the engine, and then a schema emerges from the attribute relationship available in the data. Ease of search and discovery from unstructured data serves as a potential gold mine for marketing. The sentimental and predictive marketing information could be retrieved with a mouse click from the whole gamut of opinions, comments, relationships, work histories, and personal and professional interests available in the social networks.

Source: *Dataquest*, November 16, 2011

Future of AI

The AI began as an attempt to answer some of the most fundamental questions about human existence by understanding the nature of intelligence, but it has grown into a scientific and technological field affecting many aspects of commerce and society. Even as AI technology gets integrated into the fabric of everyday life, AI researchers remain focused on the grand challenges of automating intelligence. The Natural Intelligence remains through the creative using of vast knowledge and experience. The work is also progressing on developing systems that converse in natural language that perceives and responds to their surroundings, and that encodes and provides useful access to all of human knowledge and expertise. The ultimate goals of AI—the design of intelligent artifacts; understanding of human intelligence; abstract understanding of intelligence—continues to have practical consequences in the form of new industries, enhanced functionality for existing systems, increased productivity in general, and improvements in the quality of life. But the ultimate promises of AI are still decades away, and the necessary advances in knowledge and technology will require a sustained and fundamental effort in research.

AI technologies in narrow fields such as speech recognition will continue to improve and will reach human levels. AI will be able to communicate with humans in unstructured English using text or voice, navigate (not perfectly) in an unprepared environment and will have some rudimentary common sense (and domain-specific intelligence). There will be an increasing number of practical applications based on digitally recreated aspects human intelligence, such as cognition, perception, rehearsal learning, or learning by repetitive practice. There are two major projects aiming for human brain simulation, CCortex and IBM Blue Brain.

KNOWLEDGE MANAGEMENT

Today's business environment is characterised by continuous, often radical change. Such a volatile climate demands a new attitude and approach within organisations—actions must be anticipatory, adaptive, and based on a faster cycle of knowledge creation. Some of the current challenges the businesses face are:

- growing emphasis on creating customer value and improving customer service;
- an increasingly competitive marketplace with a rising rate of innovation;
- reduced cycle times and shortened product development times;
- need for organisational adaptation because of changing business rules and assumptions;
- requirement to operate with a shrinking number of assets;
- reduction in the amount of time employees are given to acquire new knowledge; and
- changes in strategic directions and workforce mobility that lead to knowledge loss.

All of these factors make knowledge management a necessity rather than a luxury. The organisations must have a clear idea about on how knowledge is discovered, created, dispersed, and put to use. In some ways, knowledge management is more essential to organisational success than capital or labour, yet often it is the most overlooked. The supply chain, for example, relies upon knowledge from diverse areas including planning, manufacturing, warehousing, and distribution. Today's volatile business environment demands a new attitude and approach within organisations—actions must be anticipatory, adaptive, and based on a faster cycle of knowledge creation.

The knowledge management is important to all kinds of organisations—public sector or private sector because of the prospective attrition of employees due to various reasons. In addition, high employee turnover, lack of adequate training, and a tendency to maintain the status quo, further impact and impede the success of knowledge retention and growth. Knowledge management attempts to secure and replenish the learning experiences, as well as the knowledge of the individuals who comprise an organisation.

The Knowledge Management is a process to develop knowledge & knowledge assets to build knowledge strategy supporting first to build strategy and then its implementation.

Understanding Knowledge Management requires an understanding of knowledge and the knowing process and how that differs from information and information management.

- A collection of data is not information.
- A collection of information is not knowledge.
- A collection of knowledge is not wisdom.
- A collection of wisdom is not truth.

The idea is that data, information, knowledge, and wisdom are more than simple collections. Figure 12.2 tries to define relationship between these. The terms data, information, and knowledge are defined in Chapter 1, just to summarise these:

Data: The Data are any facts, numbers, or text that can be processed by a computer. It data helps in understanding relations.

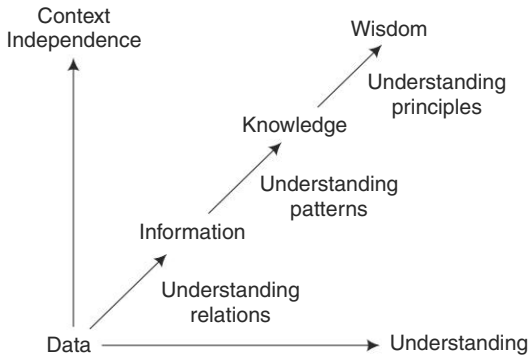

Figure 12.2 Data-Information-Knowledge-Wisdom Relationships

Information relates to description, definition, or perspective (what, who, when, where). Information helps in finding patterns.

Knowledge: Information can be converted into *knowledge* about historical patterns and future trends. Knowledge comprises of strategy, practice, method, or approach (how). Knowledge helps in defining principles.

Wisdom: Wisdom is achieved when one understands the foundational principles responsible for the patterns representing knowledge being what they are. Further wisdom, even more so than knowledge, tends to create its own context. These principles are universal and completely context independent. The wisdom embodies principle, insight, moral, or archetype (why).

The Knowledge is the process of translating information and past experience into a meaningful set of relationships, which can be applied by an individual.

Examples of Knowledge & Wisdom

The summary information on retail supermarket sales can be analysed in light of promotional efforts to provide knowledge of consumer buying behaviour. Thus, a manufacturer or retailer could determine, which items are most susceptible to promotional efforts. When a pattern relation exists amidst the data and information, the pattern has the potential to represent knowledge. It only becomes knowledge, however, when one is able to realise and understand the patterns and their implications. The patterns, which represent knowledge have completeness to them that information simply does not contain. For example, Product A is bought 40 per cent of time if product B is bought; Product A is mostly used in North India; The customers in 25–30 years age group will use Product B during summer. These are examples of knowledge and wisdom drawn is – let's promote product A in north region; send catalogues to houses of middle-aged people.

Note that the sequence data → information → knowledge → wisdom represents an emergent continuum. That is, although data is a discrete entity, the progression to information, to knowledge, and finally to wisdom does not occur in discrete stages of development. One progresses along the continuum as one understands. Everything is relative, and one can have partial understanding of the

relations that represent information, partial understanding of the patterns that represent knowledge, and partial understanding of the principles which are the foundation of wisdom as explained in Figure 12.3.

In an organisational context, data represents facts or values of results, and relations between data and other relations have the capacity to represent information. The patterns of relations of data and information and other patterns have the capacity to represent knowledge. For the representation to be of any utility it must be understood, and when understood the representation is information or knowledge to the one that understands. Yet, what is the real value of information and knowledge, and what does it mean to manage it?

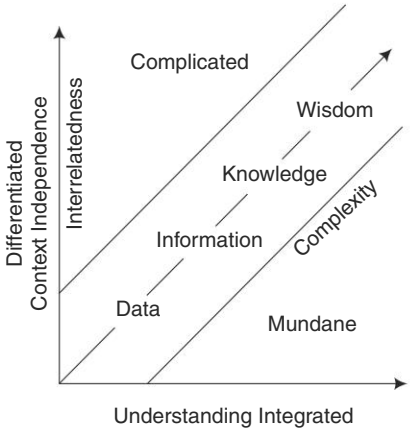

Figure 12.3 Sequence of Data Flow

Value of Knowledge Management

The ***Knowledge management (KM) is the access, retrieval, and distribution of human experiences and relevant information between related individuals or workgroups.*** Human knowledge and interaction is the key; sharing ideas, solutions, and relevant information in an effort to create new solutions. A Gartner Group study recognises that Knowledge Management (KM) emphasises human interactions as the focal point surrounding the collection, distribution, and reuse of information. The information management emphasises on technology as the focal point for information collection, distribution, and reuse.

The Knowledge is an organisational asset: it should be identified, managed, and valued to the same degree as other assets. The Knowledge is an asset and is of two types:

- ***Explicit knowledge*** can be documented, categorised, transmitted, and demonstrated. It can be accessed by other people even if the knowledge source is absent.
- ***Tacit knowledge*** draws on the accumulated experience and learning of an individual. It is hard to reproduce or share with others.

At the centre of all successful knowledge management strategies resides a powerful application that enables the organisation to capture, access, browse, search, retrieve, and share what is already known or possessed. Any organisation that can begin to disseminate their information assets quickly and easily across their enterprise infrastructure can start managing their knowledge assets. The relevant information can include any type of knowledge asset, which can be paper based and workgroup documents, text RDBMS, e-mail, PDFs, images, or video from virtually at any location. In order to succeed in today's rapid changing IT environment requires organisations to efficiently and effectively use and reuse the knowledge stored in their repositories.

The key to knowledge management is to get the necessary knowledge to the necessary person(s) within a specified workgroup across the company infrastructure. It is the goal of knowledge management to help those people work better together, using and managing increasing amounts of information. The result of a successful knowledge management implementation is a knowing,

Explicit Vs Tacit Knowledge

Explicit Knowledge	*Tacit Knowledge*
• The explicit knowledge can be articulated into formal language text, mathematical expressions, specifications, manuals, etc. • The explicit knowledge is often more systematic and codified. • The explicit knowledge in electronic media can be readily transmitted to others. • It can easily be processed by a computer, transmitted electronically, or stored in databases. • The explicit knowledge is that which is written down or expressed in some tangible form, such as in a procedure manual, document, or computer database. • **Examples:** Dictionary, Recipe Book, Ready Reckoner, Rule books, Procedure, Program, Heuristics, Solution Model.	• It is a personal knowledge embedded in individual experience and involves intangible factors, such as personal beliefs, perspective, and the value system. • The tacit knowledge is not easily captured or expressed; it is often composed of intuition, unanalysed experiences, values, skills, and habits. • In addition, there are two dimensions to tacit knowledge. For communication of tacit knowledge, it must be converted into words, models, or numbers to understand and to communicate. The tacit knowledge cannot be shared or transferred easily as it is not possible to code. • It is subjective, personal and may have a bias, context specific and difficult to share due to its nature. It is termed as insight, experience, judgment, ability to differentiate, and also termed as know-how and know-why.

learning, and growing enterprise. There are three essential components of knowledge management which are people, process, and technology.

- people to relay past experience and generate new ideas (innovation);
- processes for sharing and distributing that information; and
- technologies to make it all work in a fast, efficient manner.

Characteristics of Knowledge Management

The challenge of Knowledge Management is to determine what information within an organisation qualifies as 'valuable'. All information is not knowledge, and all knowledge is not valuable. The key is to find the worthwhile knowledge within a vast sea of information.

- **Knowledge Management is about people:** It is directly linked to what people know, and how. What they know can support business and organisational objectives. It draws on human competency, intuition, ideas, and motivations. It is not a technology based concept. Although technology can support a Knowledge Management effort, it should not begin there.
- **Knowledge Management is goal directed:** It is inextricably tied to the strategic objectives of the organisation. It uses only the information that is the most meaningful, practical, and purposeful.
- **Knowledge Management is ever changing:** There is no such thing as an immutable law in Knowledge Management. The knowledge is constantly tested, updated, revised, and sometimes even deleted when it is no longer practicable. It is a fluid, ongoing process.

- **Knowledge Management is value added:** It draws upon pooled expertise, relationships, and alliances. The organisations can also be dependent on external experts to advise or educate managers on recent trends and developments. Forums, councils, and boards can be instrumental in creating common ground and organisational cohesiveness.
- **Knowledge Management is visionary:** This vision is expressed in strategic business terms rather than technical terms, and in a manner that generates enthusiasm, buy in, and motivates managers to work together towards reaching the common goals.
- **Knowledge Management is complementary:** It can be integrated with other organisational learning initiatives such as Total Quality Management (TQM). It is important for knowledge managers to show interim successes along with progress made on more protracted efforts such as multi-year systems developments infrastructure, or enterprise architecture projects.

Advantages of Knowledge Management

Whether to minimise loss, risk, improve organisational efficiency, or embrace innovation, knowledge management efforts and initiatives add great value to an organisation. Some of the advantages that KM offers:

- facilitates better, more informed decisions;
- contributes to the intellectual capital of an organisation;
- encourages the free flow of ideas which leads to insight and innovation;
- eliminates redundant processes, streamlines operations, and enhances employee retention rates;
- improves customer service and efficiency; and
- leads to greater productivity.

In addition, KM also helps in addressing the following problem areas:

- Ageing workforce leading to loss of knowledge due to their exit.
- Mergers & acquisitions disturbing human resource balance.
- Urgent need of expertise to be fulfilled which is not planned.
- Lack of resilience in the organisation to face the competition onslaught.
- Not able to generate economic value out of investment in human capital & technology.

Components of Knowledge Management

People, processes, and technology are the three building blocks for corporate success in today's information rich markets.

1. People. People are necessary for brainpower, innovation, creativity, and the experiential knowledge to solve technical problems. People working together multiply an organisation's wealth of knowledge, and potential for success. The tacit knowledge is shared freely in an unprompted manner among fellow employees. Finding, annotating, refining, and re-using knowledge helps an organisation increase its efficiency, gain a competitive advantage, and enhance productivity.

2. Processes. An organisation must also have effective and efficient business processes in place to create a sharing, collective atmosphere. Otherwise, all the best solutions in the world would get stalled if they were not distributed for revision and execution. The work happens in ad hoc workgroups with a common set of people working to solve a common problem or challenge. It is important for organisations to implement processes and technology that would help facilitate knowledge sharing. The organisations must encourage and accelerate the flow of information from people to people and from individuals to the enterprise. The mutual sharing of personal knowledge and organisational knowledge fuels innovation and adds value. The major challenge for all organisations is to change the culture of knowledge sharing.

3. Technology. Finally, to support human innovation and progress, a basic technological infrastructure must be in place to help leverage collective brainpower and corporate knowledge and deliver new ideas and solutions quickly and practically. The knowledge management is not a standard IT solution available in boxes or can be downloaded from the Internet. It consists of the business plans and human interaction. The knowledge management does, however, require technological tools, supported by knowledge retrieval architecture. The knowledge retrieval is one of the key enabling technologies of knowledge management. It is impossible to manage and effectively use the intellectual capital existing and being created within an organisation if it cannot be quickly and easily accessed. The technologies that are used in a KM process may include:

- Database Management Systems
- Expert systems, AI systems
- Groupware and Collaborative systems
- Document management systems for content organisation & knowledge search
- DSSs and BI systems
- Computer simulation tools
- Internet & Web technology
- Search Engines, etc.

Steps Involved in Creation of KM System

- *Identification of Knowledge.* The knowledge is not to be searched in isolation of business and business needs. It has to be identified as the relevant one, so that it is useful to the organisation and fits well with the objective of the organisation.
- *Validation of Knowledge.* The knowledge identified needs to be validated with respect to the organisational objectives and relevance.
- *Create Knowledge.* Given the objective of the organisation – it creates the knowledge. This would involve identification, formulation & recognition of its source & testing for vitality.
- *Acquisition of Knowledge*. If means acquiring knowledge from various sources and assembling & organising knowledge entities into unified sets for easy storage, retrieval, and dissemination.

- *Transfer of Knowledge.* It means dissemination of knowledge to the user.
- *Measure.* It measure the effectiveness of the knowledge by keeping track of usage log. This use of the knowledge happens at the initiative or choice of the user. The process keeps track & watch on the knowledge, and keeps the log of *'Who, When, Where'*. Such log at the time of review reveals the level & quality of usage.
- *Re-Validity of Knowledge.* The knowledge needs validation regularly at some interval to check its utility for which it is created. Such review may not reject the knowledge but enrich it by its experienced usage.

Knowledge Management and Business Intelligence

How do you get to the right business decision, improve employee productivity, and track the order and even the performance of the product and service, and how to improve overall performance of the enterprise? The business analytics will allow you to get answer to these kinds of questions, and many more. The business analytics in itself is not a simple activity. Currently, organisations are running on pre-defined processes, but they would need the process analytics in the future. For CRM application one needs to track the customer behavior in terms of buying and/or payment patterns, so customer data needs to be analysed in details. One may do the analysis based on past transaction data stored in data warehouses or might do the analysis to find how things might turn out in case of introduction of a new product, process or service.

The Business Intelligence (BI) is a decision-making tool for the CEO to a business enabler for the store in-charge. Gradually BI will percolate down the line, and is slated to eventually punctuate the entire value chain of the enterprise including its partners. Besides, operational BI emerging as the next frontier in business analytics, it is also in turn driving the key movement towards real time BI.

While the first phase of traditional data warehousing effort was focused on query and reporting to understand what happened, the second wave focused on technologies like on line analytical processing (OLAP) and data mining for historical data analysis to understand the trend and patterns; third generation of solutions are focusing on front line workers, and providing them with increased business insight within the context of the business processes. This means enabling the call centre and support staff to better service customers and identifies the cross sell opportunities.

The CIOs in effect are driving the enterprise BI. There are competitive pressures that are demanding the companies to react faster to changing business conditions and customer requirements. This requires the need to optimise business operations on daily basis and, in some cases even facilitate decision-making at the functional level on a daily basis. In addition to this, some aspect of day to day decision-making is also going down to the operational level staff. If implemented properly, BI has the capability to move beyond the traditional decision support systems for the top management and cater to the unique requirements of the lower level managers. Starting from customer behaviour at a transactional level, which helps in taking strategic decision and where to open the next store, everything is driven by analysing huge amount of transactional data stored in data warehouse. The dashboard alerts, event driven analytics, predictive modelling, etc. gives a distinct advantage to companies at each level of operations and can cater to key performance indicators (KPIs) targeted from operational level right up to strategic level.

The call centres, customer retention, sales, marketing, fraud detection, all these will require a real-time decision-making ability and that is where operational BI will play a major role. The BI has slowly graduated to predictive modelling and optimisation levels delivering functions like "what will happen next, what is the best that can happen" and help companies influence the outcome.

BUSINESS INTELLIGENCE (BI)

The Business Intelligence (BI) is the user centred process of exploring data, data relationships and trends—thereby, helping to improve overall decision-making. This involves an iterative process of accessing data ideally stored in the data warehouse and analysing it—thereby deriving insights, drawing conclusions and communicating findings—to effect change positively within the enterprise. The BI is an application of a data warehouse, but does not necessitate a data warehouse. The BI is comprised of four major product segments: interactive query tools, reporting tools, advanced DSSs, and EISs.

The Business Intelligence covers strategies, processes, and technologies in order to achieve knowledge about status, potentials, and perspectives of a company out of heterogeneous and distributed data.

- The Business Intelligence is about making effective business decisions.
- The BI enables organisations to make well informed business decisions and gain competitive advantage.
- The BI enables organisations to use information to quickly and constantly respond to changes.

The BI empowers enterprises with systems that promote understanding and action through facts and opinions; quality information; meaningful delivery; proliferation of data analysis; and shared insights. Many enterprises have dedicated experts for data analysis. With BI implementations, enterprises will have smart managers, who would be spending not more than 10 per cent of their time in analysing data. The BI systems will help them to interpret historical data, spot trends, and measure performance against established goals, so they can quickly identify variances, dynamically allocate resources and better adapt to unpredicted events.

Traditionally, analysis, and reporting on enterprise business data has been the domain of dedicated analysts. Now, with increasing pressure to shorten the decision cycle and decrease expenses, these tasks are becoming a part of the daily routine for information workers in every facet of the organisation.

The BI solutions that are tailored to meet specific business needs help these employees remain productive, allowing them to remain focused on their line of business rather than learning or implementing new technologies and tasks. The common BI platform includes the building blocks for flexible solutions designed to meet the specific needs of an enterprise or of a subset of users within that enterprise. These tailored solutions deliver intuitive tools that enable information workers to incorporate advanced decision-making processes into their daily routines. For example:

- A solution that aggregates service, support, and purchasing history can help customer service representatives anticipate individual customers' needs and interacts knowledgeably with each customer. The account information and purchase history can also inform up sell or cross sell opportunities. As a result, the solution improves customer service and maximises the profit potential of every customer.

- A solution that analyses production and performance data can enable operations managers to quickly assess the efficiency of production processes—identifying bottlenecks as soon as they occur, or making modifications and improvements, where they can have the greatest impact on productivity.
- A solution geared towards marketing intelligence can be used to identify trends in product performance and response to marketing campaigns. Given this information, marketing managers can respond immediately to patterns in customer behaviour, modifying campaigns in near real time to maximise their effectiveness.

One result of this trend is that enterprises' views of business and systems are expanding. In the past, automated systems—whether transaction or information based—focused on internal data and users. For example, transaction processing systems are beginning to include customers and suppliers via Internet, intranet, extranet, and EDI, eliminating the need for paper forms and post offices. Likewise, information based BI systems will broaden their scope to include key customers and suppliers through BI networks. The prepared data and analytical models will be shared electronically; the recipients will merge these with their own BI systems, facilitating analysis that is more complete, timely and accurate. Some suppliers already offer this capability as a competitive differentiator; in the future, this will be a prerequisite for doing business.

The Users' BI needs vary among line managers, knowledge workers and executives (Refer Figure 12.4). In addition, a BI plan must be appropriate to the enterprise's political style of sharing information; for example, some enterprises follow hierarchical structure with tight information control, while others follow flat structure with free sharing of information. The enterprises should also consider whether a solution's underlying technologies and architectures are open, extensible, and compatible with internal, strategic technical directions.

BI: Beyond reporting, to operational control

The BI is no longer just a reporting tool. It is more about gaining operational control and insight into what lies ahead

The market analyst companies forecast about the industry trends and give an outlook that forms the key element of vendors business strategies. But when it comes to enterprises and its core areas of operations, IT plays an enabling role in aligning business goals to give a tangible impact on the companys bottomline.

The enterprise computing in India is still very young as organisations aggressively started automating only from the late 1980s when global vendors started upping their ante in the domestic market. So one saw new age apps like ERP getting into the enterprise IT landscape for the first time. In many instances, Indian enterprises leapfrogged in IT as they did not have major standardised IT assets expect for peripheral administrative processes like payroll, finance, and HR. So when they embraced apps like ERP, they entered into the big league by skipping decades while the western counterparts needed to phase out the legacy assets accrued over decades. India's key advantage is the absence of a legacy IT baggage that has augured well for adopting new age IT apps.

As we look at large IT deployments over the last 2 decades, the debate about ERP has raged for quite some time. Once when an enterprise adopts ERP, the sequence was followed by CRM and in some instances SCM. But now after the economic meltdown, the strategies enterprises adopted were increasingly challenged and when they looked at better leveraging IT for more competitive advantage, the

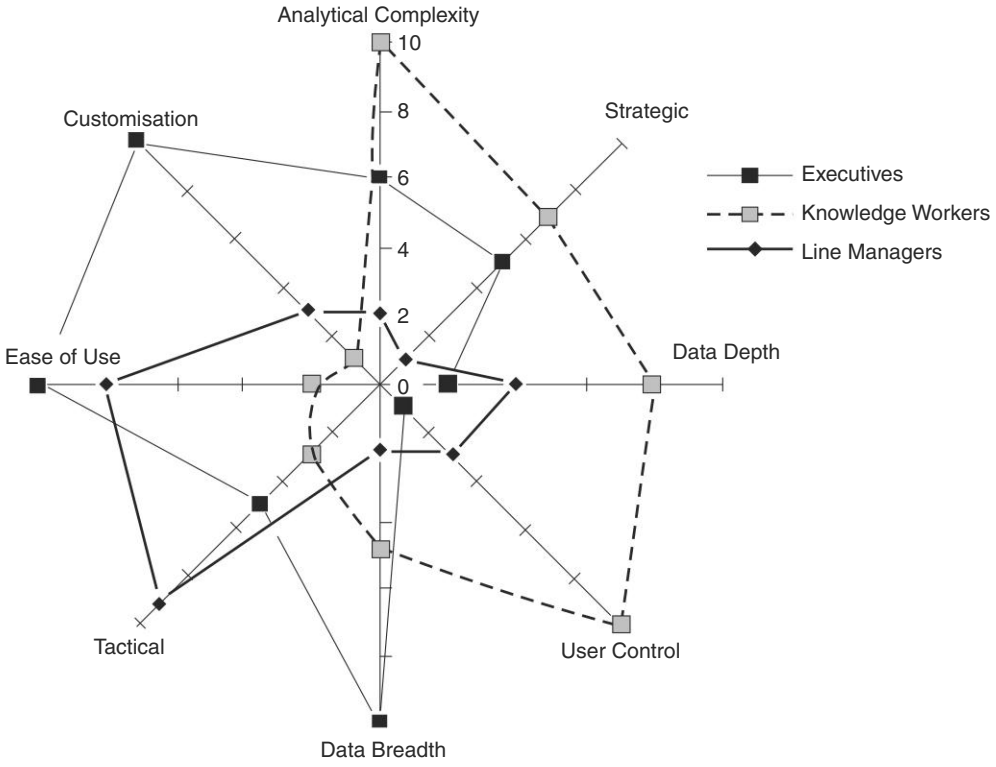

Figure 12.4 User Usage Pattern

one big missing link was the absence of a proactive BI and analytics solution. So that acted as a tipping point for the aggressive adoption of BI and analytics that we are seeing today.

BI the Business Enabler

Many organisations are seeing across the board benefits out of BI and analytics. As we look at global examples, take the case of New York fire department by using analytics not just to fight fire, but prevent them. In 2007, 2 NYC fire fighters lost their lives in a fire at the former Deutsche bank building which was scheduled for demolition. The fire investigators attributed the loss of life to a lack of timely information available to responding fire fighters. If the New York Fire Department (FDNY) had a system in place for collecting and sharing data in real-time, the accident could have been avoided, they concluded. The FDNY partnered with IBM to come up with a new Coordinated Building Inspection and Data Analysis System that rely heavily on predictive modeling to anticipate fire exposure, analyse possible impacts, and improve communication processes.

Another interesting instance is the city of Amsterdam in which IBM is helping the Dutch utility Nuon and the city of Amsterdam makes a smarter use of energy by enabling consumers to make more informed decisions about their energy consumption. The consortium will jointly implement an innovative energy management system based on smart metering and home energy management technology. It will enable

500 selected households to gain better insight into their energy consumption and help drive change in usage behaviour. It is anticipated that as a result of the pilot, customers will be able to save on energy costs and realize a CO2 reduction of at least 14%.

Yet another instance, a life-saving one in which, Duke University Health System which analysed close to 20 mn patient records using BI that provided new insights to keep patients at its 3 hospitals and 100 clinics healthier and more involved in their own care. For example, by sifting through patient records in only 1 hour, Duke was able to identify 120,000 patients with risk factors for complications from swine flu. These patients such as young children with respiratory problems and pregnant women were immediately notified by Duke that they were at risk and given priority access to the vaccine. The predictive analytics on the basis of large data sets is indeed transforming the healthcare industry.

These examples clearly indicate the far reaching ramifications of BI and analytics whether it is public or the private sector. Closer home in India, a lot of enterprises are increasingly turning the BI way and using it in many different ways. Take the case of logistics major Gati, which saw a significant tweak in its operational efficiency post the deployment of BI. We have deployed an Oracle BI and it has become a critical component of our operations. Earlier we used to get a lot of manual reports that needs to be painstakingly analysed using conventional means. But now everything is at the click of the button and we get critical information on dashboards and are able to figure out what is happening in each operating units. We have seen wide ranging benefits from increased service levels to overall improvement in our operations, says GS Ravikumar, CIO, Gati.

Yet another organisation that has leveraged BI to the fullest is Mahindra and Mahindra Financial Services, which is one of the India's leading non-banking finance companies. The MFSLs rural financing is considered as the cornerstone of poverty reduction, rural development and inclusive growth in many parts of the country by providing loans to over 1,000,000 customers belonging to the low income groups. At Mahindra & Mahindra Financial Services, BI plays a transformational role given the reach and depth of our operations across India. One of the biggest benifts of BI is that we are able to access information anytime and that this makes for a whole lot of impact right from operational efficiency to business forecasting. Mahindra has gone in for the BI solution from MAIA intelligence.

Why BI?

As we look at the examples of enterprises that has deployed BI, the single biggest benefit they have derived was the BIs ability to consolidate and deliver information on one unified platform through dashboards. Before BI, decision-making process was not that easy but after the BI deployment information, availability at a single point was indeed a boon. We are able to access so many things and are able to devise effective strategies. The BI is all about intelligence and hence any solution that just collates all the information is just a reporting tool. A good BI is one which enables new insights and improves the quality of overall decision-making.

The demand for the deep analytical skills has begun to emerge as a strategic imperative as companies seek a competitive advantage in today's transformed global economy. In fact, 83% of the CIOs in the IBM Global CIO study last year identified business intelligence and analytics as #1 priority to enhance their organisations competitiveness.

The enterprises can no longer ignore BI and in a way it is becoming mandatory. The CIOs need to deploy a solution that best fits their requirements. Moreover, when a company goes from a transactional to an analytical one, it calls for whole lot of change management issues. The BI is for all verticals and things have come to a stage that enterprises cannot ignore BI any longer. All verticals are reaping the benefits. If we take IT as a vertical for instance, the IT companies are using it for the better understanding of the client

requirements and also for effective people management. By using the BI, they are getting critical data on the market like the quality of service offered to attrition patterns within the company. We can take the case of Mindtree which has gone in for BI from IBMs Cognos. The BI at Mindtree covers critical operations and encompasses financial, operations reporting, and engineering metrics. It has helped in many different ways.

Road Ahead

A lot of companies are now looking exclusively at the business outcomes. One needs technology and feeds to deliver a business outcome, but experts say that the companies are very focused on the end game. They will say, Were a telco and we need to reduce customer churn, so how do we do that? or I'm a police chief and I need to do smart things to reduce crime in my area.

Clearly BI and analytics is increasingly getting meshed. So CIOs will look at solutions that have the ability to see patterns in vast amounts of data and extract actionable insights.

Source: *Dataquest*, May 26, 2011

Aligning BI Systems

The BI systems are strategically important and essential to compete successfully. However, when the enterprises start implementing these solutions they find an internal mismatch of skills with tasks. The business intelligence applications and their associated data warehouses are not aligned and were viewed until recently as strategic and tactical decision-making systems separate from the transactional applications that manage day-to-day business operations. There is now, however, significant momentum in organisations toward using the analytics produced by a business intelligence system for optimising day-to-day business operations, i.e., towards using business intelligence to drive the business. The increasing exploitation of e-business is also encouraging the use of operational business intelligence, since organisations need to be able to react much faster to changing business conditions in the e-business world than they do in the traditional business environment, and business intelligence offers major benefits here in optimising e-business operations.

Using business intelligence to drive business operations requires that business intelligence processing and transactional processing systems become more integrated. This integration can be achieved in a variety of ways. One common approach is to develop a closed loop performance optimisation system whereby the output of business intelligence applications is routed to business users in the form of business alerts and recommendations. For example, product pricing changes, marketing campaign modifications, identification of fraudulent transactions, and so forth for identifying and addressing specific business issues. In the e-business environment, many companies are looking towards extending this closed loop process to the automatic adjustment of business operations and marketing campaigns, based on decisions made by the business intelligence system. In fact, some companies would like this automated closed loop processing to occur in close to real time.

In order to support the optimisation of business performance, the business intelligence system must provide easy-to-use self-service business intelligence applications that enable rapid decision-making. It must also include a methodology either formal or informal to help organisations assign responsibilities to specific business users for handling business intelligence and to define actions to be taken when the business intelligence identifies business problems that require urgent attention. Such a system can be thought of as supporting integrated and actionable business intelligence, which enables an organisation to become an intelligent business, rather than just a business with a business intelligence and data warehousing system.

As regards technology, organisations can deploy a closed-loop performance optimisation system by using business intelligence tools to build the appropriate applications in house, or can purchase ready built packaged analytical applications. In reality, it is likely that most organisations will use a combination of both approaches, i.e., they will build and buy a variety of optimisation applications and packages and integrate them into a business intelligence framework. In addition to the business intelligence tools and packaged analytical applications already mentioned, the framework contains a data integration platform that captures and transforms transactional data and loads it into a data warehouse, and a data analysis platform that supports the analytical processing required for creating actionable analytics.

It is important in building the business intelligence framework to determine the costs associated with acquiring an integrated solution from a single vendor, compared with licensing best-of-breed products from multiple vendors and integrating them. The cost of licensing packaged solutions for producing actionable analytics versus developing applications in-house is also a key factor in determining total cost of ownership. Regardless of the approach used, it is essential that a BI framework is built on top of an open and scalable data warehousing and database infrastructure.

BI Issues

The following are some of the important issues that one needs to address while building a successful BI solution.

- **Unrealistic Expectations:** Before the software system is purchased, it is important that a core group be designated to lead the initiative and help achieve compliance. This group will be responsible for orchestrating the rollout of the business intelligence software and maintaining it while moving forward, as well as eliminating any old systems of data collection that could cause duplication.
- **Limiting Access to Results:** In organisations that allow limited access to reports, most of the time the sales team, marketing department, and other key teams and groups are left out of the loop, and the business intelligence software is not used to its full potential. While business intelligence reports are very important during the decision-making process at the corporate level, they can also help guide the teams who face the customers most of the time, resulting in increased customer satisfaction and retention.
- **Poor Data Quality:** If the data your program is using is poor, then the results it produces will be unreliable, no matter how excellent the business intelligence software is. No one will end up using the information during the decision-making process or while interacting

with customers after being burnt by shoddy results. By entrusting the core group with data quality, one can follow through with the program knowing that poor quality data will be cleaned up and that new data coming in will be of minimum quality standard.

- **Resistance to Change:** Business intelligence does not exist in a vacuum. When the business intelligence software is selected, there is a need to find a vendor who can help to pick a product that can adapt to changing variables or that can support additional applications as time goes on. Both the customers and the employees will probably have some suggestions on how to improve the system within the first couple of months or even weeks of its launch, so one must be ready and willing to change the business intelligence program. The team should also take the users along.
- **Winning It:** Without a clearly defined set of variables and objectives, any organisation will have a hard time finding value in their business intelligence software. The core group should be aware of what the organisation's goals are and what will be the key milestones towards those goals. They should also know exactly what constitutes revenue and the specifics of other important variables when they process incoming data. With a clear view of what the business intelligence initiative was expected to accomplish, they will be able to help the system provide useful business intelligence for the entire company.

Stages in Business Intelligence Process

The BI process is multi-stage process and it depends on the organisation's BI implementation strategy. The multiple stages of BI process include:

Stage 1: Reporting (What Happened?) – Focus primarily on batch processing based on pre-defined queries to access and transform corporate data into highly formatted reports for greater insight.

Stage 2: Analysing (Why did it happen?) – Focus on increase in ad-hoc queries and interact with information using dashboards and visualisation tools.

Stage 3: Predicting (What will happen?) – Developing analytical model. In order to determine trends from complex historical data and to make better forecasts.

Stage 4: Operationalising (What is happening?) – Continuous updation of query based system, with powerful reporting and query tools.

Stage 5: Active Data Warehousing (What do I want to happen?) – Event based triggering of activities.

INTELLIGENT BUSINESS

The intelligent business is a fundamental shift in thinking for the world of data warehousing and business intelligence. The enterprises always had two set of systems—operational systems on one side and analytical systems on the other side, thereby creating a divide. ***The Intelligent business is about taking business intelligence and putting at the very heart of the enterprise.*** The idea here is that so called 'traditional' data warehousing

The intelligent business is BI integrated into operational business processes.

and business intelligence continues as normal but in addition, operational applications, and portals can request trusted business intelligence on demand.

The intelligent business is also event driven. There is automatic monitoring of business activity events as well as responding to requests for just-in-time business intelligence, which may or may not need to be integrated with other operational data on the move before delivering this data to applications. It also includes on-demand requests for predictive analysis to provide a recommendation, for example. The objective is clear, ubiquitous BI in every activity in every business process across the enterprise so as to guide business operations towards achieving strategic business objectives. Hence, The intelligent business uses BI as an on demand resource to guide core business operations as the company operates. In most cases, the operational business user does not know they are using business intelligence. In other words, BI is just there, transparent but integrated into their normal operational application. Behind the scenes, BI web services make it possible to dynamically integrate with operational systems. In this case, intelligence is used to guide people and systems in the context of the business process activity being performed such that operations are steered towards meeting strategic objectives and goals.

The intelligent business offers:

- On-demand requests for specific intelligence, e.g. about a specific customer
- On-demand requests for automatic analysis of data, rule driven automatic alerts, and automatic recommendations
- Automatic capturing of events in business operations that trigger the integration of other data on demand, to be automatically analysed to take manual or automatic actions. This is known as business activity monitoring (BAM).

All this requires that BI is used as an intelligent resource for on demand processing in the context of an operational business task being performed in a business process. Therefore, business process activities have to be 'attached' to business objectives and goals declared in corporate performance management (CPM) software to help a company align business processes with its business objectives. Once this is done, we can then associate or target BI at specific business process activities so that the BI is used in an operational context to achieve a strategic business objective. Currently, it is difficult just to integrate CPM and BI. Nevertheless, these requirements are critical to intelligent business.

Given this description, it is clear that an intelligent business strategy must be based on common trusted intelligence. Also this vision says that the number of requests for BI from people is likely to be dwarfed by the number of requests coming from operational applications. The vast majority of users in different roles do not have time to use a BI tool because their job function is real time and therefore makes it impossible for the user to use such tools. People in these operational roles spend the majority of their time in managing or using transaction processing system or other manual activities. These people could be customer serving staff including customer service representatives in call centres, banking staff in branches at counters, mobile workers such as sales and field service, people in distribution, procurement, and even finance people, for example. Figure 12.5 below shows the concept of intelligent business.

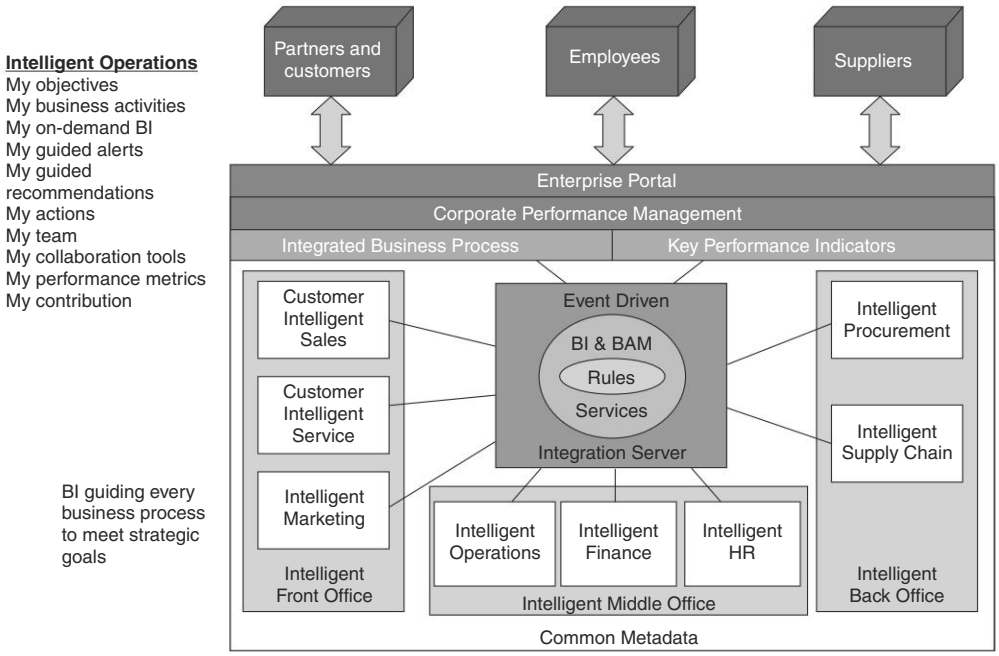

Figure 12.5 The Concept of Intelligent Business

One can notice from the above figure that operational applications surround rule driven BI services that access consistent integrated data in data warehouses and data marts. Also, the CPM software is not only integrated with BI but also integrated with business processes so that one gets to know the process activities that are associated with particular strategic objectives. Through the enterprise portal, people see their alerts, their recommendations, their actions, the on demand BI that is relevant to their role in the context of any business process activity they are performing at that time. They also see the collaboration tools that they need to do their jobs and collaborate with others.

Intelligence @ Work

The companies are pouring millions of dollars into analytics, reporting, infrastructure, and systems every year, and still do not see full returns on their investment.

Understanding the Process

Many companies cannot articulate the current way they work today. They know, for example, that they have too much margin exposure, that returns management is a problem and that new product introduction is a key to success over the next several quarters, yet, those managers can't clearly articulate the order management process, do not have confidence that everyone on the team is executing against the same metrics, and know it is still taking them too long to get sales orders approved, inventory shipped, and sales people paid. Was not BI going to solve these problems?

If the business truth is that you can't manage what you can't measure, then the corollary is that the first step to business performance is process articulation. The first step in a performance management strategy should be to bring business and IT owners and contributors to the table to share a common definition of the current process. This may be new product introduction, expense management, or quote to cash. Almost without exception, any process can be improved upon and many of them can be automated. The BPM provides the catalyst required to take the information gathered from BI and to create actionable processes for improvement.

All the data and the analytics in the world are worthless if no one understands how they inform the process of how people work. The core value proposition of BPM is the ability to articulate, simulate, and optimise this informed knowledge of how people work and integrate it into the enterprise.

When organisational improvement starts from a focus on people, it increases the likelihood that analytics can be applied to decision points that drive measurable, repeatable improvement. The BPM provides a prescription for analytics as well as progressive, measurable improvement. It also helps configure information and context to accommodate the way people work, increasing repeatability of the process.

Make it Actionable

Once the process is defined and optimised, it is critical that it become actionable. This is where the intersection of BI and Business Process Management (BPM) is best illustrated. The BI and analytics platforms with business activity monitoring are great for helping identify a problem, often in near real-time. However, they often fail when it comes to helping the user actually do anything about the problem.

For the IT side of the house, a BPM platform allows system-to-system, system-to-human interactions and human-to-human exchanges to be captured in a repeatable, manageable way as a complete solution. The BPM allows execution on business activities without production system, or code changes, or human intervention. In addition, these solutions can be supported with minimal IT involvement while working with existing legacy infrastructure and systems. The BPM often fills in the gap, where existing anchor applications leave off, when business conditions change and people have problems.

For business line owners and executive management, The BPM makes their metrics actionable, often without requiring direct human interactions. It allows business owners to drive process improvement while providing the flexibility for the process to reflect the way people and teams actually work. It also enables process improvement without big bang costs or large IT integration projects. Many times, initial process projects can be deployed in 3090 days. The result is a strategic approach to process that starts with rapid modeling and iteration followed by a fast rollout enabling measurable results. Using BPM, organisations can begin improving top line and bottom line metrics in the same quarter they are rolled out.

Work with the People

The reality for many organisations is that process improvement is stalled by the legacy of past failed projects and a lack of concrete requirements from business owners. The IT budgets are often constrained and IT departments naturally default to existing infrastructure and systems for new projects when possible. The hard truth is that existing systems do not match the way people work and every system that ever reached the capital expenditure committee has some form of workflow. With multiple projects, teams, applications, geographies, and workflow tools, process improvement can turn into chaos. The result: workflow gone wild.

The outcome is that organisations attempt to respond to people-driven process issues by attempting to perform unnatural acts with existing applications. While BI has helped fill some information gap for people, it has not truly unlocked the promise of putting data in the hands of people where it can become actionable. In addition, complex middleware and application infrastructure may conspire to make the problem worse. Add in the buzz about SOA the requirements around compliance, and business owners insistence on 'real-time' everything, and process projects, and problems become hugely complex and costly. In this scenario, the likely outcome is highly taxed IT systems and people who are not equipped to truly solve the underlying problem.

The BPM provides the ability to capture users and system requirements to optimise how people work. It is more than just workflow. In BPM, the same process model that is defined, iterated, and optimised becomes the application specification to deploy in an enterprise environment. The model becomes the common language to meet user requirements for automating and improving processes and the IT specification for system connections, business rules, and data architecture.

The process management tools also become a highly customisable platform to enable the continued, rapid roll out of process applications while maintaining common security, administration, flexibility, and control.

While considering investments in the BI, one doesn't just think about the ability to monitor metrics and reports consistently. Instead, think about intelligence as content and context for how people and organisations work. The ability to unlock the power of intelligence is usually directly connected to the organisations ability to define their current processes, optimise and improve those processes and make them actionable. The BPM becomes the engine to drive the performance-driven organisation to the next level. It should be considered a strategic part of business improvement strategy, and IT architecture. More importantly, process should be considered key to competitive advantage, and that's just something you can't get from BI alone. The process makes your BI strategy actionable.

Source: *Dataquest*; March 31, 2008

Role of Metadata

The success of intelligent business is dependent on the common business metadata. The common metadata means common data names, common data definitions, common data integrity rules such that all data items in dimensions and metrics used in a data warehousing system are absolutely consistent. If there is one prerequisite to integrating the BI into operational business processes it has to be that the BI is trustworthy and has common understanding. The trusted metrics, trusted meaning, trusted unambiguous data names, and an audit trail of how data has got to be in the data warehouse and/or the data marts that store it. Without this, integrating BI into operations could cause damage to business operations, especially if automated analysis and actions cause business changes to be made.

The common metadata is the very basis of data sharing. It is common definitions of data items, common data names, common integrity rules, common reference data, common mappings, and common transformations for all subjects, subject attributes, transactional data, dimensional data and metrics associated with data that are considered 'standard' within an organisation. These standards are called data assets that can be used not only in business intelligence systems, but also in operational systems. The point here is that for BI to be at the centre of enterprise operations,

with automated alerts, recommendations and action messages being fired off on detection of exceptions, then that BI had better be correct and understood. So the prerequisite to intelligent business from a BI perspective is to resolve all inconsistencies in data naming, data definitions and data integrity rules across all BI systems by making these systems adhere to common data definitions.

So a common business model is needed. The benefits of a common business model include:

- A better understanding of data
- Increases awareness and reduces uncertainty about data
- Formally named, comprehensively defined, properly structured and high quality data
- Delivers incremental short-term benefits while moving towards a long-term goal
- Reduces volume of data through removal of redundant data
- Reduces need for transformations if data is common
- Improves productivity as people spend less time struggling to understand data and more time using it to do their jobs

Therefore, the very first step involved in intelligent business is to put in place a common business model and resolve BI inconsistencies by repairing existing BI systems to adhere to that common business model. In that sense, all BI data stores and BI tools need to:

- Use common naming, definitions, and structuring of common data across all BI systems. Use common data integrity rules on common data items across all BI systems.
- Identify the definitions of disparate data. This means finding the metadata in these source systems and integrating the metadata. Given the disparate data in source systems and indeed the discrepancies across existing BI systems, it would seem obvious that data integration software like ETL software could be used to integrate the metadata describing disparate source data on these source systems and bring it into a repository for cross reference to a common business model.
- Map the definitions of disparate data in source system models to the definitions of data items in the common business model such that all data is correctly sourced.
- Assessing data quality in disparate data.
- Generate/define cleanup and translation rules for disparate data to get it into a common state.
- Integrate disparate data to create a common trusted set of business intelligence.

While all these steps seem somewhat formal, they nevertheless make it possible to resolve inconsistencies in BI systems and resolve inconsistencies between source operational systems and BI systems so that we reach a point, where BI is trusted and clearly understood. Once this is done, it is safe to integrate BI into business operations.

COMPETITIVE INTELLIGENCE

The Competitive Intelligence (CI) is the purposeful and coordinated monitoring of the organisation competitor(s), wherever and whoever they may be, within a specific marketplace.

The 'competitors' are those firms which the organisation considers rivals in business, and with whom they compete for market share. The CI also has to do with determining what the business rivals WILL DO before they do it. Strategically, CI helps to gain prior knowledge of the competitor's plans and helps the organisation to plan their business strategy to countervail their competitor's plans. This will involve many methods at the tactical collection level, but it will also require integration into the existing information infrastructure, analysis, and distribution of the information, and finally, the calculation of business decisions on the grounds of that information and the analysis of the same. This is the 'intelligence' part of the formula.

The Competitive Intelligence is a systematic and ethical program for gathering, analysing, and managing external information that can affect your organisation's plans.

Most of the value addition, in manufacturing or product organisations is created by knowledge-based service activities such as research and development, marketing research, product design, customer service, advertising, or distribution. The winning organisations are those that most successfully master the business issues critical to their performance, and develop the most precise understanding of the definitions of value and creation of value. The competitive advantage has a lot to do with leveraging the knowledge assets of the firm, while at the same time determining how competitors are likely to leverage theirs.

The goals of Competitive Intelligence are many such as:

- adopt a strategic approach to the use of competitive intelligence;
- to see the intelligence function as an integral part of strategy formulation;
- show how competitive intelligence is used by firms to achieve competitive advantage; and
- examine the process, the tools, and the output of CI.

The majority of the organisations worldwide make use of competitive information in formulating business strategy. Each organisation is a leader in its industry and each of them knows its enemies. The organisations and industries prosper through improvements in competitiveness, leveraging core competencies, and competitive intelligence is at the core of the objective of improving competitive advantage.

BI Vs. CI

Business Intelligence (BI)	*Competitive Intelligence (CI)*
• Business Intelligence–Internal Focus • Relies on internal reports • Depends on company personnel for information • Resulting analysis provides insight into the organisation's competitive business advantage	• Competitor Intelligence–External Focus • Relies on non-traditional sources • Makes heavy use of personal contacts

Value of Competitive Intelligence

The economies of scale which was the foundation on which large organisations had based their dominance in the Industrial Era, is no longer an advantage. The advances in information

technology, in the financial system, in just-in-time production techniques, and many other business techniques, have changed the competition. Most of these were previously offered by only the larger companies, now even smaller companies have adopted these techniques. These changes have altered the business rules.

Followings are some of the important issues that the organisation must address, while implementing a CI programme:

- How clearly the organisation has defined its mission, its strategic intentions, its objectives, and its strategic choices?
- What the organisations need to know to develop and select strategies which are not only successful, but sustainable?
- What new products should the organisation produce and which markets should they enter and how?
- How do they implement the competitive strategy?

Whatever strategic framework the organisation chooses to embrace for the management of its business, no one element remains more fundamental to competitive strategy than competitive intelligence. The competitive intelligence is more concerned with doing the right thing, than doing the thing right.

The goal of a competitor analysis is to develop a profile of the nature of strategy changes each competitor might make, each competitor's possible response to the range of likely strategic moves other firms could make, and each competitor's likely reaction to industry changes and environmental shifts that might take place. The competitive intelligence should have a single minded objective—to develop the strategies and tactics necessary to transfer market share profitably and consistently from specific competitors to the organisation.

An organisation which does not rigorously monitor and analyse key competitors is poorly equipped to compose and deploy effective competitive strategy and this approach leaves the firm and its markets vulnerable to attack. The basis for CI revolves around decisions made by managers about the positioning of a business to maximise the value of the capabilities that distinguish it from its competitors. The failure to collect, analyse and act upon competitive information in an organised fashion can lead to failure of the organisation itself.

The upside of successfully predicting a competitor's future plans are apparent; as are the consequences of making business decisions based on information that is faulty.

The competitive intelligence is usually composed of five major areas of endeavour, and is performed under three main approaches in the CI framework:

- assessment of strategies
- competitor perceptions
- effectiveness of current operations
- competitor capabilities
- long-term market prospects

The strategic intelligence is concerned mainly with competitor analysis or gaining an understanding of a competitor's future goals, current strategy, assumptions held about itself and

the industry, and capabilities—diagnostic components. The intelligence about the organisation's major customers, suppliers, and partners is often also of strategic value.

The tactical intelligence on the other and is generally operational and on a smaller scale, not so centred on being predictive. The tactical issues include competitors' terms of sale, their price policies and the plans they have for changing the way in which they differentiate one or more of their products from that of the organisation. The middle level marketing and sales managers number among some of the main users of tactical intelligence. They want to know how to win the day, today.

The counter intelligence is defending company secrets. Every organisation has competitors, who are interested in knowing your plans as you are in knowing theirs, maybe even more so. Often, this area of endeavour will involve security and information technology, but others are often overlooked, such as hiring and firing strategies, to contain competitor opportunities within the firm.

The competitive intelligence is the determination of solutions to these principle factors and determinants of ongoing competitive advantage:

- What is the basis of competition?
- Where the firm competes?
- Who are the competitor's rivals?
- How does the firm compete?

Role of CI in Business

Seldom do people realise that business, just like life is merely a series of decisions. The global firms have a growing need for the information necessary on which to base decisions concerning the conduct and development of each of their firm's strategic objectives, and the protection of their organisations against threats from their competitors.

The intelligence is a process and a product—an analytical process that transforms recklessly gathered competitor and market information into actionable knowledge about competitors' capabilities, intentions, performance, and position; as well as the final product of that process.

The focus of market research tends to be on the problems associated with the profitable marketing of a firm's products and services. The scope of competitive intelligence is far broader. The competitive intelligence is a value-added concept that layers over the top of business development, market research and strategic planning.

The research objectives of a competitive intelligence project will often involve issues such as: the manufacturing capabilities of the competitor; analysis of alliances and/or joint ventures entered into by competitors; the competitor's future plans and strategies for specific markets, or product lines; reasons behind changes in the corporate or business unit strategy, etc.

In today's global enterprise, CI happens at two levels—corporate and business unit. The corporate strategy concerns two different questions: what businesses the corporation should be in and how the corporate office should manage the array of business units. The competitive strategy on the other hand is concerned with how to create competitive advantage in each of the businesses in which a company competes based upon core competencies.

The intelligence cycle is defined as "the process, by which raw information is acquired, gathered, transmitted, evaluated, analysed and made available as finished intelligence for policymakers to use in decision-making and action." There are five steps which constitute this cycle:

- planning and direction
- collection and research
- processing and storage
- analysis and production
- dissemination and delivery

The product of the intelligence cycle is evaluated information. It is finished intelligence, packaged in a format appropriate to the intelligence itself for its customer or the decision-maker.

In practice, the intelligence product is unlikely to be created from perfect input. The firm finds itself in a position where it can only react to the competitor's move; it has lost the advantage it might have had if the right intelligence had been available earlier. The CI's real value is to provide managers with the organisational tool to learn what the competitor will do, not what the competitor has already done.

The ethics and ethical behaviour are concerns here and since the area is usually perceived as positive to a company's reputation and competitiveness, it would not be useful for a firm to undertake its intelligence activities without regard to ethical or legal considerations. Everything a firm needs to know about the competition can be obtained by legally available means.

The bottom line benefits of CI include—improved market knowledge, improved cross-functional relationships in the organisation, greater confidence in making strategic plans, and improvements in product quality versus the competition. In short, better business performance through doing things better.

SUMMARY

- The intelligent systems are those that learn from the environment and their past actions. One can create intelligent systems by embedding the intelligence artificially into the machine, so that the machine starts behaving intelligently. The intelligent system found its applications in business areas like financial services, customer satisfaction, and material management. It is also being widely adopted in diagnostics and testing.
- The artificial intelligence is the science of making machines do things that would require intelligence. Artificial Intelligence (AI) is concerned with two basic ideas—first, it involves studying the thought processes of humans; second, it deals with representing those processes via machines. The AI is concerned with the studying of thought processes of humans and representing those processes via machines. The AI is behaviour by a machine that, if performed by a human being, would be called intelligent. The AI is a vast area of science and number applications have been developed over decades like Artificial Neural Network, Fuzzy Logic, Genetic Algorithm, and Expert Systems and many more.
- The Neural Networks are intelligent systems with architecture and processing capabilities that replicate certain processing capabilities of the human brain. The Knowledge representation is

based on massive parallel processing, fast retrieval of large information, and ability to recognise patterns based on experience is called neural computing.

- The Artificial Neural Networks (ANN) simulates neural networks found in nature, such as the human brain. The term artificial is used to distinguish ANNs from their biological counterparts. The Nodes as referred for artificial neuron receive input and fire output if a certain weight is exceeded.
- The Fuzzy logic is an AI technique that deals with uncertainties by simulating the process of human reasoning, allowing the computer to behave less precisely and logically than conventional computers do. The fuzzy logic was conceived as a better method for sorting and handling data but has proven to be an excellent choice for many control system applications since it mimics human control logic.
- The expert system are created with objective to transfer expertise from an expert to a computer and then on to other humans. In developing such systems, designers usually work with experts to determine the information and decision rules (heuristics) that the experts use to solve particular types of problems. An expert system is a form of artificial intelligence that uses a knowledge base (KB) and inference engine to make decisions. The input for the knowledge base is gathered through a user interface.
- As organisations have become more complex and information more readily accessible, forward thinking managers have grown concerned with how to allow knowledge to flow freely and how to control and manage this vital flow of information and technology at the same time. All of these factors make knowledge management a necessity rather than a luxury. The organisations must have a clear idea about how knowledge is discovered, created, dispersed, and put to use.
- The data relates to facts about business transactions; information relates to description, definition, or perspective (what, who, when, where); knowledge comprises strategy, practice, method, or approach (how); and wisdom embodies principle, insight, moral, or archetype (why). The Knowledge Management (KM) is the access, retrieval and distribution of human experiences and relevant information between related individuals or workgroups. The challenge of knowledge management is to determine what information within an organisation qualifies as 'valuable'. All information is not knowledge, and all knowledge is not valuable.
- People, processes and technology are the new building blocks for corporate success in today's information rich markets. People are necessary for brainpower, innovation, creativity, and the experiential knowledge to solve technical problems. An organisation must also have effective and efficient business processes in place to create a sharing, collective atmosphere. In order to support human innovation and progress, a basic technological infrastructure must be in place to help leverage collective brainpower and corporate knowledge and deliver new ideas and solutions quickly and practically.
- The Business Intelligence (BI) is the user-centred process of exploring data, data relationships and trends—thereby helping to improve overall decision-making. This involves an iterative process of accessing data ideally stored in the data warehouse and analysing it—thereby deriving insights, drawing conclusions and communicating findings—to effect change positively within the enterprise. The BI empowers enterprises with systems that promote understanding and action through facts and opinions; quality information; meaningful delivery; proliferation of data analysis; and shared insights.
- The BI systems are strategically important and essential to compete successfully. However, when the enterprises start implementing these solutions they find an internal mismatch of skills with tasks. The business intelligence applications and their associated data warehouses are not aligned and were viewed until recently as strategic and tactical decision-making systems separate from

the transactional applications that manage day-to-day business operations. In order to support the optimisation of business performance, the business intelligence system must provide easy-to-use self-service business intelligence applications that enable rapid decision-making.

- The intelligent business is BI integrated into operational business processes. It is also event driven. There is automatic monitoring of business activity events as well as responding to requests for *just-in-time* business intelligence which may or may not need to be integrated with other operational data on the move before delivering this data to applications. It also includes on-demand requests for predictive analysis to provide a recommendation, for example.
- The success of intelligent business is dependent on the common business metadata. The common metadata means common data names, common data definitions, common data integrity rules such that all data items in dimensions and metrics used in a data warehousing system are absolutely consistent. If there is one pre requisite to integrating BI into operational business processes it has to be that the BI is *trustworthy and has common understanding.*
- The Competitive Intelligence (CI) is the purposeful and coordinated monitoring of the organisation competitor(s), wherever and whoever they may be, within a specific marketplace. The major benefits of CI include—improved market knowledge, improved cross-functional relationships in the organisation, greater confidence in making strategic plans, and improvements in product quality versus the competition. In short, better business performance through doing things better.

KEY TERMS

Artificial Intelligence
Artificial Neural Networks
Business Intelligence
Cognitive Science
Competitive Intelligence
Customer Relationship Management (CRM)
Data
Data Warehouse
Expert Systems
Explicit Knowledge
Fuzzy Logic
Genetic Algorithms
Inference Engine
Information
Intelligence
Intelligent Business
Intelligent Systems
Justifier
Knowledge
Knowledge Acquisition System
Knowledge Base
Knowledge Engineering
Knowledge Management
Natural Language
Neural Networks
Neurons
Pattern Recognition
Robots
Speech Recognition
Supplier Relationship Management (SRM)
Supply Chain Management (SCM)
Tacit Knowledge
Wisdom

SELF-STUDY QUESTIONS

1. Which one of the following is NOT the key characteristic of intelligent system?
   (a) Human like reasoning process
   (b) Learning from experience (or training)
   (c) Waiting for instructions
   (d) Dealing with imprecise expressions of facts

2. The AI is concerned with the studying of thought processes of _____ and representing those processes via machines.
3. Which one of the following is NOT an application of AI?
   (a) Expert Systems (b) Management Information Systems
   (c) Fuzzy Logic (d) Robotics
4. _____ is an explanation system of Expert System.
5. Genome, Gene, Allele are the terms used in _____.
6. Knowledge is the process of translating _____ and _____into a meaningful set of relationships which can be applied by an individual
7. Components of KM does not include
   (a) Partners (b) Process (c) People (d) Technology
8. _____enables organisations to make well informed business decisions and gain competitive advantage.
9. _____is about taking business intelligence and putting at the very heart of the enterprise.
10. _____ has internal focus whereas _____ has external focus.

REVIEW QUESTIONS

1. Define Intelligence. Why we need to create intelligent systems?
2. Define Artificial Intelligence and its characteristics.
3. List some of the common applications of AI.
4. What are expert systems? List the major components of expert systems.
5. How one can derive knowledge from a database? List the steps required.
6. Give business application of knowledge management.
7. Differentiate between neural networks and fuzzy logic.
8. Define business intelligence. How is it different from intelligent business?
9. Why organisation needs to implement competitive intelligence?
10. Does one need to create data warehouse to implement business intelligence?

QUESTIONS FOR DISCUSSION

1. Microsoft office is an office management tool. Does it use any applications of AI? If yes, identify those.
2. Most of the home appliances have integrated AI technology. Justify with examples.
3. Find the relationship between knowledge management and business intelligence.
4. The data mining techniques are same as business intelligence. Justify your answer.
5. Implementing competitive intelligence is unethical. Justify.

APPLICATION EXERCISES

1. Load the Sales.xls data file. It has four data sheets. Load the customer-sales sheet to find information and data patterns:
   (a) Find the total city wise sales
   (b) Find the total city wise, region wise sales
   (c) Find the buying pattern of customers
   (d) Find the profile of customers who prefer to buy bread and butter
   (e) Find the profile of customers who prefer to buy coke and lays snack
2. From the same sales.xls data file, load the service sheet.
   (a) Find the profile of customers who have subscribed to passport programme
   (b) Find the profile of customers who have not subscribed to passport programme
   (c) Identify the information, knowledge, and wisdom from the above data set.

GROUP PROJECTS

1. Visit the library or Internet sites to find the details about the emerging business applications of AI. Prepare a report and make presentation.
2. Search the Internet to find more details about the genetics algorithm. How business organisations can make use of this technology?
3. Identify the Indian companies that have implemented knowledge management. Do a detailed study of one of these companies to find the problems that they faced while implementing knowledge management?

Caselets

1. Maruti Udyog Ltd.

The Maruti Udyog Ltd. a subsidiary of the Suzuki Motor Corporation of Japan, has been the leading Indian Passenger car manufacturer for about two decades now. "In early 2000, all the product design work was being done on paper, and a growing need was felt to automate the process," CV Raman, GM Engineering, Maruti said. "The management also wanted to integrate the engineering function with manufacturing", he added.

Among the company's product development challenges, the need for shorter cycle times was always a major concern. The management wanted to launch new models faster, and reduce the time taken in making minor changes, and in the development of product variants.

A second challenge was joint development, since Maruti's goal was to collaborate closely with its global teams and suppliers on the development of new platforms. Other challenges included streamlining the process of vehicle localisation and enhancing quality and reliability. All of these challenges pointed towards the need to have a product life cycle management (PLM) solution with capabilities for information management, process management, knowledge capture and support for global collaboration.

Maruti selected UGS's PLM software solution that included Team centre, NX and Tecnomatix software.

The Team centre provides a wide range of functionalities for release management, including bills of material management and change management. It handles the vehicle localisation process, coordinates the parts approval process and integrates design and engineering information with the company's ERP system. It also provides the infrastructure for global collaboration by permitting real time data-sharing with suppliers in India and with the global Suzuki team.

The NX supports vehicle design by providing advanced tools for styling, product design, and digital mockup. Its system based modelling solution (WAVE) simplifies the creation of product variants. The NX is also used for tool design and the development of machining programmes.

The Tecnomatix automates manufacturing process planning and allows for assembly feasibility studies, ergonomic analyses, welding cell simulations, etc.

'Post PLM, the time taken to reach the market has been reduced because of "quicker decision making," says Raman.

Since implementing the UGS PLM solution, engineering change notice (ECN) time at Maruti decreased by 50 per cent. The number of ECN errors was also reduced by half.

The three-dimensional parametric models showing all elements of a vehicle and design reviews including digital mockups made design much easier to understand than when it was all done on paper.

The factory simulation functionality had equally beneficial results. The digital three dimensional plant layouts reduced errors and cut-down on personnel costs for accommodating new product introductions. In addition, Maruti saw a 50 per cent reduction in assembly/build issues.

From the business perspective, all this meant that the vehicles got to the market sooner with a 25 per cent reduction in design-to-launch time and a further expected reduction of 15 per cent, as more of the collaboration with Suzuki and the suppliers is done electronically in real time.

From the customers' perspective, the implementation of Team centre, NX and Tecnomatix, has resulted in reduced prices for five car models.

Underlining the significance of PLM, Raman says: 'As the number of projects increases with time, there will be an urgent need to integrate project management virtually across the organisation.'

Questions for Discussion

1. What are the key challenges faced by the company?
2. Identify the competitive intelligence parameters that the company might adopt by implementing the system.
3. What are the perceived benefits of the system?

Source: *Dataquest*, 28 Feb. 2007, Vol. XXV No. 04

2. Wireless Intelligent System

The Business Intelligence (BI) is typically the process of converting data into information and then into knowledge. The organisations gather information to assess macro level performance such as financial trends, marketing, or competitor analysis, as well as tactical and event driven activity like threshold alerts.

BEFORE WIRELESS

A VP of operations is responsible for the domestic, EMEA, and American operations of a large and publicly traded multinational manufacturer. He is also a part of an executive committee tasked with evaluating how best to expand into China. This project is a strategic imperative and the VP is spending significant time in Asia, as well as at countless local seminars and conferences on the subject. He is getting ready for another two weeks trip to China to meet numerous people in both the government and private industries.

His company is part of a highly competitive industry where any wrong steps can have serious consequences on the street. He has seasoned operations managers in each location, but is concerned that he is not as 'hands on' as he used to be. In the past, he would make regular visits to all sites, but as the company expanded, and with the special China assignment, he has been forced to cut back on these personal visits.

In preparation for his trip, he sends an email to all his first line managers requesting that he be appraised of any critical issues. It is the last month of the third quarter and the company needs to meet performance targets. He packs his laptop and cell phone, and a complete set of printed reports and begins his travels. On the way to the airport he gets a phone call from his US manufacturing plant telling him they are going to be hard pressed to make their shipment target, due to some unexpected component supplier delays. The VP calmly but firmly says, "Missing the schedule is not an option."

At the airport, he locates a Wi-Fi hotspot and, after paying the ₹ 100 per hour fee, uses his laptop to send one final email to all his managers reminding them of how critical it is to make their shipping schedules. He also tells them that he expects to be notified instantly. After he sends the email, he disconnects and realises that this is a tall order for them to fill. The last time he was in China, he experienced substantial difficulties in getting conventional email and phone coverage.

He had even greater difficulties logging on remotely to access vital performance statistics from the corporate ERP system. He further realises that he will need to devote his full time and attention to the Chinese delegates in all his meetings. He boards the plane with trepidation, worried he will not be on top of the situation at all times. He can also imagine the mountain of emails he will have to deal with when he is lucky enough to get access. He hasn't even taken off yet, and already he is feeling swamped and out of touch.

CAPABILITIES NEEDED

In addition to standard phone, email, calendar, and messaging functions, when managers are away from the office, it is vital that they still have access to key information from back-office BI and ERP applications such as:

- Virtual real-time KPI alerts and escalation
- Six SIGMA scorecards
- Lean scorecards
- Essential P&L information
- News bulletins
- Competitive updates

AFTER WIRELESS

The VP of operations is getting ready for another two weeks trip to China. Over the past several months, he has been working with his management team and the IT group to provide a mobile version of all company Lean and Six Sigma scorecards, to be accessed from their mobile applications. He packs his mobile application and begins his travels. On the way to the airport he gets an email from his US manufacturing plant advising him of unexpected component supplier delays. The VP sees that the message has been broadcast as a 'priority case' to a special cross-functional team comprising production, supply chain, and procurement. He is confident they will do what it takes to fix the

problem. He also knows that he will automatically be alerted as soon as the issue is resolved.

At the airport, he scrolls through the scorecards on his mobile application to see the latest performance figures before he boards. Each scorecard has predetermined thresholds set to alert him of any deviations from the plan across every aspect of operations. The last time he made this trip he was impressed when he automatically received up-to-date performance statistics from the corporate ERP and BI systems. He knew that unless there was a critical alert, he would be able to devote all his time and attention to his meetings with the Chinese delegates. He boards the plane feeling confident and is on top of the situation, eagerly anticipating his exciting journey.

Questions for Discussion

1. What are the key challenges that the company might have faced?
2. Why did the company require the wireless Intelligent system?
3. What are the values and benefits that the company achieved after the project?

Source: *Dataquest*, 15 Oct. 2007

Answers to Self-Study Questions

1. (c)
2. Humans
3. (b)
4. Justifier
5. Genetic Algorithm
6. Information and past experience
7. (a)
8. BI
9. Intelligent business
10. BI and CI

The McGraw·Hill Companies

The McGraw-Hill Companies

Section VI

Planning, Implementing and Managing Information Systems

CASE VI: Managing IT

The businesses spend over trillions of dollars a year on information technology. Yet economists have found little correlation between organisations' IT expenditures and financial performance, while managers complain that the information they receive is little better than before. The reason for this is that most IT programmes neglect the human side of the information equation—that is, they take little account of what information people want or need and how they use it. To redress this balance, there are several steps that companies can take. These include mapping where information resides in the organisation, giving librarians a more prominent role than technicians, adopting journalistic or narrative techniques for corporate communication, and observing how workers actually use information. We have the technology; the challenge now is to manage information.

The senior managers' views on the relation between information and corporate performance fall into three main categories. First, there are those who believe that improved IT alone will boost performance. Then there are those who believe that improved information practices—for example, policies for capturing customer information—is what matters. Finally, some managers believe that behavioural factors, such as whether people trust one another enough to share information are critical. This explains why so many senior executives are disappointed by their chief information officers' performance—their views on this issue fall into different categories. However, research indicates that such discrepancies will soon be a thing of the past in the highest performing companies, as senior managers move towards a more inclusive perspective. This emerging 'information orientation' mindset should ultimately close the—currently yawning—gap between corporate performance and the expectations that senior executives have on the basis of their IT investments.

So the question arises, what qualities does a successful CIO have? There are couple of research studies indicate, which that the most important are a vision shared with the company's wider management, so that IT supported strategy; a close relationship with senior executives, especially the CEO, a willingness to pay attention to day-to-day IT performance, and an ability to judge the importance of changes in the business. These qualities are still critical for CIOs who want to flourish in their posts. But IT and all things connected with it change quickly, and CIOs have been confronted with new responsibilities in recent years. The perception that CIOs have a good understanding of business processes means that their job descriptions are now likely to encompass HR and strategic planning. Like all managers, they have to be able to lead their departments through rapid change but they are often also expected to be the 'corporate radar' for new technologies. Finally, today's CIO needs to manage relationships with an ever growing range of external suppliers and contractors.

As the pace of technological change accelerates, workers are expected to learn more and more about new IT applications. Unlike managers and IT specialists their reactions to new technology vary greatly; although in some cases they are enthusiastic, in others poor communications, organisational power shifts, and a host of other factors can lead to hostility or apathy. Fortunately, negative reactions usually die down as people become accustomed to new systems and glitches are ironed out. But the bad news is that many people simply 'get by' with IT applications and do not use them with maximum effectiveness. It is worse still, many companies fail to push for continuous improvement and do not treat training as a priority. Another issue is the rise of standardised enterprise resource planning packages, which may entail more work for some employees in spite of overall benefits.

Top Ten Challenges Faced by CIOs in IT Implementations

- Change management
- Getting funds from the management
- Handling attrition
- Interoperability
- Identifying processes for automation
- Keeping cost under control
- Project plan justification
- Scaling up—working in a limited space
- Scaling down—consolidation
- Training geographically dispersed teams

Source: Adapted from *PCquest* June 2007

ORGANISING IT FUNCTION

A critical factor in the successful management of IT and information, especially in multinational companies, is the quality of the IT function. This should be assessed along two dimensions; the function's structure and transmission within the organisation; and its culture, including the personal skills and qualities of its staff. Despite its name, however, the hardware should not be set in stone. It can be seen with change in industrial contexts and development of new technologies, the IT function may need to change too—from a decentralised decision-making model, for example, to one that is more centralised. Such developments may cause friction between the function and the line managers with which it has to work, and this is where the function's cultural 'software' is important. The problem is that all IT professionals have not been educated to handle the political aspects of the organisations in which they earn their living, yet quality of relationships is perhaps as important as quality of product in this field.

With the dawning of the information economy, organisations cannot afford to neglect their IT professionals. Yet surveys indicate that many are dissatisfied. This is partly due to factors that affect all people within organisations, such as re-engineering and inflexible working patterns. But other problems arise from the changing nature of IT and from the fact that organisation fail to recognise the needs of their IT professionals. Although, they prefer to work autonomously on clearly defined problems, promotional structures often reward them with more managerial posts, which have fuzzy responsibilities and entail political wheeling and dealing. The IT professionals are also having to work more and more closely and frequently with IT users. The solution may be to focus managerial attention on team behaviour and commitment while allowing a high degree of autonomy in technical matters.

One of the forces behind the sense that we live in a 'global village' is the growing power of information technology. Hence, it is tempting for organisations to assume global homogeneity in the way information and IT is managed. But significant local and cultural differences manifest themselves in this area of corporate activity. For one thing, adoption of new technologies is not instantaneous but diffuses across the world over time. The western companies have tendency to see IT based decision support capabilities as a reason to spread decision-making powers more widely. The Japanese decision-making is still normally more organisational in nature. Such differences mean that companies should be on the look-out for best practices that may be hidden within local units. Perhaps the most important lesson that western companies can learn from their Japanese counterparts is a more down to earth, more integrated view of IT strategy.

NEW ORGANISATIONAL FORMS

The boundaries between industries are blurring. This process, known as 'convergence' is taking place not only in high-tech industries but also in more traditional sectors, such as banking and insurance. There are two types of convergence. The 'supply driven convergence', in which products from one industry enhance the value of products from another industry, occurs when companies strive to shape emerging technical standards. On the other hand in the 'demand driven convergence', in which products from different industries come to be seen as interchangeable, happens when companies attempt to provide broader products to increasingly demanding customers. A useful way to understand corporate strategy in converging industries is to examine organisations' 'intellectual capital' profiles, which indicate the degree to which businesses focus on customers, internal processes, employees, and long-term investments. Generally, companies seek mergers and alliances with companies with dissimilar intellectual capital when convergence is demand driven, but when it is supply driven, 'Like attracts like'.

These convergence and mergers demands standardised global information systems. But it is only in the 1990s that projects to put such systems in place have met with much success. This is primarily due to better project management; among other things, companies now recognise the need for senior business managers to support such projects and for stakeholders' involvement and expectations to be carefully managed. Of less importance has been the emergence of packaged enterprise resource planning systems, although these do allow managers to focus on implantation while reducing the need for debate on data standards and common business processes.

The IT has gone from being a separate, rather arcane business function to being a central part of competitive strategy. But how can companies maximise its potential to create value? First, they must understand

that IT is far more than just a means of boosting operational efficiency. It can change profoundly the nature of products, services and business processes. Second, successful implementation of IT systems requires the establishment of cross-functional 'communities of expertise', for which hierarchical 'command and control' management is inappropriate. Third, the ever increasing complexity of the IT market requires extensive use of selective outsourcing. Fourth, companies must ensure that their IT infrastructures maximise the knowledge locked within them and allow it to be directed wherever there are problems to be solved. Finally—and most importantly—managers must constantly work to keep these principles in alignment with one another and with their corporate strategies in a fast changing world economy.

Questions to Think About

1. Define the role of CIO in case of merger and acquisitions.
2. List the key challenges being faced by CIO's while managing the IT infrastructure of global organisation. What structural changes they need to carry out for effective management of IT?

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Chapter 13

Planning and Implementing Information Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- Why is information system planning necessary?
- What are the different approaches to plan an information system solution?
- How to go about developing an information system solution?
- What are the different methodologies that are being adopted by various developers?
- What are the stages of capability maturity models (CMM) and software quality issues?

INTRODUCTION

The organisations of all sizes, from all sectors, and all types have continued to increase their expenditures in information technology (IT) in recent years throughout the world. These organisations implemented Information Systems solutions of various complexities, some independent, some integrated, and some bought off-the-shelf. Some organisations developed in house, while some built these systems with perfect Information System Planning and some not. Information System (IS) planning has also evolved simultaneously with information technology. In the late 1970s, primary objectives were to improve communications between computer users and MIS department, increase top management support for computing, and identifying new and payback computer applications. In the late 1980s, two new objectives emerged—identification of strategic IS applications and development of organisation wide information architecture. With the emergence of Strategic Information Systems, Information System Planning (ISP) has become increasingly an important issue for the business organisations.

The ISP helps organisations use IS in innovative ways to build barriers against new entrants, change the basis of competition, generate new products with built-in switching cost. As such ISP promotes innovation and creativity. On the other hand, ISP is also a process of identifying a portfolio of computer based applications to assist an organisation in executing its current business plans and thus realising its existing business goals. The distinction between the two approaches results in the former being referred to as attempting to impact organisational strategies and the latter as attempting to align MIS objectives with organisational goals.

Once the organisations plan for the information system solution, they need to get it developed. An information system development process is a structure imposed on the development of a software product. There are various methodologies that are being used by organisations and each methodology describes approaches to a variety of tasks or activities that take place during the process. A software development process is a structure imposed on the development of a software product. (Synonyms include software life cycle and software process.)

The information system development projects involve the creation of software applications or integrated application systems. The software development projects are completed in-house, through outsourcing, or by a combined approach. The organisations typically manage development projects using systematic methodologies that divide large, complex tasks into smaller, more easily managed segments or phases. Some of the development teams manage these projects as IT projects and some manage these as corporate strategy projects. There is always a difference between the two approaches of IS project development.

For many years relationship between information system functions and corporate strategy was not of much interest to Top Management of organisations. Till 1970s, Information Systems were thought to be synonymous with corporate data processing and treated as some back room operation in support of day-to-day mundane tasks. In the 80s and 90s, however, there has been a growing realisation of the need to make information systems of strategic importance to an organisation. Consequently, information systems planning (ISP) became a critical issue.

The planning for information systems, as for any other system, begins with the identification of needs. In order to be effective, development of any type of computer-based system should be a response to need—whether at the transaction processing level or at the more complex information and support systems levels. Such planning for information systems is much like strategic planning in management. The objectives, priorities, and authorisation for information systems projects need to be formalised. The systems development plan should identify specific projects slated for the future, priorities for each project and for resources, general procedures, and constraints for each application area. The plan must be specific enough to enable understanding of each application and to know where it stands in the order of development. Also, the plan should be flexible so that priorities can be adjusted if necessary. The researchers have argued that strategic capability architecture—a flexible and continuously improving infrastructure of organisational capabilities—is the primary basis for a company's sustainable competitive advantage. The ISP is the analysis of an organisation's information and processes using business information models together with the evaluation of risk, current needs, and requirements. The result is an action plan showing the desired course of events necessary to align information use and needs with

the strategic direction of the company. In today's context IS planning is being considered as a management function and not a technical one. There are different approaches to system planning which leads to system development.

Traditionally, many organisations used the systems development life cycle (SDLC) method to assist in developing software systems. The SDLC provided a satisfactory method to manage the projects because the functional and security requirements of the software were limited. The functional requirements were primarily limited to transaction processing and output reporting. The security requirements were limited because of the closed environment in which mainframes operated. The client/server systems provide significantly more users access to systems and data. Therefore, the need to develop software with greater functionality and stronger internal controls contributed to the development of alternative, risk focused software development techniques.

The alternative development techniques such as spiral, iterative, and modified SDLC methodologies involve the completion of project activities in repetitive (iterative) cycles. The techniques reduce project risks by ensuring the requirements of each user are considered during each project phase. Involving all parties during each project phase reduces the risk that organisations will not identify problems until late in a project's life cycle. The newer methodologies often employ prototyping or modelling techniques during initial project phases. This prototyping enhances user's ability to visualise how systems will look and work after the systems are installed.

The organisations also have established development standards that, address project management, system control, and quality assurance issues. The project management standards addresses issues such as project management methodologies, risk management procedures, and project approval authorities. The system control standards addresses items such as an application's functional, security, and automated control features. The quality assurance standard addresses issues such as the validation of project assumptions, adherence to project standards, and testing of a product's performance.

This development standards also include procedures for managing changes during the development process. 'Scope creep' is a common problem associated with software development projects. It occurs when developers receive requests to add or modify a program's features while the program is being developed. Although the addition or modification of functional, security, or control features may be appropriate, uncontrolled changes disrupt the development process. The establishing drive for change approval procedures and cut-off dates assist organisations manage change during the development process.

INFORMATION SYSTEM PLANNING (ISP)

In the information age, evaluation, prioritisation, and selection of information system projects are the major concerns of IS managers. As a matter of fact, no organisation has enough resources to meet all system projects' needs, nor are all the requests necessarily good ones. Also, most of the organisations are unable to match the IS plan with the business plan. Therefore, a method must be applied to prioritise system projects' requests based on the right criteria. This is done by initiating the Information System Planning (ISP) process. The ISP is the first stage in the system

development life cycle. ***The main purpose of ISP is to identify which information systems are needed rather than planning the details for any specific system.*** Also, to identify the new systems that are required keeping the business objectives in mind. It should also show the sequence in which they should be implemented.

The Information Systems Planning (ISP) is part of business planning that is concerned with developing the organisation's information systems resources.

The information systems planning should be an integral part of business planning. The Information systems planning is a major change for organisations, from planning for information systems based on users' demands to those based on business strategy. Also, an information system planning changes the planning characteristics in major ways. The major questions associated with information systems planning are related to the scope of the planning study, the focus of the planning exercise—corporate organisation versus strategic business unit, number of studies and their sequence, choosing an information system planning methodology or developing one if none is suitable, targets of planning process and deliverables. Owing to the complexity of the information systems planning process and uniqueness of each organisation, there is no single best way to tackle it.

Principles for IS Planning:

- Support the firm's business strategy with appropriate technical architecture
- Evaluate technology as a component of a larger system
- Recognise life cycle costs, not just acquisition costs
- Design information systems to be maintainable
- Recognize the human side of technology use
- Support and control the technical system

Some of the best known IS planning methods include IBM's Business Systems Planning (BSP), Strategic Systems Planning (SSP), Critical Success Factors (CSF), and End/Mean Analysis. Some of these methodologies help create and justify uses of IT, while some help in aligning IS objectives with organisational objectives and goals. Some of these methods deal with the challenging problem of determining the set of IS projects that require implementation within the planning horizon, but they do not provide structured, optimal solutions to the problem of setting up priorities. In other words, they fail to determine the order of project implementation. For example, the CSF method is based on factors which determine the success or failure of the organisation. The method involves: definition of organisational objectives, definition of success factors and measures for each, and analysis of the existing information systems. These components define the crucial subsystems, their interrelationships and the information types for each subsystem, but do not determine the order of subsystem implementation.

Four Stages of IS Planning

The organisations do IS planning because of various reasons. The broader set of activities that are performed as part of IS planning includes:

- Strategic Planning – Establishing the relationship between the overall organisational strategy and IS plan. In this the system team reviews the relevant business objectives, and tries to build information system architecture. It can be viewed as:
  - Understanding the Business Strategy – Where is the business going and why?
  - Defining the System Strategy – What is required?
  - Developing IT Strategy – How it can be delivered?
- Requirement Analysis – It involves identifying broad, organisational information requirements to establish strategic information system architecture. The Information Systems Architecture (ISA) provides a unifying framework with which various people with different perspectives can organise and view the fundamental building blocks of information systems.
  - ISA provides a "*context within which managers throughout the organisation can make consistent decisions concerning their information systems*".
  - The benefits of ISA include:
    - Provides a basis for strategic planning of IS
    - Provides a basis for communicating with top management and a context for budget decisions concerning IS
    - Provides a unifying concept for the various stakeholders in information systems
    - Communicates the overall direction for information technology and a context for decisions in this area
    - Helps achieve information integration when systems are distributed
    - Provides a basis for evaluating technology options (for example, downsizing and distributed processing)
- Resource Allocation – Allocating both IS application development resources and operational resources
- Project Planning – Developing a plan that details schedules and resource requirements for specific information system projects

The Information System Architecture is a conceptual blueprint or plan that expresses the desired future structure for information systems in an organisation.

IS Planning Methodologies

As defined earlier, number of IS planning methods are being followed by different organisations. As part of this chapter we try to explain some of the popular methods like Value Chain Models, Critical Success Factors (CSF), IBM's Business Systems Planning (BSP), Strategic Systems Planning (SSP), Information Engineering, Method/1 and End/Mean Analysis.

1. Value Chain Model. The concept of value chain has already been discussed in Chapter two. An important concept that highlights the role of information technology in competition is the 'Value Chain'. The basic concept is to understand the competitive advantage of any organisation, one cannot look at the organisation as a whole. It is necessary to identify the key activities being performed by an organisation to do business transactions. Each organisation is a collection of activities that add value to the final product or service being delivered to the customer.

As per Porter's Value Chain Model, the organisation's activities can be divided into nine generic activities. These nine activities are further classified as five Primary and four Secondary activities. Once the value chain is created, executives can rank the steps in order of importance to determine which activities are central to the strategic objectives of the organisation. Also, executives can then consider the interfaces between primary activities along the chain of production, and between support activities. This helps in identifying critical points of inter-departmental collaboration. Thus, value chain model:

- is a form of business activity analysis which deconstructs an enterprise into its parts. Information systems are derived from this analysis;
- helps in devising information systems which increase the overall profit available to a firm;
- helps in identifying the potential for mutual business advantages of component businesses, in the same or related industries, available from information interchange; and
- concentrates on value adding business activities and is independent of organisational structure.

The main strength of value chain analysis is that it concentrates on direct value adding activities of a firm and thus pitches information systems right into the domain of value adding rather than cost cutting. The value chain model only provides a higher level information model for an organisation and fails to address the developmental and implementation issues. Owing to its focus on internal operations instead of data, it fails to define a data structure for the firm. The value chain analysis, therefore, needs to be used in conjunction with some other methodology which addresses the development and implementation issues and defines a data structure.

2. Critical Success Factor (CSF). The critical success factors analysis is powerful and widely used IS planning methodology. ***The Critical Success Factors (CSF) in the context of ISP are used for interpreting more clearly the objectives, tactics, and operational activities in terms of key information needs of an organisation and its managers, and strengths and weaknesses of the organisation's existing systems.*** The CSF addresses the information needs of individual managers.

The CSF means "What has to go right to achieve a business goal?"

They represent the few key areas where things must go right for the business to flourish. Consequently, critical success factors are areas of activity that should receive constant and careful attention from management. The CSFs can exist at any level, i.e., industry, organisational, business unit, or manager. The CSFs at a lower level are derived from those at the preceding higher level. The CSF approach introduces information technology into the initial stages of the planning process and helps provide a realistic assessment of the IT's contribution to the organisation. To identify CSF:

- start with identifying the goals of the organisation;
- identify what are the CSFs supporting these goals;
- identify what decisions or actions are key to these CSFs;
- what variables are at the base of these decisions, and how they are measured; and
- what information systems can supply these measures.

Figure 13.1 shows that the CSFs can exist at various levels and one can follow a top down or bottom up approach. Figure 13.2 depicts the CSF identification and finalisation process, which can also be understood as:

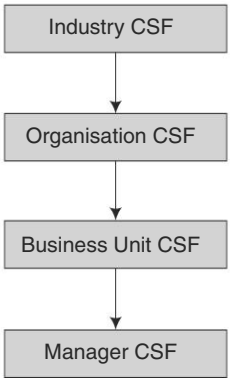

Figure 13.1 CSF Approach

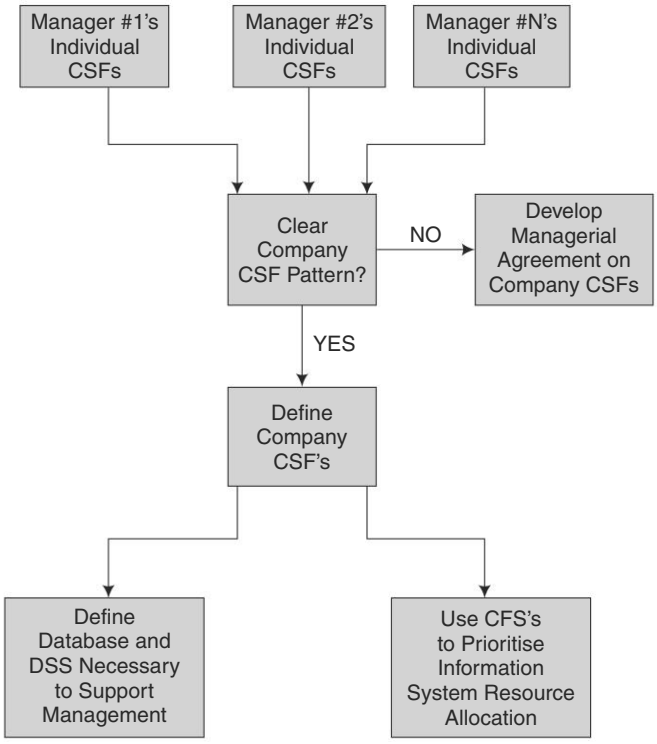

Figure 13.2 CSF Process

- Collect managers' CSfs
- Aggregate, analyse individuals' CSfs
- Develop agreement on Organisation CSfs
- Define company CSfs
- Use CSfs to develop information system priorities
- Define DSS & databases

The CSF analysis provides a very powerful method for concentrating on key information requirements of an organisation, a business unit, or of a manager. This allows the management to concentrate resources on developing information systems around these requirements. Also, CSF analysis is easy to perform and can be carried out with few resources. The CSF methodology enables individuals to determine their own CSFs. It focuses on relevant report generation and costly accumulation of unnecessary data is less. The emphasis is on effective control and monitoring of existing systems with changes being accommodated in the external environment.

Although, a useful and widely used technique, CSF analysis by itself is not enough to perform comprehensive ISP—it does not define data architecture or provides automated support for analysis. It focuses on individual needs rather than organisational needs. The CSFs focus primarily on management control and thus tend to be internally focused and it is analytical rather than creative. CSFs partly reflect a particular executive's management style. The use of CSFs as an aid in identifying systems, with the associated long lead times for developing these systems, may lead to giving executive information that s/he does not regard as important. The CSFs do not draw attention to the value-added aspect of information systems. While CSF analysis facilitates identification of information systems which meet the key information needs of an organisation/ business unit, the value derived from these systems is not assessed.

3. Business Systems Planning (BSP). ***This methodology was developed by IBM, combining top down planning with bottom up implementation. The methodology focuses on business processes which in turn are derived from an organisation's business mission, objectives, and goals.*** The business processes are analysed to determine data needs and, then, data classes. Similar data classes are combined to develop databases. The final BSP plan describes an overall information systems architecture as well as installation schedule of individual systems. The BSP identifies information needs that support both short and long term requirements. It helps to establish IS priorities that support business needs. It utilises number of matrixes to establish relationship among the organisation, its processes, its location, and data requirements. The interviews are also conducted to determine problems and priorities. The thrust of BSP is data planning. The methods include—identifying business processes, information requirements, and establishing data elements needs.

Since BSP combines a top down business analysis approach with a bottom up implementation strategy, it represents an integrated methodology. In its top down strategy, BSP is similar to CSF method in that it develops an overall understanding of business plans and supports IS needs through joint discussions. It gives a comprehensive view of the organisation. It involves number of managers and develops data architecture that supports IS development activities.

The Business System Planning (BSP) is a method for analysing, defining, and designing information architecture of organisations.

The BSP requires a firm commitment from the top management and their substantial involvement. It also requires a high degree of IT experience within the BSP planning team. It produces enormous amount of data besides being an expensive and time-consuming methodology. There is a problem of bridging the gap between top down planning and bottom up implementation. It does not incorporate a software design methodology.

4. Strategic Systems Planning (SSP). The Strategic System Planning methodology is quite similar to BSP. A business functional model is defined by analysing major functional areas of a business. The data architecture is derived from the business function model by combining information requirements into generic data entities and subject databases. The new systems and their implementation schedules are

The Strategic Systems Planning (SSP) is a method of studying an organisation's information needs, identify strategic opportunities, and develop a plan to address those information needs.

derived from this architecture. This architecture is then used to identify new systems and their implementation schedule. Although, steps in the SSP procedure are similar to those in the BSP, a major difference between SSP and BSP is SSP's automated handling of the data collected during the ISP process. The software produces reports in a wide range of formats and with various levels of detail. The affinity reports show the frequencies of accesses to data and clustering reports give guidance for database design. The users are guided through menus for online data collection and maintenance. The software also provides a data dictionary, interface for sharing SSP data with an existing data dictionary or other automated design tools. The steps followed in SSP approach is given in Figure 13.3.

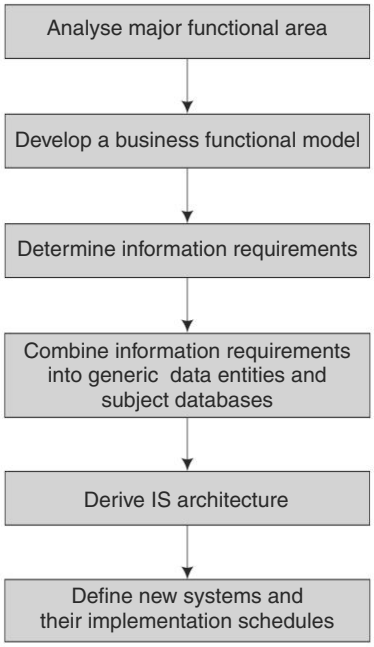

Figure 13.3 Steps Followed in SSP Methodology

5. Information Engineering (IE). This methodology provides techniques for building enterprise, data and process models. These models combine to form a comprehensive knowledge base which is used to create and maintain information systems. Basic philosophy underlying this technique is the use of structured techniques in all the tasks relating to planning, analysis, design and construction of enterprise wide information systems. Such structured techniques are expected to result in well-integrated information systems. IE relies on an information systems pyramid for an enterprise. The pyramid has three sides which represent the organisation's data, the activities the organisation carries out using the data and the technology that is employed in implementing information systems. The IE views all three aspects of information systems from a high-level, management oriented perspective at the top to a fully detailed implementation at the bottom. The pyramid describes the four levels of activities, namely strategy, analysis, systems design, and construction that involves data, activities, and technology.

The Information Engineering is an integrated methodology used to develop information systems within an organisation, starting with enterprise-wide strategic planning and ending with running an application.

A major difference between IE and other methodologies is the automated tools provided by IE to link its output to subsequent systems development efforts, which is the major strength of this methodology. The major weaknesses of IE have been identified as difficulty in securing top management commitment, difficulty in finding the team leader meeting criteria, too much user involvement and the planning exercise takes long time.

6. Method/1. Method/1 is a layered approach for IS planning. The top layer is the methodology itself, the middle layer is of techniques that support the methodology, and the bottom layer of

tools that supports the techniques. The techniques supported by this methodology include data flow diagramming, matrix analysis, functional decomposition, focus groups and Delphi studies. This methodology has five distinct objectives:

- To identify the organisation's information needs.
- To find new opportunities for using information to achieve competitive advantage.
- To define an overall IT strategy for satisfying the organisation's IT objectives.
- To define data, applications, technology, and organisational requirements for supporting the overall IT strategy.
- To define the activities needed to meet the above requirements and thereby implement the overall IT strategy.

This methodology incorporates the value chain analysis in its approach towards business and competitive assessment. The work segments of Method/1 methodology includes: Scope definition and organisation; business and competitive assessment; present state assessment; information technology opportunities; information technology strategies; organisational plan; data and application plan; technology plan; information action plan; product definition and planning.

7. End/Means Analysis. The purpose of End/Means analysis is to determine the effectiveness criteria for outputs and to specify efficiency criteria for processes used to generate outputs. Most of the IS planning methodologies do not focus on the effectiveness of end and efficiency of means. Most of the system developers focuses on integrating the end/means analysis along with one of the other IS planning methods. The End/Means analysis forces the organisation to answer the following six questions:

- What is the end/good/service provided by the business process?
- What makes these goods/services effective to the customers?
- What information is needed to evaluate that effectiveness?
- What are the key means/processes used to generate goods/services?
- What constitutes efficiency in providing these services?
- What information is needed to evaluate that efficiency?

DEVELOPING INFORMATION SYSTEM

Like any other set of products, information system products are also oriented towards the customer. It is either market driven or it drives the market. An information system development process is a structure imposed on the development of a software product. (Synonyms include software life cycle and software process.) ***The system development process is a set of activities, methods, best practices, deliverables, and automated tools that stakeholders use to develop and maintain information systems and software.***

The System Development Process is a set of methodologies, different phases of system development activities, and best practices that stakeholders use to develop and maintain information systems.

There are several models for such processes, each describing approaches to a variety of tasks or activities that take place during the process. The systems development life cycle is a project

management technique that divides complex projects into smaller, more easily managed segments or phases. The segmenting projects allows managers to verify the successful completion of project phases before allocating resources to subsequent phases. The **Systems Development Life Cycle (SDLC)** is the traditional systems development method used by organisations. The SDLC is a structured framework that consists of sequential processes by which information systems are developed. Each process consists of well-defined tasks.

The software development projects typically include initiation, planning, design, development, testing, implementation, and maintenance phases. However, the phases may be divided differently depending on the organisation involved. For example, initial project activities might be designated as request, requirements definition, and planning phases, or initiation, concept development, and planning phases. The end users of the system under development should be involved in reviewing the output of each phase to ensure the system is being built to deliver the needed functionality. One may also combine number of stages and try to define the system development project that includes only four stages as depicted in Figure 13.4 and described as follows:

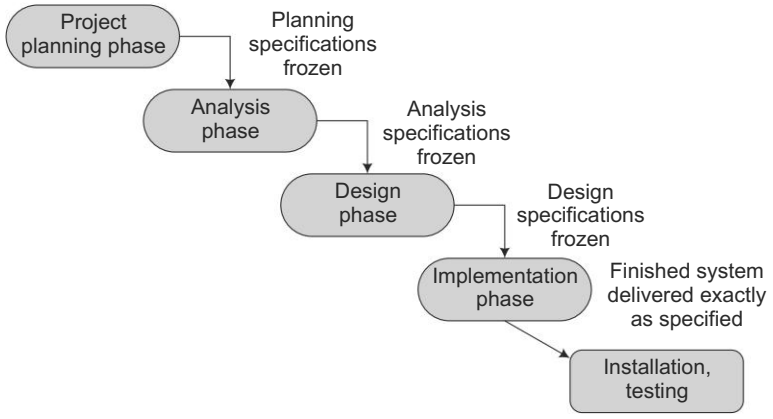

Figure 13.4 Steps in System Development

- **System initiation/planning:** The initial planning for a project is done to define initial business scope, goals, schedule, and budget.
- **System analysis:** The study of a business problem domain to recommend improvements and specify the business requirements and priorities for the solution.
- **System design:** The specification or construction of a technical, computer-based solution for the business requirements identified in a system analysis.
- **System implementation:** The construction, installation, testing, and delivery of a system for production.

The stages of SDLC are not fixed; some may use all the stages, whereas some may subdivide these four stages and create more. The flow of tasks, however, remains largely the same, regardless of the number of stages. In the early days of SDLC, system teams used the '**waterfall approach',**

in which tasks of SDLC are executed in a sequential manner. Over a period, this approach has changed and system teams started using iterative process and then a hybrid kind of approach. These different approaches of system development will be discussed later in the chapter.

Before one starts discussing the different stages of software development, let us try to understand why the information system projects are initiated and who initiates these projects. The system projects can be initiated by any one in the organisations. It need not always be by the owner of the organisation or the end user. It actually depends more on the identification of the need for the project. An organisation may initiate the system project because of one or more of the following reasons:

- There exists a problem either real or anticipated in the system or process that requires a corrective action. This can be identified by any one in the organisation.
- There exists an opportunity to improve a system or process despite the absence of complaints.
- There exists a directive to modify the system, or process may be because of business partners need or a directive from the regulator.

It is important for an organisation to formulate the information system development team, which is going to drive the project through all stages of SDLC. A team member of the software development team can be any person who has an interest in an existing, or proposed information system. For the successful development of the project, it is important to formulate the team which has following players:

- **System owners,** who sponsor the project and has clear understanding of the business objectives and goals. The owner is one who also has the power to take strategic decisions in terms of policies, structures and procedures.
- **System users,** who are going to use the system. The system user is an end user, or the user at the level where the actual work is performed.
- **System designers** are the ones who design the system to meet the users' requirements.
- **System builders** are the ones, who construct, test, and deliver the system.
- **Systems analysts** are the ones, who facilitate the development of information systems by bridging the communications gap that exists between end users, system owners and technical system designers, and builders.
- **IT vendors and consultants,** who sell hardware, software, and services to business organisations for implementation of their information systems solutions.

SYSTEM DEVELOPMENT PHASES

Depending on the system development methodology, software development project may be handled in a four stage process as explained in the previous section or may be divided into more stages. In order to understand the system development phases, we will discuss the seven stage model which includes initiation, planning/analysis, design, development, testing, implementation, and maintenance phases.

Initiation Phase

The software development initiation phase addresses the initial planning for a project to check the viability of the project and define initial business scope, goals, schedule, and budget. At this stage answer to the following basic questions are seeked:

- Is the project worth looking at?
- Is it going to meet the business objectives?

The initiation phase begins with answering these two questions and defining the baseline of the project by identifying the problems, opportunities, and directives. The information system request form is usually either filled by the end user or whosoever is initiating the project. The request form would have minimum details about the project in terms of: purpose of the project, urgency, visibility, expected benefits, and explain how the proposed system supports the organisation's business strategies. The proposal should also identify alternative solutions and detail as many informational, functional, and network requirements as possible.

The presentation of a business case proposal provides an opportunity to the system team to evaluate the proposal before they allocate resources for the formal feasibility study. When evaluating software development requests and during subsequent feasibility and design analysis, management should consider inputs from all affected parties. The management should also closely evaluate the necessity of each requested functional requirement. A single software feature approved during the initiation phase can require several design documents and hundreds of lines of code. It can also increase testing, documentation, and support requirements. Therefore, the initial rejection of unnecessary features can significantly reduce the resources required to complete a project.

If provisional approval to initiate a project is obtained, the request documentation serves as a starting point to conduct a more thorough feasibility study. The completion of a feasibility study requires the management to verify the accuracy of the preliminary assumptions and identify resource requirements in greater detail. At this basic level of feasibility analysis being carried out by the project team to access the "Is the project worth taking?" If yes, then the answer is "Is the project taking the same shape and form?" The system team normally tries to carry out the feasibility shortly in terms of economics, technology, operational, schedule, and scope. The primary issues organisations should consider when carrying out the feasibility study should include:

- Project Scope
  - Strategic business and technology goals and objectives;
  - Expected benefits measured against the value of current technology;
  - Potential organisational changes regarding facilities or the addition/reduction of end users, technicians, or managers;
  - Budget, scheduling, or personnel constraints;
  - Potential business, regulatory, or legal issues that could impact the feasibility of the project.

- Functional Requirement: It includes:
  - End user functional requirements;
  - Internal control and information security requirements;
  - Operating, database, and backup system requirements;
  - Connectivity requirements in terms of Local Area Network and Wide Area Network, external;
  - Interface requirements in terms of internal or external applications.
- Economic Factors: It includes:
  - Expected useful life of the proposed product;
  - Alternative solutions—buy versus build;
  - Non-recurring project costs in terms of personnel, hardware, software, and overhead;
  - Recurring operational costs for personnel, maintenance, telecommunications, and overhead;
  - Tangible benefits in terms of increased revenues, decreased costs, return on investments;
  - Intangible benefits for improved public opinions or more useful information.

The feasibility study document should provide an overview of the proposed project and identify expected costs and benefits in terms of economic, technical, and operational feasibility. The document should also describe alternative solutions and include a recommendation for approval or rejection. The document should be reviewed and signed by all affected parties. If approved, management should use the feasibility study and support documentation to begin the planning phase.

Planning/Analysis Phase

The planning phase of system development is one of the most critical steps in completing the project. In simple terms, this phase would include problem analysis, requirement analysis and decision analysis. In the problem analysis phase, the system team tries to understand the Problem Domain by analysing Problems and Opportunities. One may prepare the problem statement document, identifying the key problems, opportunities, objective for improvement and also identifying the constraints under which the project is to be developed. The system would analyse the business processes and establish the system improvement objectives. After a detailed review, the team might update or refine the project plan. Teams also tend to do cause and effect analysis, which is a technique in which problems are studied to determine their causes and effects. After this a detailed requirement analysis is carried out, where the focus is to identify and express the system requirements; to set the priority of the system requirements; to update the project plan and communicate the requirement statement. The requirement analysis is focused on:

- What capabilities should the new system provide for its users?
- What data must be captured and stored?
- What performance level is expected?

- What are the priorities of the various requirements?
- Requires decision about **What the system must do**, not how it should do those things.

A careful planning, particularly in the early stages of a project, is necessary to coordinate activities and manage project risks effectively. The depth and formality of project plans should be commensurate with the characteristics and risks of a given project. The project plans refine the information gathered during the initiation phase by further identifying the specific activities and resources required to complete a project. A critical part of a project manager's job is to coordinate discussions between all stakeholders of the system project including end user, audit, security, design, development, and network personnel to identify and document as many functional, non-functional, security, and network requirements as possible. The formal project plan is created by the system team, which should include:

- Project Overview—It provides an outline of the project plan—identify the project, project sponsors, project managers, project goals, background information, and development strategies.
- Roles and Responsibilities—The primary responsibilities of key personnel, including project sponsors, managers, and team members is defined. Additionally, project plans should also identify the responsibilities of third party vendors and internal audit, security, and network personnel.
- Defined Deliverables—The clearly defined expectations are a prerequisite for successfully completing projects. The system team with representatives from all departments involved in, or affected by, must define realistic project objectives, accurate informational, functional, and interface requirements, and objective acceptance criteria.
- Control Requirements—An essential part of the planning process involves designing and building automated control and security features into applications. Identifying all required features and exactly where they should be placed is not always possible during initial project phases. However, the system team should consider security and control issues throughout a project's life cycle and include those features in applications as soon as possible during a project's life cycle.
- Risk Management—Managing risks is an important part of the project planning process. Organisations should establish procedures to ensure managers appropriately assess, monitor, and manage internal and external risks throughout a project's life cycle. The procedures should include risk acceptance, mitigation, and/or transfer strategies.
- The external risks include issues such as vendor failures, regulatory changes, and natural disasters. The internal risks include items that affect budgets, such as inaccurate cost forecasting or changing functional requirements, scheduling difficulties, such as unexpected personnel changes or inaccurate development assumptions, and work flow challenges, such as weak communication or inexperienced project managers.
- Change Management—The personnel often request the addition or modification of functional requirements during software development projects. Although the addition or modification of requirements may be appropriate, standards should be in place to control changes in order to minimise disruptions to the development process. The project

managers should establish cut-off dates after which they defer changes requested to subsequent versions. Additionally, representatives from the same departments involved in establishing requirements should be involved in evaluating and approving proposed changes. Large, complex, or mission critical projects should include formal change management procedures.

- Standards—The project plans should reference applicable standards relating to project oversight activities, system controls, and quality assurance. The oversight standards should address project methodology selections, approval authorities, and risk management procedures. The system controls standards should address functional, security, and automated control requirements. The quality assurance standards should address the validity of project assumptions, adherence to project standards, and testing of a product's overall performance. The management should review, approve, and document deviations from established standards.
- Documentation—The project plans should identify the type and level of documentation personnel must produce during each project phase. For instance, personnel should document project objectives, system requirements, and development strategies during the initiation phase. The documentation should be revised as needed throughout the project.
- Scheduling—The system team should identify and schedule major project phases and the tasks to be completed within each phase. Owing to the uncertainties involved with estimating project requirements, management should build flexibility into project schedules. However, the amount of flexibility built into schedules should decline as projects progress and requirements become more defined.
- Budget—The system team should develop initial budget estimations of overall project costs so that they can determine if projects are feasible. The managers should monitor the budgets throughout a project and adjust them if needed; however, they should retain a baseline budget for post-project analysis. In addition to budgeting personnel expenses and outsourced activities, it is important to include the costs associated with project overhead such as office space, hardware, and software used during the project.
- Testing—The system team should develop testing plans that identify testing requirements and schedule testing procedures throughout the initial phases of a project. The end-users, designers, developers, and system technicians may be involved in the testing process.
- Staff Development—The system team should develop training plans that identify training requirements and schedule training procedures to ensure employees are able to use and maintain an application after implementation.

Once the system team completes the system planning, the system specifications are passed on to the design phase. All these stages of planning need to be managed using the project management utilities.

Design Phase

The design phase involves converting the informational, functional, and network requirements identified during the initiation and planning phases into unified design specifications that

developers use to script programmes during the development phase. The programme designs are constructed in various ways. Using a top down approach, designers first identify and link major program components and interfaces, then expand design layouts as they identify and link smaller subsystems and connections. Using a bottom up approach, designers first identify and link minor program components, and interfaces, then expand design layouts as they identify and link larger systems and connections.

Depending on the approach, the system team would design the Application Architecture. The system application architecture is a specification of the technologies to be used to implement information systems. It defines the technologies to be used to build the information system solution. The design phase also helps in designing the system databases, system interfaces, and design specifications. The system design is a blueprint to communicate the following design decisions:

- The degree to which the information system will be centralised or distributed.
- The distribution of stored data.
- The implementation technology for software to be developed in-house or outsourced.
- The integration of commercial off the shelf software.
- The technology to be used to implement the user interface.

There are different kinds of system modelling techniques, which are in use in different organisations.

As per the planning phase output, the system team would convert the logical model to the physical model. The logical models are those which represent a non-technical pictorial representation that depict what a system is or does. The physical model is a technical pictorial representation that depicts what a system is or does and how the system is implemented. At the design phase, selected logical model is converted into the physical model. The physical design is the translation of business user requirements into a system model that depicts a technical implementation of the users' business requirements. The two extreme philosophies of physical design are:

- *Design by specification.* The physical system models and detailed specification are produced as a series of computer-generated blueprints for construction.
- *Design by prototyping.* The incomplete but functioning applications or subsystems called *prototypes* are constructed and refined based on feedback from users and other designers.

The contemporary design techniques often use prototyping tools that build mock designs of items such as application screens, database layouts, and system architectures. The end users, designers, developers, database managers, and network administrators should review and refine the prototyped designs in an iterative process until they agree on an acceptable design. The audit, security, and quality assurance personnel should be involved in the review and approval process.

The system team should be particularly diligent when using prototyping tools to develop automated controls. The prototyping can enhance an organisation's ability to design, test, and establish controls. However, employees may be inclined to resist adding additional controls, even though they are needed, after the initial designs are established. The designers should carefully document completed designs. The detailed documentation enhances a programmer's ability to

develop programs and modify them after they are placed in production. The documentation also helps management ensure final programs are consistent with original goals and specifications. Thus organisations should create initial testing, conversion, implementation, and training plans during the design phase. Additionally, they should also draft user, operator, and maintenance manuals.

Application Control Standards. The application controls include policies and procedures associated with user activities and the automated controls designed into applications. The controls should be in place to address both batch and online environments. The standards should address procedures to ensure management appropriately approves with overriding control.

Designing appropriate security, audit, and automated controls into applications is a challenging task. Often, because of the complexity of data flows, program logic, client/server connections, and network interfaces, organisations cannot identify the exact type and placement of the features until interrelated functions are identified in the design and development phases. However, the security, integrity, and reliability of an application is enhanced if management considers security, audit, and automated control features at the start of a project and includes them as soon as possible in application and system designs. Adding controls late in the development process or when applications are in production is more expensive, time consuming, and usually results in less effective controls.

The standards should be in place to ensure end users, network administrators, auditors, and security personnel are appropriately involved during initial project phases. Their involvement enhances a project manager's ability to define and incorporate security, audit, and control requirements. The same groups should be involved throughout a project's life cycle to assist in refining and testing the features as projects progress.

The application control standards enhance the security, integrity, and reliability of automated systems by ensuring input, processed, and output information is authorised, accurate, complete, and secure. The controls are usually categorised as preventive, detective, or corrective. The preventive controls are designed to prevent unauthorised or invalid data entries.

Input Design and Controls. The input design helps the designer to identify the inputs; categorise the inputs in terms of variables, constants, etc.; finalisation of input content; layouts to accept input; form and screen design; and data capture modes. The input controls helps to ensure accurate input of information into the system. While doing so systems properly evaluate the inputs and records. Sometimes depending on the controls, system either rejects, or accepts and records. The examples of automated input controls include:

- Check Digits—The check digits are numbers produced by mathematical calculations performed on input data such as account numbers. The calculation confirms the accuracy of input by verifying the calculated number against other data in the input data, typically the final digit.
- Completeness Checks—The completeness checks confirm that blank fields are not input and that cumulative input matches control totals.
- Duplication Checks—The duplication checks confirm that duplicate information is not input.

- Limit Checks—The limit checks confirm that a value does not exceed predefined limits.
- Range Checks—The range checks confirm that a value is within a predefined range of parameters.
- Sequence Checks—The sequence checks confirm that a value is sequentially input or processed.
- Validity Checks—The validity checks confirm that a value conforms to valid input criteria.

Processing Controls. The automated processing controls help to ensure systems accurately process and record information. Depending on the processing controls, it may either reject, or process and record. The processing includes merging files, modifying data, updating master files, filtering data, and extracting data based on certain criteria and performing file maintenance. The examples of automated processing controls include:

- Batch Controls—The batch controls verify processed run totals against input control totals. The batches are verified against various items such as total sales in value, items, or documents processed.
- Error Reporting—The error reports identify items or batches that include errors. The items or batches with errors are withheld from processing, posted to a suspense account until corrected, or processed and flagged for later correction.
- Transaction Logs—The users verify logged transactions against source documents. The administrators use transaction logs to track errors, user actions, resource usage, and unauthorised access.
- Run-to-Run Totals—The run-to-run totals compiled during input, processing, and output stages are verified against each other.
- Sequence Checks—The sequence checks identify or reject missing or duplicate entries.
- Interim Files—The operators revert to automatically created interim files to validate the accuracy, validity, and completeness of processed data.
- Backup Files—The operators also revert to automatically created master-file backups if transaction processing corrupts the master file.

Output Design and Controls. The output design includes identification of outputs to be generated by the system; identification of output devices on which the output will be generated; content and layout of the output; sequence of output processing; copies and frequencies of each output; identification of users to whom the outputs will be circulated; and defining output controls. The automated output controls help ensure systems securely maintain and properly distribute processed information. The examples of automated output controls include:

- Batch Logs—The batch logs record batch totals. The recipients of distributed output verify the output against processed batch log totals.
- Distribution Controls—The distribution controls help ensure output is only distributed to authorised individuals. The automated distribution lists and access restrictions on information stored electronically or spooled to printers which are examples of distribution controls.

- Destruction Controls—The destruction controls help ensure electronically distributed and stored information is destroyed appropriately by overwriting outdated information or demagnetising disks and tapes.

Shortening Product Development Cycles

Polaris ports an application from Java to .NET environment and observes marked enhancement in productivity and lowered TCO.

The Polaris Software Lab provides integrated global technology solutions for the banking and financial sector. It offers specialty solutions and end-to-end suite of banking products in corporate, investment and retail banking. These products are developed using Service Oriented Architecture (SOA) framework.

The polaris develops a number of products in Java and Oracle. The company wanted to shorten product development cycles and reduce difficulties in customising solutions for customers. The polaris chose Intellect Collect, a web based collection and recovery solution for the financial services industry, as a test case. The Polaris' Intellect suite of products is based entirely on the J2EE platform. There was an impression within Polaris, reinforced by its customers that Microsoft platforms did not cope well under high volumes. Commenting on the reason of choosing this product for the test scenario, says, Jaideep Billa, CTO, "We also needed to benchmark data on developer productivity before porting more applications to the .NET platform. Therefore, we selected Intellect Collect as a test case to measure these parameters."

The developers were three times more productive working in the Microsoft environment than on the existing platform.

The company did not consider other vendors for developing an alternative platform since the products were already on the J2EE platform and therefore Microsoft was the first choice. "Our research and experience showed that banks preferred Microsoft as a platform requiring rich presentation interface such as in branch banking and collection systems," says Billa.

The developers ported the application from Java environment to the Microsoft.NET Framework 2 environment. This is an integral component of Windows operating system which provides a programming model and runtime for web services, web applications, and smart client applications.

For developing Intellect Collect.NET, developers used Visual Studio 2005 development system and worked with the Microsoft Visual C# development tool. This tool is designed to build enterprise applications that run on the .NET framework using SQL Server 2005 as database server.

"We started developing the Collect.NET project in August 2004. This was completed in a record time of four and a half months. The size of Collect.NET is 1936 Function Points (FP) and we achieved a productivity of 33 FP per person per month using .NET 2 and Visual Studio 2005," says Billa.

The website Collect.NET provides an all in one solution for improving collections and enhancing customer relationships. By using Collect.NET, companies can collect on multiple products and link collection cases for a single customer. It also helps collection agents make intelligent treatment decisions based on a customer's relationship with the organisation. The solution can be easily adapted to any collection strategy and provides modules and capabilities for supervisory control, resource allocation, and customised incentive plans.

The company has not launched the product as part of its Global Banking suite. However, says Billa, "We have built upon the product and launched it as part of our insurance suite and also closed some orders." As a test case, the porting project was a huge success. The developers were three times more productive working in Microsoft environment and development tools than on the existing platform. The website Collect.NET also delivered lower total cost of ownership than previous solutions.

At a Glance

Challenges

- Long product development and customisation cycles
- Product scalability issues affecting company's competitiveness

Solution

- The Polaris ported its collection and recovery solution, Intellect Collect, to Microsoft's .NET based technologies, using the Microsoft Visual Studio 2005 development system and Microsoft SQL Server 2005 database

Benefits

- Threefold increase in developer productivity
- Highly scalable and cost-effective solution
- Reduced time-to-market

Source: *Dataquest*, 28 Feb, 2007, Vol. XXV No. 04

Development Phase

The development phase involves converting design specifications into executable programs. The effective development standards include requirements that programmers and other project participants discuss design specifications before programming begins. The procedures help ensure programmers clearly understand program designs and functional requirements.

The programmers use various techniques to develop computer programs. The large transaction-oriented programmes associated with financial institutions have traditionally been developed using procedural programming techniques. Procedural programming involves the line-by-line scripting of logical instructions that are combined to form a program.

The primary procedural programming activities include the creation and testing of source code and the refinement and finalisation of test plans. Typically, individual programmers write and review program modules or components, which are small routines that perform a particular task within an application. The completed components are integrated with other components and reviewed, often by a group of programmers, to ensure the components properly interact. The process continues as component groups are progressively integrated and as interfaces between component groups and other systems are tested.

The advancements in programming techniques include the concept of 'object-oriented programming'. The object-oriented programming centres on the development of reusable programme routines (modules) and the classification of data types (numbers, letters, dollars, etc.) and data structures (records, files, tables, etc.). The linking of prescripted module objects to predefined data class objects reduces development times and makes programs easier to modify.

The organisations should complete testing plans during the development phase. Additionally, they should update conversion, implementation, and training plans and user, operator, and maintenance manuals.

Development Standards. The development standards should be in place to address the responsibilities of application and system programmers. The application programmers are

responsible for developing and maintaining end user applications. The system programmers are responsible for developing and maintaining internal and open source operating system programmes that link application programs to system software and subsequently to hardware. The managers should thoroughly understand development and production environments to ensure they appropriately assign programmer responsibilities.

The development standards should prohibit a programmer's access to data, programs, utilities, and systems outside their individual responsibilities. The library controls can be used to manage access to, and the movement of programs between, development, testing, and production environments. The management should also establish standards requiring programmers to document completed programs and test results thoroughly. The appropriate documentation enhances a programmer's ability to correct programming errors and modify production programs.

Library Controls. The libraries are collections of stored documentation, programs, and data. The program libraries include reusable program routines, or modules stored in source or object code formats. The program libraries allow programmers to access frequently used routines and add them to programs without having to rewrite the code. The dynamic link libraries include executable code programs which can automatically run as part of larger applications. The automated Password Controls—establish logical access controls for all libraries or objects within libraries. The establishing controls on individual objects within libraries can create security administration burdens. However, if similar objects, executable and non-executable routine test and production data, etc. are grouped into separate libraries, access can be granted at library levels.

Version Controls. The library controls facilitate software version controls. Version controls provide a means to systematically retain chronological copies of revised programs and programs documentation. The development version control systems, also known as concurrent version systems, assist organisations in tracking different versions of source code during development. The systems do not simply identify and store multiple versions of source code files; they also maintain the changes carried out in another file. When a user requests a particular version, the system recreates that version. The concurrent version systems facilitate the quick identification of programming errors. For example, if programmers install a revised program on a test server and discover programming errors, they only have to review the changed code to identify the error.

Software Documentation. The organisations should maintain detailed documentation for each application and application system in production. A thorough documentation enhances an organisation's ability to understand functional, security, and control features and improves its ability to use and maintain the software. The documentation should contain detailed application descriptions, programming documentation, and operating instructions. The standards should be in place that identify the type and format of required documentation such as system narratives, flow charts, and any special system coding, internal controls, or file layouts not identified within individual application documentation.

The system team should maintain documentation for internally developed programs and externally acquired products. In the case of acquired software, the system team should ensure either through an internal review or third party certification prior to purchase, that an acquired product's documentation meets their organisation's minimum documentation standards.

The system documentation should include:

- System Descriptions—The system descriptions provide narrative explanations of operating environments and the interrelated input, processing, and output functions of integrated application systems.
- System File Layouts—The system file layouts describe collections of related records generated by individual processing applications. For example, personnel may need system file layouts to describe interim files, such as sorted deposit transaction files, in order to further define master file processing requirements.
- Program Documentation—The program documentation details specific data input, processing, and output instructions, and should include documentation on system security. The program listings/source code and related narrative comments are the most basic items in program documentation and consist of technical programming scripts and non-technical descriptions of the scripts. It is important that developers update the listings and comment documentation when they modify programs. There are many software development tools available that automatically create source listings and narrative descriptions. Traditionally, designers and developers have used flow charts to present pictorial views of the sequencing of procedural programs. The flow charts provide a practical way to illustrate complex programs and routines. The flow charting software is available that can automatically chart programs or enable programmers to chart programs dynamically without the need to draw them manually. The programming techniques, such as object oriented programming, have contributed to the use of dynamic flow charting products. The maintaining of detailed documentation of object oriented code is particularly important because a primary benefit of the programming technique is the reuse of program objects.
- Naming Conventions—The naming conventions are a critical part of program documentation. The software programs are comprised of many lines of code, usually arranged hierarchically into small groups of code (modules, subroutines, or components), that perform individual functions within an application. The programmers should name and document the modules and any related subroutines, databases, or programs that interact with an application. The standardised naming conventions allow programmers to link subroutines into a unified program efficiently and facilitate technicians' and programmers' ability to understand and modify programms.
- End User Instructions—The system team should establish end user instructions that describe how to use an application. The operation manuals, online help features, and system error messages are forms of instructions that assist individuals in using applications and responding to problems.

Testing Phase

The testing phase requires organisations to complete various tests to ensure the accuracy of programmed code, the inclusion of expected functionality, and the interoperability of applications and other network components. A thorough testing is critical that ensures systems meet organisational and end user requirements.

If organisations use effective project management techniques, they will complete test plans while developing applications, prior to entering the testing phase. The weak project management techniques, or demands to complete projects quickly may pressure organisations to develop test plans at the start of the testing phase. The test plans created during initial project phases enhance an organisation's ability to create detailed tests. The use of detailed test plans significantly increases the likelihood that testers will identify weaknesses before products are implemented.

The testing groups are comprised of technicians and end users who are responsible for assembling and loading representative test data into a testing environment. The groups typically perform tests in stages, either from a top down or bottom up approach. A bottom up approach tests smaller components first and progressively adds and tests additional components and systems. A top down approach first tests major components and connections and progressively tests smaller components and connections. The progression and definitions of completed tests vary between organisations.

The bottom up tests often begin with functional (requirements based) testing. The functional tests should ensure that expected functional, security, and internal control features are present and operating properly. The testers then complete integration and end-to-end testing to ensure application and system components interact properly. The users then conduct acceptance tests to ensure systems meet defined acceptance criteria.

The testers often identify program defects, or weaknesses during the testing process. Procedures should be in place to ensure programmers correct defects quickly and document all corrections or modifications. The correcting problems quickly increases testing efficiencies by decreasing testers' downtime. It also ensures a programmer does not waste time trying to debug a portion of a program without defects that is not working because another programmer has not debugged a defective linked routine. The documenting corrections and modifications is necessary to maintain the integrity of the overall program documentation.

The organisations should review and complete user, operator, and maintenance manuals during the testing phase. Additionally, they should finalise conversion, implementation, and training plans.

The primary testing techniques include:

- Acceptance Testing—The end users perform acceptance tests to assess the overall functionality and interoperability of an application.
- Alpha testing is done in a simulated environment using simulated data. It checks for errors and omissions regarding end use and design specifications.
- Audit testing certifies that the system is free from errors and is ready to be placed into operation.
- End to End Testing—The end users and system technicians perform end to end tests to assess the interoperability of an application and other system components such as databases, hardware, software, or communication devices.
- Functional Testing—The end users perform functional tests to assess the operability of a program against predefined requirements. The functional tests include black box tests, which assess the operational functionality of a feature against predefined expectations, or white box tests, which assess the functionality of a feature's code.

- Integration Testing—The end users and system technicians perform integration tests to assess the interfaces of integrated software components.
- Parallel Testing—The end users perform parallel tests to compare the output of a new application against a similar, often the original, application.
- Regression Testing—The end users retest applications to assess functionality after programmers make code changes to previously tested applications.
- Stress Testing—The technicians perform stress tests to assess the maximum limits of an application.
- String Testing—The programmers perform string tests to assess the functionality of related code modules.
- System Testing—The technicians perform system tests to assess the functionality of an entire system. A test performed on the final system enables users conduct verification, validation, and audit test. It uses real data over an extended time period.
- Unit Testing—The programmers perform unit tests to assess the functionality of small modules of code.
- The verification testing runs the system in a simulated environment using simulated data.
- The validation testing runs the system in a live environment using real data.

Implementation Phase

The implementation phase involves installing approved applications into production environments. The primary tasks include announcing the implementation schedule, training end users, and installing the product. Additionally, organisations should input and verify data, configure and test system and security parameters, and conduct post implementation reviews. The system team should circulate implementation schedules to all affected parties and should notify users of any implementation responsibilities.

At the system implementation phase, the system team plans on how to convert from old system to new system by getting answers to—how to install and populate databases; how to train users; finalise documentation; and finalise conversion issues. Once the system conversion takes place, new system databases are populated with existing data from old system. Generally, they have to restructure data as it is populated and must confirm that data is translated correctly. The system users are trained and provided with documentation. Ownership is transferred from analysts and builders to end users.

The different system conversion techniques that are used are:

- **Direct cutover:** In this implementation strategy, the new system is fully tested and on the pre specified date and time the old system is replaced with the new system.
- **Parallel implementation strategy:** In this the new system is implemented and executed in a parallel fashion for a pre defined period and testing is done on live data.
- **Location implementation strategy:** In this the new system is implemented location by location instead of the entire organisation.
- **Phased implementation strategy:** In this the new system is implemented in phases, which are dependent either on location, or on functionality.

After organisations install a product, pre-existing data is manually input or electronically transferred to a new system. The verification of the accuracy of the input data and security configurations is a critical part of the implementation process. The organisations often run a new system in parallel with an old system until they verify the accuracy and reliability of the new system. The employees should document any programming, procedural, or configuration changes made during the verification process.

Project Evaluation: The system team should conduct post implementation reviews at the end of a project to validate the completion of project objectives and assess project management activities. The management should interview all personnel actively involved in the operational use of a product and document and address any identified problems.

The management should analyse the effectiveness of project management activities by comparing, among other things, planned and actual costs, benefits, and development times. They should document the results and present them to the senior management. The senior management should be informed of any operational or project management deficiencies.

Maintenance Phase

The maintenance phase involves making changes to hardware, software, and documentation to support its operational effectiveness. It includes making changes to improve a system's performance, correct problems, enhance security, or address user requirements. In order to ensure modifications do not disrupt operations or degrade a system's performance or security. The organisations should establish appropriate change management standards and procedures.

The change management sometimes referred to as configuration management involves establishing baseline versions of products, services, and procedures and ensuring all changes are approved, documented, and disseminated. The change controls should address all aspects of an organisation's technology environment including software programs, hardware and software configurations, operational standards and procedures, and project management activities. The system team should establish change controls that address major, routine, and emergency software modifications and software patches.

The major modifications involve significant changes to a system's functionality. The system team should implement major modifications using a well-structured process, such as an SDLC methodology. The routine changes are not as complex as major modifications and can usually be implemented in the normal course of business. The routine change controls should include procedures for requesting, evaluating, approving, testing, installing, and documenting software modifications.

The emergency changes may address an issue that would normally be considered routine, however, because of security concerns or processing problems, the changes must be made quickly. The emergency change controls should include the same procedures as routine change controls. The system team should establish abbreviated request, evaluation, and approval procedures to ensure they can implement changes quickly. The detailed evaluations and documentation of emergency changes should be completed as soon as possible after changes are implemented. The system team should test routine and, whenever possible, emergency changes prior to implementation, and quickly notify affected parties of all changes. If the system team is unable to thoroughly test

emergency modifications before installation, it is critical that they appropriately backup files and programs and have established back-out procedures in place.

The software patches are similar in complexity to routine modifications. This document uses the term 'patch' to describe program modifications involving externally developed software packages. However, organisations with in-house programming may also refer to routine software modifications as patches. **The patch management** programs should address procedures for evaluating, approving, testing, installing, and documenting software modifications. However, a critical part of the patch management process involves maintaining an awareness of external vulnerabilities and available patches.

The maintaining of accurate, up-to-date hardware and software inventories is a critical part of all change management processes. The management should carefully document all modifications to ensure accurate system inventories. The management should also coordinate all technology related changes through an oversight committee and assign responsibility to an appropriate party for administering software patch management programs. Add to that the quality assurance, security, audit, regulatory compliance, network, and end user personnel should be appropriately included in change management processes. The risk and security review should be done, whenever a system modification is implemented to ensure controls remain in place.

SYSTEM DEVELOPMENT METHODOLOGIES

The system development methodology is a standardised development process that defines a set of activities, methods, best practices, deliverables, and automated tools that system developers and project managers may use to develop and continuously improve information systems and software. These methodologies ensure:

- Consistent, reproducible approach to all projects
- Reduced risk associated with shortcuts
- Complete and consistent documentation
- Standardisation of process
- All development teams can constantly change

The System Development Methodology is a framework that is used to structure, plan, and control the process of developing an information system.

It is an old objective to find repeatable, predictable processes, or methodologies that improve productivity and quality. Some try to systematise or formalise the seemingly unruly task of writing software. Others apply project management techniques to writing software. Without project management, software projects can easily have delayed delivery or exceed budget. With large numbers of software projects not meeting their expectations in terms of functionality, cost, or delivery schedule, effective project management is proving difficult. The following are some basic, popular models that are adopted by many software development firms:

- Waterfall Model
- Prototyping Model
- Rapid Application Development Model
- Extreme Programming
- Component Assembly Model

Waterfall Model

This is also known as Classic Life Cycle Model, (or) Linear Sequential Model, (or) Waterfall Model. The best known and oldest process is the waterfall model, where developers follow these steps in a sequential order. All projects can be managed better when segmented into a hierarchy of chunks such as phases, stages, activities, tasks, and steps. In system development projects, the simplest interpretation of this is called the 'waterfall' methodology, as shown in Figure 13.5.

The waterfall model is a system development method that is linear and sequential and has distinct goals for each phase of development.

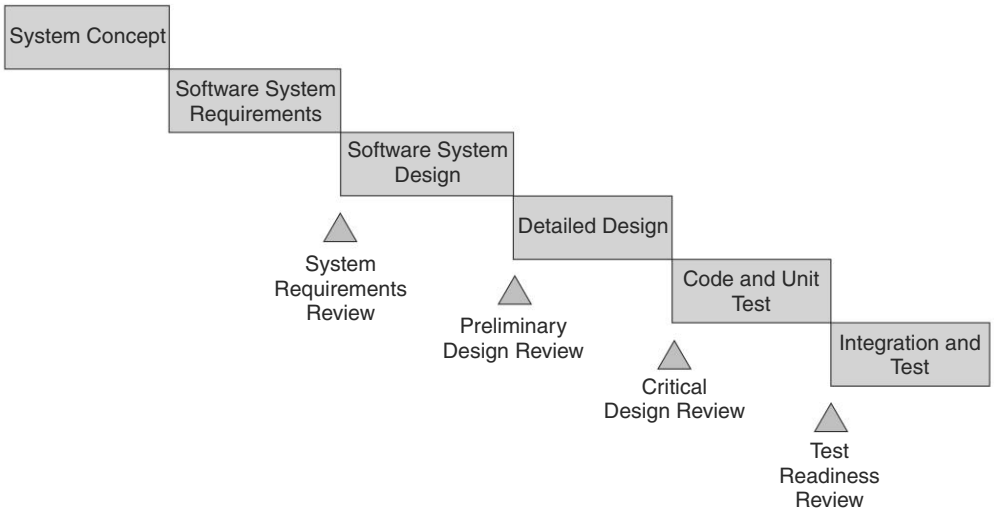

Figure 13.5 Waterfall Model

If one looks at the figure, it is clear that each step of the system development is completed before the next step is started. Nevertheless, the model illustrates a few critical principles of a good methodology:

- Work is done in stages
- Content reviews are conducted between stages, and
- Reviews represent quality gates and decision points for continuing.

The waterfall provides an orderly sequence of development steps and helps ensure the adequacy of documentation and design reviews to ensure the quality, reliability, and maintainability of the developed software.

Prototyping Model

This is a cyclic version of the linear model. In this model, once the requirement analysis is done and the design for a prototype is made, the development process gets started. Once the prototype is

created, it is given to the customer for evaluation. The customer tests the package and gives his/her feedback to the developer who refines the product according to the customer's exact expectation. After a finite number of iterations, the final software package is given to the customer. In this methodology, the software is evolved as a result of periodic shuttling of information between the customer and developer. This is the most popular development model in the contemporary IT industry. This model works best in scenarios where not all of the project requirements are known in detail ahead of time. It is an iterative, trial-and-error process that takes place between the developers and the users. There are many variations of this model skewed with respect to the project management styles of the companies. The new versions of a software product evolve as a result of this prototyping.

The prototyping model is built, tested, and then reworked as necessary until an acceptable solution is finally achieved from which the complete system can be developed.

While the waterfall methodology offers an orderly structure for software development, demands for reduced time-to-market makes its series steps inappropriate. The next evolutionary step from the waterfall is where the various steps are staged for multiple deliveries or handoffs. The ultimate evolution from the waterfall is the spiral. Taking advantage of the fact that development projects work best when they are both incremental and iterative, where the team is able to start small and benefit from enlightened trial and error along the way.

The spiral methodology reflects the relationship of tasks with rapid prototyping, increased parallelism, and concurrency in design, and build activities. The spiral method should still be planned methodically, with tasks and deliverables identified for each step in the spiral. Figure 13.6 describes the spiral methodology.

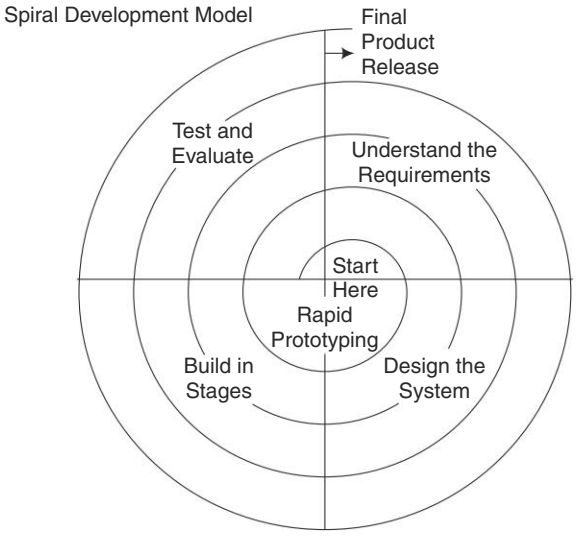

Figure 13.6 Spiral Methodology

Extreme Programming

The Extreme Programming (XP), is the best known agile process. In XP, the phases are carried out in extremely small or 'continuous' steps compared to the older, 'batch' processes. The intentionally incomplete first pass through the steps which might take a day or a week, rather than the months or years of each complete step in the Waterfall model. First, one writes automated tests, to provide concrete goals for development. Next is coding, which is complete when all the tests pass, and the programmers cannot think of any more tests that are needed. The design and architecture emerge out of refractory, and come after coding. The design is done by the same people who do the coding. The incomplete but functional system is deployed or demonstrated for the users. At this point, the practitioners start again on writing tests for the next most important part of the system.

The Extreme Programming (XP) is an intense and agile software development methodology focusing on coding within each stage of SDLC.

While iterative development approaches have their advantages, software architects are still faced with the challenge of creating a reliable foundation upon which to develop. Such a foundation often requires a fair amount of upfront analysis and prototyping to build a development model. The development model often relies upon specific design patterns and entity relationship diagrams (ERD). Without this upfront foundation, iterative development can create long-term challenges that are significant in terms of cost and quality.

Rapid Application Development Model

The Rapid Application Development (RAD) model is a linear sequential software development process that emphasises an extremely short development cycle. The RAD model is a 'high speed' adaptation of the linear sequential model in which rapid development is achieved by using a component based construction approach. It is used primarily for information systems applications. The RAD approach encompasses the following phases:

The RAD is a system development model that enables system team to quickly build working system.

Business modelling The information flow among business functions is modelled in a way that answers the following questions:

- What information drives the business process?
- What information is generated?
- Who generates it?
- Where does the information go?
- Who processes it?

Data modelling The information flow defined as part of the business modelling phase is refined into a set of data objects that are needed to support the business. The characteristic called attributes of each object is identified and the relationships between these objects are defined. The common tool used to do data modelling is entity relationship diagrams (ERD).

Process modelling The data objects defined in the data modelling phase are transformed to achieve the information flow necessary to implement a business function. Then processing the descriptions which are created for adding, modifying, deleting, or retrieving a data object. The common tool used to do the process modelling is data flow diagrams (DFD).

Application generation The RAD model assumes the use of the RAD tools like VB, VC++, Delphi, etc. rather than creating software using conventional third generation programming languages. The RAD model works to reuse existing program components (when possible), or create reusable components (when necessary). In all cases, automated tools are used to facilitate construction of the software.

Testing and turnover Since the RAD process emphasises reuse, many of the program components have already been tested. This minimises the testing and development time.

Component Assembly Model

Object technologies provide the technical framework for a component-based process model for software development. The object oriented paradigm emphasises the creation of classes that encapsulate both data and the algorithm that are used to manipulate the data. If properly designed and implemented, object oriented classes are reusable across different applications and computer based system architectures. Component Assembly Model leads to software reusability. The integration/assembly of the already existing software components accelerates the development process. Nowadays, many component libraries are available on the Internet. If the right components are chosen, the integration aspect is made much simpler.

- Use of object-oriented technology
- Components-classes that encapsulate both data and algorithms
- Components developed to be reusable
- Paradigm similar to spiral model, but engineering activity involves components
- System produced by assembling the correct components

Computer-aided Software Engineering

Computer-aided Software Engineering (CASE)—the use of automated software tools that support the drawing and analysis of system models and associated specifications. Some CASE tools also provide prototyping and code generation capabilities. Some CASE tools can even work backward, modifying the model after modifying the coding. CASE tools provide advantages for systems developers. These tools can produce systems with a longer effective operational life that meet more closely user requirements. CASE tools can speed up the development process and result in systems that are more flexible and adaptable to changing business conditions. Systems produced using CASE tools typically have excellent documentation. The CASE tools are difficult to customise and may be difficult to use with existing systems. Some of the common CASE tools are: Computer Associate's ERWIN, Oracle's Designer 2000, Popkin's System Architect, Rational Rose, and Visible System's Visible Analyst.

HSBC: Making IT Dynamic

The implementation of Microsoft Dynamics NAV not only improved the workflow at HSBC's software centre but also enhanced its productivity.

HSBC Software Development India (HSDI) was created in India in April 2002 with the objective of providing software solutions and services to the HSBC Bank worldwide. Since setting up the software centre in Pune, in the span of four years, its strength has grown to more than 3,500 associates. HSDI has grown in size and experience, and has been successful in achieving SEI CMMi Level 5 certification for software processes.

HSDI had to generate various MIS reports on a real-time basis. "We were looking for a single application to take control of our international and domestic operations," recalls Vishal Jadhav, assistant manager finance, HSBC Software Development (India). The company required an easy to use ERP application to manage its day-to-day business processes, with an established Indian localisation and appropriate monitoring facilities. In order to meet the growing needs of HSBC globally and to streamline its internal business processes, the company evaluated various software solutions like SAP, PeopleSoft, and Sun Solaris based solutions before settling on Microsoft Dynamics NAV version 4.0.

The implementation by Ontrack Systems, a Microsoft Dynamics Partner, did not require any additional hardware, software or networking infrastructure investments. The implementation, inclusive of training and deployment, was completed in one month. This was followed by a month of hand-holding support.

HSDI implemented fixed assets management with bar code tracking. With the help of a portable data capturing unit, directly interfaced with Microsoft Dynamics NAV 4.0, it is now possible to scan, upload and reconcile the bar-code encrypted fixed assets on a real-time basis. Earlier the entire payment and cash cycles were tracked manually. The system now tracks them automatically. For example, vendor payments were maintained on the old system but there was no possibility of getting a report. With NAV this can be provided in minutes.

Prior to the implementation of Microsoft Dynamics NAV 4.0, most of the reporting was done using Microsoft Office Excel 2003. This is now automatically generated from the ERP solution. Records of employee reimbursements were also maintained in Excel worksheets, and the billing was derived from it. Now, the company is able to tag the reimbursable expenses during the initial stages of the expenses being incurred. This automates the billing system on a real-time basis, with due adjustment of reimbursable expenses.

Customer ageing reports have now become real time, with Microsoft Dynamics NAV. The detailed reports about reimbursements from customers is now a boon to the finance team. The Dynamics NAV 4.0 facilitates faster report generation and provides senior management ready access to daily reports. Features such as Analysis by Dimensions and Account Schedule Reporting have been a major enhancement. HDIS is able to generate reports on the fly such as real time Profit and Loss (P and L), department wise income statements, advances, etc.

The ease of implementation strategy has resulted in an effortless and reduced project roll out. Dynamics NAV is easy to implement, thereby reducing deployment and customisation requirements considerably. Improved financial management has been another major benefit; it is a central application area of Microsoft Dynamics NAV, where all financial information is posted, summarised and reported. "With the implementation of Microsoft® Dynamics NAV 4.0, we are now able to calculate the fixed asset depreciation of more than 4,000 assets within 5–7 minutes. This is a significant achievement for us," Jadhav elucidates.

At a Glance

Challenges

- Streamlining the internal business processes
- Identifying suitable monitoring facilities so as to avoid delays in report generation

Solution

- Microsoft Dynamics NAV 4.0

Benefits

- Automated procedures to improve workflow
- Consolidated approach for all cash transactions
- Complete audit trails generated
- Reports made using historical data
- Project roll out time reduced by 50 per cent

Source: *Dataquest*, 28 Feb, 2007, Vol. XXV No. 04

CAPABILITY MATURITY MODEL INTEGRATION

The Capability Maturity Model Integration (CMMI) broadly refers to a process improvement approach that is based on a process model. The Capability Maturity Model (CMM) refers specifically to the first such model, developed by the Software Engineering Institute (SEI) in the mid-1980s, as well as the family of process models that followed. A process model is a structured collection of practices that describe the characteristics of effective processes; the practices included are those proven by experience to be effective.

The CMMI (Capability Maturity Model Integration) is a proven industry framework to improve product quality and development efficiency for both hardware and software performance.

The CMMI can be used to assess an organisation against a scale of five process maturity levels. Each level ranks the organisation according to its standardisation of processes in the subject area being assessed. The subject areas can be as diverse as software engineering, systems engineering, project management, risk management, system acquisition, information technology (IT) services, and personnel management.

A maturity model can be used as a benchmark for assessing different organisations for equivalent comparison. It describes the maturity of the company based upon the project the company is dealing with and the clients.

The model identifies five levels of process maturity for an organisation. Within each of these maturity levels are Key Process Areas (KPAs), which characterise that level, and for each KPA there are five definitions identified:

- Goals
- Commitment
- Ability

- Measurement
- Verification

The KPAs are not necessarily unique to CMMI, representing—as they do—the stages that organisations must go through on the way to becoming mature.

The CMMI is the designated successor of the three source model CMM. The five levels of CMMI are shown in figure 13.7 and is described below:

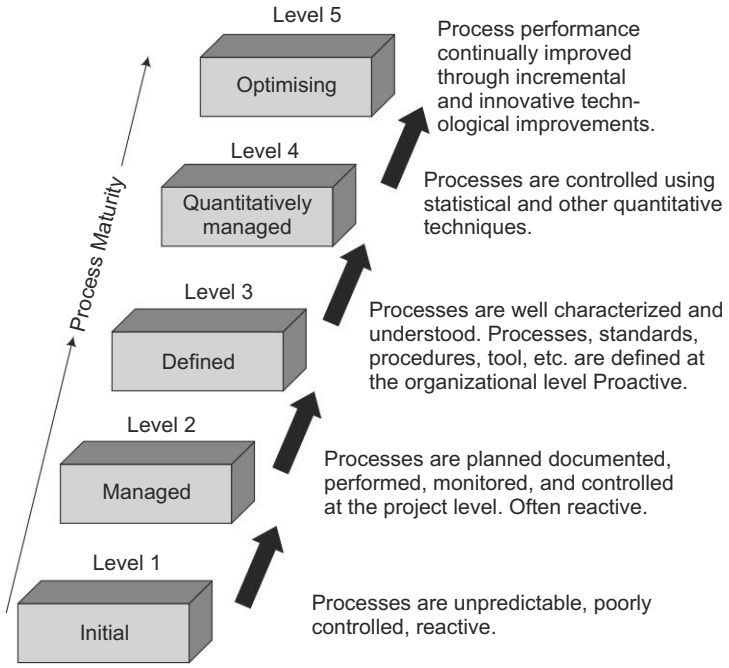

Figure 13.7 CMMI Five Stage Maturity Levels

Level 1—Initial

The processes are usually ad hoc and the organisation usually does not provide a stable environment. The success in these organisations depends on the competence of the people in the organisation and not on the use of proven processes. In spite of this ad hoc, chaotic environment, maturity level 1 organisations often produce products and services that work; however, they frequently exceed the budget and schedule of their projects.

The success of software project depends on having quality people.

Level 2—Repeatable

The software development successes are repeatable. The processes may not require repeating for all the projects in the organisation. The organisation may use some basic project management to track cost and schedule. The process discipline helps ensure that existing practices are retained

during times of stress. When these practices are in place, projects are performed and managed according to their documented plans.

The basic project management processes are established to track cost, schedule, and functionality. The minimum process discipline is in place to repeat earlier successes on projects with similar applications and scope. There is still a significant risk of exceeding cost and time estimate.

Level 3—Defined

The organisation's set of standard processes, which is the basis for level 3, is established and improved over time. These standard processes are used to establish consistency across the organisation. The projects establish their defined processes by the organisation's set of standard processes according to tailoring guidelines.

The organisation's management establishes process objectives based on the organisation's set of standard processes and ensures that these objectives are appropriately addressed. A critical distinction between level 2 and level 3 is the scope of standards, process descriptions, and procedures. At level 2, the standards, process descriptions, and procedures may be quite different for each specific instance of the process. At level 3, the standards, process descriptions, and procedures for a project are tailored from the organisation's set of standard processes to suit a particular project or organisational unit.

Level 4—Managed

Using precise measurements, management can effectively control the software development effort. In particular, management can identify ways to adjust and adapt the process to particular projects without measurable losses of quality or deviations from specifications. At this level organisations set a quantitative quality goal for both software process and software maintenance.

The sub-processes are selected that significantly contribute to overall process performance. These selected sub-processes are controlled using statistical and other quantitative techniques. A critical distinction between maturity level 3 and maturity level 4 is the predictability of process performance. At maturity level 4, the performance of processes is controlled using statistical and other quantitative techniques, and is quantitatively predictable. At maturity level 3, processes are only qualitatively predictable.

Level 5—Optimising

The Level 5 focuses on continually improving process performance through both incremental and innovative technological improvements. The quantitative process improvement objectives for the organisation are established and continually revised to reflect changing business objectives, and used as criteria in managing process improvement. The effects of deployed process improvements are measured and evaluated against the quantitative process improvement objectives. Both the defined processes and the organisation's set of standard processes are targets of measurable improvement activities.

The process improvements to address common causes of process variation and to measurably improve the organisation's processes are identified, evaluated, and deployed. The optimising processes that are nimble, adaptable and innovative depends on the participation of an empowered workforce aligned with the business values and objectives of the organisation. The organisation's ability to rapidly respond to changes and opportunities is enhanced by finding ways to accelerate and share learning.

A critical distinction between maturity level 4 and maturity level 5 is the type of process variation addressed. At maturity level 4, processes are concerned with addressing special causes of process variation and providing statistical predictability of the results. Though processes may produce predictable results, the results may be insufficient to achieve the established objectives. At maturity level 5, processes are concerned with addressing common causes of process variation and changing the process to improve process performance while maintaining statistical probability to achieve the established quantitative process improvement objectives.

CMMI Components

- Within each of the 5 Maturity Levels, there are basic functions that need to be performed – these are called Process Areas (PAs).
- For Maturity Level 2 there are 7 Process Areas that must be completely satisfied.
- For Maturity Level 3 there are 11 Process Areas that must be completely satisfied.
- Given the interactions and overlap, it becomes more efficient to work the Maturity Levels 2 and 3 issues concurrently.
- Within each PA there are Goals to be achieved and within each Goal there are Practices, work products, etc. to be followed that will support each of the Goals.

Building and reinforcement of corporate culture that supports methods, practices, and procedures so they are the ongoing way of business. It must be able to demonstrate institutionalisation of all CMMI process areas for all organisations and technologies, etc.

SUMMARY

- The information system development projects involve the creation of software applications, or integrated application systems. The software development projects are completed in-house, through outsourcing, or by a combined approach. The organisations typically manage development projects using systematic methodologies that divide large, complex tasks into smaller, more easily managed segments or phases.
- The information system planning (ISP) is the first stage in the system development life cycle. The main purpose of ISP is to identify, which information systems are needed rather than planning the details for any specific system. It is also to identify the new systems that are required keeping the business objectives in mind. It should also show the sequence in which they should be implemented. The major questions associated with information systems planning are related to the scope of the planning study, the focus of the planning exercise—corporate organisation versus strategic business unit, number of studies and their sequence, choosing an information system planning methodology, or developing one if none is suitable, targets of planning process and deliverables.

- The BM's Business Systems Planning (BSP), Strategic Systems Planning (SSP), Critical Success Factors (CSF) and End/Mean Analysis are the popular ISP methods. Some of these methodologies help create and justify new uses of IT, while some help in aligning IS objectives with organisational objectives and goals. Some of these methods deal with the challenging problem of determining the set of IS projects that require implementation within the planning horizon, but they do not provide structured, optimal solutions to the problem of setting up priorities.
- The four stages of IS planning includes strategic planning, requirement analysis, resource allocation, and project planning. The strategic planning helps in establishing the relationship between the business plan and the IS plan of the organisation. The requirement analysis helps in building the information system architecture. The information system architecture provides a unifying framework.
- An information system development process is a structure imposed on the development of a software product. A software development process is a structure imposed on the development of a software product. (Synonyms include software life cycle and software process). The system development process is a set of activities, methods, best practices, deliverables, and automated tools that stakeholders use to develop and maintain information systems and software.
- There are several models for such processes, each describing approaches to a variety of tasks or activities that take place during the process. The systems development life cycle (SDLC) is the traditional systems development method used by organisations. The SDLC is a structured framework that consists of sequential processes by which information systems are developed. Each process consists of well-defined tasks.
- The software development projects typically include initiation, planning, design, development, testing, implementation, and maintenance phases. However, the phases may be divided differently depending on the organisation involved. Irrespective of number of phases in system development, every system will always have minimum four stages—system initiation, system analysis, system design, and system implementation.
- The system projects can be initiated by any one in the organisation. It need not always be by the owner of the organisation or the end user. It actually depends more on the identification of the need for the project. An organisation may initiate the system project because of existence of the problem, existence of opportunity and directive. The system project team must include the system owner, system user, system designer, system builder, system analyst, and IT vendors, and consultants.
- The feasibility study about the system project is normally done at two stages—one at the system initiation stage and the other at the planning stage. The feasibility study document should provide an overview of the proposed project and identify expected costs and benefits in terms of economic, technical, and operational feasibility. The document should also describe alternative solutions and include a recommendation for approval or rejection.
- At the initiation stage, the scope of the system project is finalised, at the planning stage, the system team does the detailed requirement analysis and suggests the best candidate system for design specifications. At the design stage, logical design specifications of the proposed system is converted to the physical design along with the input, process and output specifications and controls. At the development phase, the system codes are developed as per the design specifications and tested at the testing phase. Once the system is ready and fully tested, system conversion strategies are formulated and implemented.
- The system development methodology is a standardised development process that defines a set of activities, methods, best practices, deliverables, and automated tools that system developers and project managers are to use to develop and continuously improve information systems and

software. Some basic popular models that are adopted by many software development firms are Waterfall Model; Prototyping Model; Rapid Application Development Model; Extreme Programming, and Component Assembly Model.

- ✦ Computer-aided Software Engineering (CASE)—The use of automated software tools that support the drawing and analysis of system models and associated specifications. Some CASE tools also provide prototyping and code generation capabilities. Some CASE tools can even work backward, modifying the model after modifying the coding. The CASE tools provide advantages for systems developers.
- ✦ Capability Maturity Model Integration (CMMI) broadly refers to a process improvement approach that is based on a process model. A process model is a structured collection of practices that describe the characteristics of effective processes; the practices included are those proven by experience to be effective. The CMMI can be used to assess an organisation against a scale of five process maturity levels. Each level ranks the organisation according to its standardisation of processes in the subject area being assessed. The subject areas can be as diverse as software engineering, systems engineering, project management, risk management, system acquisition, information technology (IT) services, and personnel management.

KEY TERMS

Business System Planning (BSP)
Capability Maturity Model (CMM)
Component Assembly Model
Computer-aided Software Engineering (CASE)
Critical Success Factors (CSF)
Data Modelling
End/Means Analysis
Extreme Programming
Feasibility Analysis
Implementation
Information Engineering
Information System Architecture
Information System Planning (ISP)
Method/1
Object Modelling
Process Modelling
Prototyping
Rapid Application Development (RAD)
Requirement Analysis
Software Development
Software Development Life Cycle (SDLC)
Software Quality
Spiral Model
Strategic System Planning
System Analysis
System Design
System Development
System Development Methodology
System Development Phases
System Initiation
Testing
Value Chain Model
Waterfall Model

SELF-STUDY QUESTIONS

1. Which of the following is NOT one of the ISP Methodologies?
   (a) Critical Success Factor
   (b) Business System Planning
   (c) Competitive Forces Integration
   (d) Ends/Means Analysis
2. The main objective of feasibility study is
   (a) to assess whether it is possible to meet the requirements specifications
   (b) to assess if it is possible to meet the requirements specified subject to constraints of budget, human resource, and hardware

(c) to assist the management in implementing the desired system
(d) to remove bottlenecks in implementing the desired system

3. The major goal of requirement determination phase of information system development is
   (a) determine whether information is needed by an organisation
   (b) determine what information is needed by an organisation
   (c) determine how information needed by an organisation can be provided
   (d) determine when information is to be given
4. The primary objective of system design is to
   (a) Design the programs, databases, and test plan
   (b) Design only user interfaces
   (c) Implement the system
   (d) Find out how the system will perform
5. _____ provides a unifying framework with which various people with different perspectives can organise and view the fundamental building blocks of information systems.
6. _____is a set of activities, methods, best practices, deliverables, and automated tools that stakeholders use to develop and maintain information systems and software.
7. Which one of the following is NOT part of four stages SDLC?
   (a) System Initiation (b) System Analysis
   (c) System Design (d) System Maintenance
8. _____ is a system development method that is linear and sequential and has distinct goals for each phase of development.
   (a) Spiral Model (b) Waterfall Model
   (c) Extreme Programming (d) Prototype
9. _____ is an automated software tools that support the drawing and analysis of system models and associated specifications.
10. In a CMMI five stage Maturity Model, _____ is at fourth stage.

REVIEW QUESTIONS

1. What is Systems Analysis and how is it different from System Design?
2. How do you define Information Systems Architecture? How relevant is it for the designing of systems?
3. When and how are the systems projects initiated?
4. Who are the major players in the systems games?
5. List Key Business and Technology Drivers for Information Systems.
6. What is middleware? How is it different from firmware?
7. What do you understand by system development models. List some of the different types of System Development Models.
8. Why use CMM (Capability Maturity Models)? How many CMM levels are there? Are they sequential?
9. Name some Standard Methodologies that you know.
10. What is RAD (Rapid Application Development)? How is it different from interactive models?

QUESTIONS FOR DISCUSSION

1. What are EAI and how important are they for the organisations?
2. What is Model Driven Analysis? How is it useful?
3. List any two model driven approaches of system analysis and design.
4. What are Accelerated System Analysis Techniques?
5. What is Reverse Engineering and why is it important?
6. List some of the commonly used Requirement Discovery Methods.
7. What role BPR plays in System Analysis?
8. Why is it important to build Logical Design of a system while developing a system project?

APPLICATION EXERCISES

1. An Analyst was asked by a bank president to look into installing online terminals for all tellers. The bank has 25 tellers in the lobby and 12 tellers in the drive-in. The teller department reports to operations. The bank has the following departments:
   (a) Operations department, which includes bookkeeping, tellers, cheque processing, customer service, and accounting. This department has 75 employees and 12 officers.
   (b) Commercial and loan department, which handles auto loans, home improvement loans, secured loans, and commercial loans for small businesses. The department has 12 employees and five officers.
   (c) Audit department, which verifies the entire bank's operations, audits the books, and investigates cash shortages.
   (d) Safe deposit department, which is in charge of 5,000 lockers housed in the basement of bank building. Three employees handle customer service and billing.
   (e) Personnel department, which performs services such as health insurance administration, recruitment, testing, training, and human resources planning. The department is run by a director and one assistant.
2. The present teller system has electronic terminals that use paper cards to capture deposits, withdrawals, and other transactions. At the end of the day, the card goes to data processing, where the information is entered on computer database for final processing. If a teller needs an account balance, she dials bookkeeping, which looks up the balance in a computer generated report. The teller then writes the balance on a slip and hands it to the customer. An online teller terminal performs the same function in a matter of seconds.
   (a) If you were the analyst, what detailed plan would you define to represent the system life cycle for a possible installation? Explain each step in detail.
   (b) In this particular case, where would you start the cycle? Which steps do you consider most crucial? Explain.

GROUP PROJECTS

1. When accounts receivable systems are designed, an important feature is the printing of the monthly account statement. Owing to the frequency of accounts receivable invoices, customers generally expect certain information to be included in the statement. Name, address, and account number details are essential, as are the previous and current account balances.
2. Customers also want to know about the transactions that have occurred during the current month. Three types of transactions are common:
   - Payments made from the account
   - Sales and purchase transactions
   - Adjustments (credits or debits)
3. A common form lists the date, type, and amount of each transaction in the main part of the invoice. Depending on the particular account, there may be none, one, or many transactions. (Statements are always sent to customers who have a balance outstanding, even if there are no transactions for the current month).
4. Some systems also charge interest on the previous month's unpaid balance. The interest charged for the current month is listed separately in a special place in the statement form.
5. If it is the end of the calendar year, a separate line is often added to inform the customer of the amount of interest paid during the year. The customers expect to see this information as a means of knowing how much they paid as interest. Sometimes they need the details for reporting their taxes to the Internal Revenue Service or state government.
6. Finally, realising that a statement will capture a customer's attention, merchants often choose to include a special message at the bottom of the statement form. The message which maybe up to a specified number of characters (say, 120 characters), can be used to promote special sales, provide consumer service telephone numbers, etc. Its use is, however, optional.
   (a) Develop the data structure(s) needed to accommodate account receivable statement preparation as described above.
   (b) Indicate which data items are mandatory and which are optional.

Caselets

1. SaaS at Millipore

The Millipore (India) is an Indian subsidiary of the Massachusetts-based Millipore, which provides tools and services for bioscience research and bio pharmaceutical manufacturing. The company has 31 locations and 7 manufacturing facilities globally. The main challenge that Millipore's sales staff faced was of managing and processing efficiently the growing amount of customer data. The company was using a CRM system that was not providing the efficiency expected in the dynamic environment, where the availability of real-time data was becoming important. Most of the information was handled manually. This resulted in loss of business opportunities due to the lack of follow up on leads.

This became a greater challenge considering that the company's business was growing and the volume was increasing. The company quickly realised that it was not able to catch all the data it needs to capture due to lack of availability of the right tools.

This led the company management to look for a solution that would help manage its portfolio in a better manner. After evaluating several available solutions, it chose to go for Software as a Service (SaaS), as it felt that all it needed to access the company data was through an Internet access. The company even gave out data cards to its sales force to ensure it was able to access and update the data more regularly than before.

According to A Sharath Chandra Prasad, Executive GM, F and A, Millipore India the single most important thing in the SaaS implementation is the empowerment of the sales force. They are now able to generate leads quickly. This has also allowed a better reporting mechanism to be put in place. The best part, according to Prasad, is that the company management can track leads and take actions when required. Above all, the data on leads about customers, or the prospective customers were accessible to the senior management. This helped Millipore forecast their manufacturing activities. The Millipore also added the sales and services component of the solution to manage customer complaints.

The website Salesforce.com, a leading player in the on demand business services, implemented Salesforce Enterprise Edition along with the Product Master at Millipore in April 2007 to enhance customer relationship. The implementation was completed in nine weeks. The solution was also integrated with the ERP system in place. The other highlight of the Salesforce.com solution was the capability of getting it deployed across multiple departments and divisions.

The support for multiple divisions and processes, workflow automation, product line forecasting, revenue allocation, and much more, the Enterprise Edition is designed to flexibly support all the complexities that are realities of many large companies. The other benefit of the solution to Millipore was that it did not require any specialised training to use the application. Based on the training it got from Salesforce.com, it has created its own training team to initiate the new users into the system. The application also allows creation of custom tabs and renaming of the existing database.

The IT teams can use industry standard tools to easily customise and extend Salesforce.com or even to build and deliver new applications with all the benefits of the on demand model—Tying It All Together. It also allows its customers to write their own integration processes using standard XML and SOAP interfaces.

Questions for Discussion

1. Define software as a service. Why organisations prefer to use this?
2. What are the key challenges being faced by the organisation?
3. List the key advantages that the organisation got by implementing the SaaS concept.
4. What are the kinds of application for which one can use SaaS?

Source: *Dataquest*, 29 Feb. 2008, Vol. XXVI No. 04

2. Implementation of FMS

With close to 400 offices across the country, Bharat Petroleum Corporation Limited (BPCL) deals in a variety of products, including LPG, petroleum, lubricants, aviation fuel, and industrial products.

A little more than seven years ago, BPCL faced several issues related to hardware and software in PCs, printers, network connectivity, etc. The internal team of engineers was not adequate to handle the increasing load.

Through a tender and evaluation process, Wipro was selected as the FMS provider for BPCL, and was given the task of managing facilities such as desktop/laptop operations, printers, LAN support, asset management, and vendor management. The BPCL procured these products from multiple vendors some of which are under warranty. The Wipro coordinates with vendors to resolve any issues and to manage those assets once the warranty period is over.

MANAGING OPERATIONS

The Wipro trained BPCL's engineers for three months, and the in-house tools, and processes were extended to them. "It took six months for the system to stabilise," says J A Braganza, DGM, IIS (Services), BPCL.

Until last year, the BPCL had six regional FM teams manned by Wipro. Each team was headed by an administrator, and included a call receiver and engineers. There was also a coordinator at the national level. For locations that had more than 50 PCs, a resident engineer was employed on a monthly basis. For other locations, engineers were paid on a per visit basis, with each visit being of mandatory six hours' duration. All issues at the location were to be resolved including proactive checking of all PCs and printer PMs preventive maintenance, as per the checklist provided by the BPCL. The calls logged by users were handled by these Regional FM centres and engineers were available from Monday through Saturday, 9 am to 6 pm.

However, from this year, there is a Centralised Service Desk (CSD) set up at the BPCL premises. This set-up comprises a technical support team to handle software related issues and is available round the clock to all users of BPCL. The regional teams have been reduced to only a few engineers, specifically for hardware support. The calls are logged by users/call coordinators into the web based service desk tool and are transferred to the CSD engineers. The engineers first try to provide remote support by guiding the user to resolve the issue. If not resolved, they try to resolve the problem by taking remote control of the system, with the permission of the end user. If that does not work either, an engineer from Wipro's closest service centre is sent to the onsite location. "Users are happy with the anytime support," states Braganza. Having a qualified team at one place, comprising both junior and senior engineers, helps in resolving issues faster.

One of the advantages with Wipro's service is their large service centre network across the country. Outsourcing FMS to Wipro has also meant that BPCL's in-house technical team can now focus on developmental work such as ERP, web based applications, etc., instead of spending their efforts on desktops/laptops, printers, and LAN related issues.

Questions for Discussion

1. Why BPCL implemented FMS? What were the perceived benefits of the system?
2. What were the main reasons for outsourcing FMS to Wipro?
3. Identify the steps involved in selecting the service provider.

Source: DQ IT Case Book 2008

Answers to Self-Study Questions

1. (c) 2. (b) 3. (b) 4. (a)
5. Information Systems Architecture (ISA) 6. System development process
7. (d) 8. (b)
9. Computer-aided Software Engineering (CASE)
10. Quantitatively Managed

The McGraw-Hill Companies

Chapter 14

Managing Information Systems

CHAPTER OBJECTIVES

After reading this chapter, you will get a clear understanding about the following:

- Information Technology Infrastructure Management
- Information Technology Service Management
- Information Technology Infrastructure Library
- COBIT an IT Governance Tool
- Roles and Responsibilities of CIO for IT Management
- Business Continuity Planning

INTRODUCTION

Today's businesses are demanding that IT organisations become more strategic by automating day-to-day reactive functions and delivering quality IT services. The drive to achieve higher quality services leads to constant change spanning the organisation itself, its business processes and technology. The change in any area generally affects the other two.

From a technology view, traditional network and system management tools address the well being of the enterprise infrastructure and associated components, but lack the ability to manage the performance and quality of business processes, applications, and services as seen by users. However, this is precisely the metric that individuals and departmental end users apply to IT organisations to determine quality of service—the end-user perspective.

The changes in technology—as well as changes in the broader business and cultural landscape in which IT must operate—directly affect IT organisations. While Business Service Management (BSM) solutions meet this new dynamics, they are not intended to directly replace existing IT infrastructure management tools. The increasing adoption of best practice standards—such as the IT Infrastructure Library (ITIL), IT service management (ITSM), Six Sigma, and CoBIT—is fundamental to this discussion.

Another area of concern is the business continuity planning (BCP). The business continuity planning process involves the recovery, resumption, and maintenance of the entire business, not just the technology component. While the restoration of IT systems and electronic data is important, recovery of these systems and data will not always be enough to restore business operations.

The information is one of the important strategic resource that any organisation has to manage its business effectively. The key to collection, analysis, production, and distribution of information within an organisation is the quality of the IT Services provided to the business. It is essential that organisation recognise that IT Services are crucial, strategic, organisational assets, and therefore organisations must invest appropriate resources into the support, delivery, and management of these critical IT services and the IT systems that support them. However, these aspects of IT are often overlooked or only superficially addressed within many organisations.

The chief Information Officer (CIO) in an organisation plays an important role in selecting and managing the IT infrastructure and IT services. With ever increasing pressure to drive higher operating efficiencies, fuel business growth and enhance shareholder value, executives today are rethinking their traditional strategies. Few areas of the business are being more challenged than information technology (IT). At the same time, the role of the CIO is also undergoing significant change. The successful CIOs recognise that IT has become far more than a means of increasing efficiency and reducing costs. Rather, they see IT as a prime stimulus for and an enabler of business innovation—and themselves as key collaborators in a process that develops business and IT strategies in concert.

Moreover, a growing number of CIOs have begun to recognise that traditional IT strategies may actually constrain innovation and efficiency. While they are critical to transforming the IT infrastructure and meeting the evolving requirements of the business, strategy, planning, and capability development; efforts are often sacrificed in favour of short-term fixes and the demands of day-to-day operations. With IT budgets virtually flat, and operations and maintenance costs on the rise, how can CIOs improve the spending mix to better enable future oriented strategic innovation, while providing a world-class IT infrastructure to support today's business requirements? Increasingly, CIOs are exploring alternative IT infrastructure sourcing and delivery strategies that will help them to reduce costs and reallocate those savings to drive new business-enabling capabilities. In parallel, they are looking to align these strategies with corporate directives and action plans aimed at delivering a lasting competitive advantage, healthy profit margins, and higher shareholder value.

Despite steadily expanding capabilities, most infrastructure management tools remain silo based and require dedicated administrators and domain experts. Introduced to manage network and system operations, the tools have proven effective at isolating problems and diagnosing root cause within a given server, or network environment, but they are not designed to provide a holistic view of applications and services end-to-end. With the lack of a unified enterprise management capability, individual departments and lines of business essentially have become walled cities. This creates the silo, or domain phenomenon, with each department, and line of business within the enterprise forming application and infrastructure support groups to manage their own IT resources. The monitoring and correlating events from these individual silos is always a challenge that is faced in an organisation.

Another big challenge is to protect the complete IT infrastructure to provide better service. The business continuity management (BCM) is a business approach to ensure critical business functions are maintained, or restored in a timely manner, in the event of material disruptions arising from internal, or external events. Its purpose is to control the likely damage to its reputation, financial, and legal position from the disruption. It is critical that a Business Continuity and Disaster Recovery Plan (BCP/DRP) be an integral part of every company's risk management and business continuity management process. A BCP/DRP is a document, developed in advance, that contains arrangements and procedures that enable an organisation to respond to an event in such a manner that critical business functions continue with planned levels of interruption.

IT INFRASTRUCTURE MANAGEMENT

Despite steadily expanding capabilities, most infrastructure management tools remain silo based and require dedicated administrators and domain experts. This all happened because of piece meal approach being followed by the organisations while implementing IT infrastructure. Most of the tools have proven effective at isolating problems and diagnosing root cause within a given server, or network environment, but they are not designed to provide a holistic view of applications and services end to end.

With the lack of a unified enterprise management capability, individual departments, and functions essentially have become independent silos. As a result each silo, with each department and line of business within the enterprise form application and infrastructure support groups to manage their own IT resources. The monitoring and correlating events from these individual silos in an attempt to gain a full enterprise wide view of IT operations is often very difficult and time consuming.

The quality of service is really the key. When designed to monitor only a given set of applications, an application management tool sometimes creates a silo of its own—but this is not always the case. There are certainly application management products in the market that take a broad view of application performance for both custom and off the shelf applications. Similarly, end user monitoring tools that measure performance—either actively, or passively—are designed to look at what is happening to the user at a particular time, in a particular location. This approach is clearly a cross domain strategy.

The legacy of IT management tools also lack visibility relating to the business impact of a fault, with limited, or no capability to link infrastructure issues with business outcomes to put them in context with the end user experience. This is because network administrators and help desk staff sees different metrics then silo teams do—and they certainly do not replicate the end user experience. The network administrator might see problems related to network bandwidth, CPU utilisation, and database tables, whereas end users only know that response time appears slow for a given application, or a login attempt has been denied for some reason. In some cases, users are able to identify the degradation in service quality, before IT staff is aware of it.

The enterprises continue to try to manage to a common set of performance goals for all of these respective groups using the same collection of silo management tools. Not surprisingly, this situation has prompted many organisations to create a support staff to look after each of the application and technology silos of the enterprise. This situation is beginning to change with emergence of service level management (SLM) groups.

The silo based approach to management simply does not work. The conflicts invariably arise in assessing service level agreement (SLA) performance. For example, a server and collection of network devices can all have 99.9 per cent uptime individually, but application and service availability presented to the end user can in some cases remain unacceptable. This is because the overall service availability is impacted by sum of the slowdown or downtime of each component comprising that service.

The situations like this create conflict within IT itself. When root-cause analysis related to an end user problem cannot be traced to the user's domain, the issue clearly lies elsewhere. Eventually, IT identifies the problem, but the damage is done in terms of business impact and diminished end-user productivity. Ironically, once identified, problems are resolved fairly quickly, because the cause and scope of the issue is known. What is needed to minimise or even avoid this situation is to have the application transactions on the back end infrastructure.

The information technology infrastructure management (IM) is the management of essential operation components, such as policies, processes, equipment, data, human resources, and external contacts, for overall effectiveness.

The infrastructure management is sometimes divided into categories of systems management, network management, and storage management. The purpose of infrastructure management is to:

- Reduce duplication of effort
- Ensure adherence to standards
- Enhance the flow of information throughout an information system
- Promote adaptability necessary for a changeable environment
- Ensure interoperability among organisational and external entities
- Maintain effective
- Change management policies and practices

IT SERVICE MANAGEMENT

It is being increasingly recognised that information is the most important strategic resource that any organisation has to manage. The key to collection, analysis, production, and distribution of information within an organisation is the quality of the IT services provided to the business. It is essential that one recognise that IT services are crucial, strategic, organisational assets, and therefore organisations must invest appropriate resources into the support, delivery, and management of these critical IT services and the IT systems that support them. However, these aspects of IT are often overlooked or only superficially addressed within many organisations. Key issues facing many of today's CIO's are:

- IT and business strategic planning
- Integrating and aligning IT and business goals
- Measuring IT effectiveness and efficiency in organisations
- Optimising costs and the Total Cost of Ownership (TCO)
- Achieving and demonstrating Return on Investment (ROI)

- Demonstrating the business value of IT
- Developing business and IT partnerships and relationships
- Using IT to gain competitive advantage
- Delivering the required, business justified IT services
- Managing constant business and IT change
- Demonstrating appropriate IT governance

The challenges for IT managers are to coordinate and work in partnership with the business to deliver high quality IT services. This has to be achieved while adopting a more business and customer oriented approach to delivering services and cost optimisation. The primary objective of service management is to ensure that the IT services are aligned to the business needs and actively support them. It is imperative that the IT services support the business processes, but it is also increasingly important that IT acts as an agent for change to facilitate business transformation.

All organisations that use IT depend on IT to be successful. If IT processes and IT services are implemented, managed, and supported in the appropriate way, the business would be more successful, suffer less disruption and loss of productive hours, reduce costs, increase revenue, improve public relations, and achieve its business objectives.

Goal of IT Service Management

- Ensure that IT services are aligned to the needs of customers and users (measurable).
- Improve availability and stability of services.
- Improve communication within IT and with users.
- Improve efficiency of internal processes.
- Ensure that all information is current and updated.

What is Service Management?

A service is a means of delivering value to customers by facilitating outcomes, which customers want to achieve without the ownership of specific costs and risks. A simple example of a customer outcome that could be facilitated by an IT service might be: "Sales people spending more time interacting with customers" facilitated by "a remote access service that enables reliable access to corporate sales systems from sales people's laptops." The outcomes that customers want to achieve are the reason why they purchase, or use the service. The value of the service to the customer is directly dependent on how well it facilitates these outcomes. The service management is what enables a service provider to understand the services they are providing, and to ensure that the services really do facilitate the outcomes their customers want to achieve. It is also necessary to understand the value of the services to their customers, and to understand, and manage all of the costs and risks associated with those services.

The Service Management is management of the agreed service to meet the customers requirements.

The ***Service Management is a set of specialised organisational capabilities for providing value to customers in the form of services.*** These 'specialised organisational capabilities' include all of the processes, methods, functions, roles, and activities that a service provider uses to enable

them to deliver services to their customers. The service management is concerned with more than just delivering services. Each service, process, or infrastructure component has a life cycle, and service management considers the entire life cycle from strategy through design and transition to operation with concurrent improvement.

The inputs to service management are the resources and capabilities that represent the assets of the service provider. The outputs are the services that provide value to the customers. The effective service management is itself a strategic asset of the service provider, providing them with the ability to carry out their core business of providing services that deliver value to customers by facilitating the outcomes customers want to achieve. Adopting good practice can help a service provider to create an effective service management system. The good practice is simply doing things that have been shown to work and to be effective. The good practice can come from many different sources, including public frameworks (such as ITIL, COBIT and CMMI), standards (such as ISO/IEC 20000 and ISO 9000), and proprietary knowledge of people and organisations.

INFORMATION TECHNOLOGY INFRASTRUCTURE LIBRARY (ITIL)

The Information Technology Infrastructure Library (ITIL) is a public framework that describes Best Practice in IT service management. It provides a framework for the governance of IT, the service packs, and focuses on the continuous measurement and improvement of the quality of IT service delivered, from both business, and customer perspective. This focus is a major factor in ITIL's worldwide success and has contributed to its prolific usage and to the key benefits obtained by those organisations deploying the techniques and processes throughout their organisations.

What is ITIL?

- Systematic approach to high quality IT service delivery
- Documented best practice for IT service management
- Provides common language with well-defined terms
- Developed in 1980s and improved upon
- Much clearer guidance on how to provide service
- Easier, more modular accreditation paths
- Keeps tactical and operational guidance
- Gives more prominence to strategic ITIL guidance relevant to senior staff
- Aligned with ISO20000 standard for service management

Benefits of ITIL

- Increased user and customer satisfaction with IT services
- Improved service availability, directly leading to increased business profits and revenue
- Financial savings from reduced rework, less time, improved resource management and usage
- Additional time to market for new products and services
- Improved decision-making with optimal risk.

The ITIL was published by Her Majesty's Stationery Office (HMSO) in the UK on behalf of the Central Communications and Telecommunications Agency (CCTA). The initial version of ITIL consisted of a library of 31 associated books covering all aspects of IT service provisions. This initial version was then revised and replaced by seven, more closely connected, and consistent books (ITIL V2) consolidated within an overall framework. This second version became universally accepted and is now used in many countries by thousands of organisations as the basis for effective IT service provision. In 2007, ITIL V2 was superseded by an enhanced and consolidated third version of ITIL, consisting of five core books covering the service life cycle (refer Figure 14.1). Following paragraphs describe the key principles of IT service management and provides a high level overview of each of the core publications within ITIL:

- Service Strategy
- Service Design
- Service Transition
- Service Operation
- Continuous Service Improvement

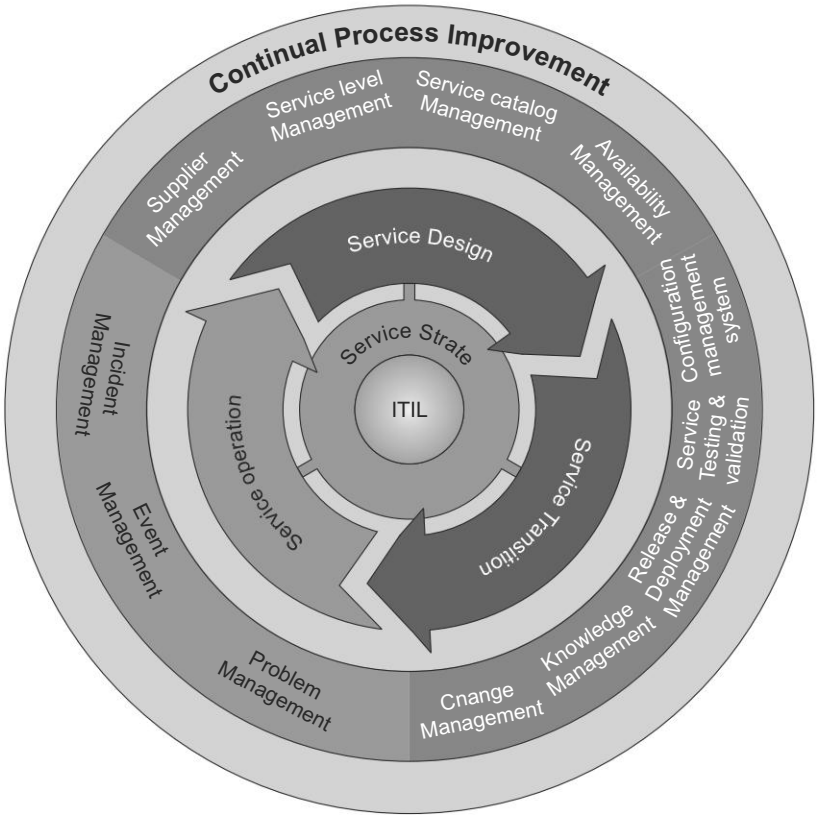

Figure 14.1 IT Service Life Cycle Stages

1. Service Strategy: In order to create a successful service strategy, the services provided must be perceived by the customer to deliver sufficient value in the form of outcomes that the customer wants to achieve. Achieving a deep understanding of customer needs, in terms of what these needs are, and when and why they occur, also requires a clear understanding of exactly who is an existing, or potential customer of that service provider. This, in turn, requires the service provider to understand the wider context of the current and potential marketplaces that the service provider operates in, or may wish to operate in. A service strategy can not be created, or exist in isolation from the over arching strategy and culture of the organisation that the service provider belongs to. The strategy adopted must provide sufficient value to the customers and all of the service provider's stakeholders—it must fulfil the service provider's strategic purpose. Irrespective of the context in which the service provider operates, its service strategy must also be based upon a clear recognition of the existence of competition, awareness that each side has choices, and a view of how that service provider will differentiate itself from the competition. All providers need a service strategy. Hence, the service strategy publication remains the core of the ITIL V3 life cycle.

It sets out guidance to all IT service providers and their customers, to help them operate and thrive in the long term by building a clear service strategy, i.e., a precise understanding of:

- what services should be offered,
- who the services should be offered to,
- how the internal and external marketplaces for their services should be developed,
- the existing and potential competition in these marketplaces, and the objectives that will differentiate the value of what you do or how you do it,
- how the customer(s) and stakeholders will perceive and measure value, and how this value will be created,
- how customers will make service sourcing decisions with respect to use of different types of service providers,
- how visibility and control over value creation will be achieved through financial management,
- how robust business cases will be created to secure strategic investment in service assets and service management capabilities,
- how the allocation of available resources will be tuned to optimal effect across the portfolio of services, and
- how service performance will be measured.

(a) **Service Management as a Strategic Asset:** The use of ITIL to transform service management capabilities into strategic assets, by using service management to provide the basis for core competency, distinctive performance and durable advantage, and increase the service provider's potential from their:

- Capabilities: the provider's ability (in terms of management, organisation, processes, knowledge and people) to coordinate, control, and deploy resources.
- Resources: the direct inputs for the production of services, e.g. financial, capital, infrastructure, applications, information, and people.

(b) **Critical Success Factors (CSFs):** The identification, measurement, and periodic review of CSFs to determine the service assets required to successfully implement the desired service strategy.

(c) **Service Oriented Accounting:** Using Financial Management to understand services in terms of consumption and provisioning, and achieve translation between corporate financial systems and service management.

(d) **Financial Management:** The Financial Management covers the function and processes responsible for managing an IT service provider's budgeting, accounting, and billing requirements. It provides the business and IT with the quantification, in financial terms, of the value of IT services, the value of the assets supporting the provisioning of those services, and the qualification of operational forecasting. The IT Financial Management responsibilities and activities do not exist solely within the IT finance, and accounting domain. Many parts of the organisation interact to generate and use IT financial information; aggregating, sharing, and maintaining the financial data they need, enabling the dissemination of information to feed critical decisions and activities.

(e) **Service Portfolio Management (SPM):** The SPM involves proactive management of the investment across the service life cycle, including those services in the concept, design, and transition pipeline, as well as live services defined in the various service catalogues and discarded services by:

- Prioritises and manages investments and resource allocation
- Proposed services are properly assessed
- Existing services assessed. The outcomes include:
  - Replace
  - Rationalise
  - Renew
  - Retire

(f) **Demand Management:** The Demand management is a critical aspect of service management. The Poorly managed demand is a source of risk for service providers because of uncertainty in demand. The excess capacity generates cost without creating value that provides a basis for cost recovery. The purpose of Demand Management is to understand and influence customer demand for services and the provision of capacity to meet these demands. At a strategic level this can involve analysis of patterns of business activity and user profiles. At a tactical level it can involve use of differential charging to encourage customers to use IT services during less busy times. A Service Level Package (SLP) defines the level of utility and warranty for a Service Package and is designed to meet the needs of a pattern of business activity. The purpose of Demand Management is to:

  - Ensures that we don't waste money with excess capacity
  - Ensures that we have enough capacity to meet demand at agreed quality
  - Patterns of Business Activity to be considered

Do Process Frameworks Such as ITIL and Six Sigma Deliver in the Context of Services Outsourcing?

The frameworks are meant to simplify complex processes and make them more efficient. But processes themselves are so dynamic that it forces one to revisit the framework and readapt it to use. If one adds outsourcing to that, the complexity increases much more. Therefore, to keep up with this change and manage the complexity, training programs in organisations are a fine mix of standardised frameworks and need-based concepts.

Most of these frameworks such as IT Infrastructure Library (ITIL), Six Sigma and Lean help customers as well as service providers in getting rid of the waste in the process, explained Derek Lonsdale, Managing Consultant-IT Practice, PA Consulting. In some cases, they help the customers in understanding what part of the process to outsource. These frameworks help in assessment of data and identification of the waste in the processes to increase the overall efficiency of the processes.

While Six Sigma and Lean are generic frameworks borrowed from the manufacturing world, and can be used in outsourcing any kind of process, the ITIL is more IT-focused, and can be used in any IT process. The trend over the past few years has been such that many providers have come out with their proprietary frameworks, in which they pick up best practices from the existing standard frameworks.

Challenges in Adopting Frameworks

These frameworks are all organisation driven and require an effort to ensure that the employees take them seriously. At IBA, we have optimised the procedures of incorporating and deploying the frameworks, and are carried out through the implementation of an automated project-management system here. We also organise trainings of software developers and regular auditing of the employees to test the process understanding.

Apart from ensuring that frameworks are well understood, the challenge also lies in the seamless integration of the customised framework into the existing one. Many of these processes are being performed in some form or fashion in the customers environment before they begin to adopt ITIL standards. The challenge they face is in adapting their current processes to take advantage of the standards and to deploy the standards for those processes that are absent. With the proper sponsorship and investment, incorporating the processes isn't difficult. Without that sponsorship and investment, it's next to impossible to be successful.

The training is another challenge that many firms face. The ITIL framework has five modules and each of which is around 250 pages long so for an employee to read through over 1,000 pages of information becomes a challenge.

Case 1 Change Management: ITIL

Customer: A global chemical company

Provider: IBM

A global chemical company outsourced its IT infrastructure to IBM to improve end-user IT services. The ITIL standards were chosen as the means to standardise the IT infrastructure across providers.

Challenge

After a year into the contract, the infrastructure-service levels failed to improve as intended, and IBMs account team investigated the issue. The main cause was determined to be the number of emergency changes that the customer approved. IBM initiated a Change Management Improvement. Team consisting of members of the CAB (Change Advisory Board), the IBM Change Coordinator and a Process Specialist.

Solution

The ITIL change process was used as a guide to determine gaps in the current change management process. The team determined that the normal change cycle time was too long, and that the project managers had not been trained on the change process when implementing software changes.

Results

- The cycle times for non-emergency changes within the customers process were examined and restructured. By using Lean to eliminate waste, the cycle times were greatly reduced so fewer emergency changes were requested.
- Through the implementation of a more thorough change from template, the change process improved. So the customers CAB had better information at the start of their process, thereby reducing the time it took to ask additional questions.
- By providing project managers with training and a calendar to use for advanced scheduling, the number of emergency changes were cut in half after three months.
- Due to the improvements in change management, the overall stability of the IT environment increased and end-user satisfaction improved.

Incorporating these frameworks at the customer site in the customer processes is another challenge. The change management is an integral part of outsourcing and in most of the cases, despite the fact that the work is outsourced to the provider, the customer is expected to have the same level of understanding of the framework as the provider to be able to govern the sourcing relationship better. So, it is the provider's responsibility to ensure that the people involved in the sourcing process from the customer side are on the same page. Herein, conducting regular training sessions would help.

Who's Driving?

Both the customer and the provider could be the driver. Based on experience, almost 95 to 98 percent of proposals that we respond to, the customers are very keen to understand quality assurance processes, the approach we will follow to deploy quality practices, our continuous improvement focus and how well bring value addition to their processes year on year.

Number of organisations have asked their customers to be certified because of the work they are doing, and they also have had contracts, where the customers have said they will sign the contract on a condition that they need to get x number of people certified.

In some cases, it is mutual adoption of frameworks that wins the case. Where the customers process maturity is believed to be below that of the service provider, the customer will adopt the service providers process. For the customer team, it means understanding the service providers process and how it's different from the current customer processes to be able to make the changes. In other cases, the customer will require the service provider to integrate to the customers process. This is a matter of understanding the point in the process where the customers process stops and the service providers process begins once the service has been outsourced.

Case 2 Fraud Analysis & Six Sigma

Customer: A global health care service provider

Provider: Genpact

Challenge

- The current processes not streamlined multiple hand offs and backlog inventory situation.
- The controllership issues around claims inventory management, process metrics and quality audit process.
- No report generation processes to monitor paid out of compliance.

Solution

- Out of compliance payment reduced from target 50 to 25% (Further reduction projected with adequate capacity planning.)
- Automated report-generation process created with new process metrics and daily inventory management.
- New Quality audit process introduced for new processes.

Results

- Twenty five percent fraud reduction, saving to customer.
- Revenue gain $1 million per annum.
- 32 FTE reduction $1.2 mn saving.

The Sourcing Decision

The customers perception of the service providers process maturity is factored into the selection decision. These frameworks are utilised through the entire service-management life-cycle, and are required for different aspects of the service provided to the customers. For example, in the ITIL framework, incident management is utilised for ensuring the customer is up and running quickly; problem management is utilised to ensure the root cause is identified and corrective and preventive action is appropriately applied. The change management is utilised in concert with configuration and release management to ensure that changes to the clients environment are stable and stay current while all the required information is tracked appropriately so that the relationships and interfaces are known and like wise. In order to keep these processes efficient, these frameworks play an important role.

The prospects and customers demand seamless, consistent, and reliable service based on industry best practices and standards such as ITIL-based Service Management and ISO 20000 are being demanded by customers.

Is it important for an organisation to undergo the framework route when processes themselves are a moving target? The answer is yes. It is like a person who after working for a few years understands the business quite well, but still opting for a management degree to get the experience of a structured learning. The person knows that eventually the knowledge will get old and would need continuous upgrading, but in order to upgrade one needs to have a thorough grounding in the basics. So is the case with these frameworks. No matter how old they get and no matter how much customisation they need, these frameworks will always be treated as a book with multiple editions.

Source: *Dataquest*, October, 2008

2. Service Design: The Service Design is a stage within the overall service life cycle and an important element within the business change process. The role of Service Design within the business change process can be defined as: ***The design of appropriate and innovative IT services, including their architectures, processes, policies, and documentation, to meet current and future agreed business requirements.***

The main goals and objectives of Service Design are to:

- design services to meet agreed business outcomes,
- design processes to support the service life cycle,
- identify and manage risks,
- design secure and resilient IT infrastructures, environments, applications, and data/information resources and capability,
- design measurement methods and metrics,
- produce and maintain plans, processes, policies, standards, architectures, frameworks, and documents to support the design of quality IT solutions,
- develop skills and capability within IT, and
- contribute to the overall improvement in IT service quality.

The Service Design starts with a set of business requirements, and ends with the development of a service solution designed to meet documented business requirements and outcomes and to provide a Service Design Package (SDP) for handover into Service Transition.

There are five individual aspects of Service Design:

- new or changed service solutions,
- service management systems and tools, especially the Service Portfolio,
- technology architectures and management systems.
- processes, roles, and, capabilities,
- measurement methods and metrics.

A holistic approach should be adopted in Service Design to ensure consistency and integration in all IT activities and processes, providing end-to-end business related functionality and quality. The good service design is dependent upon the effective and efficient use of the four Ps of Design: people, products, processes, and partners. The key processes and activities include:

(i) ***Service Design Package (SDP).*** The SDP defines all aspects of an IT service and its requirements through each stage of its life cycle. An SDP is produced for each new IT service, major change, or IT service retirement.

(ii) ***Service Catalogue Management (SCM).*** The Service Catalogue provides a central source of information on the IT services delivered to the business by the service provider organisation, ensuring that business areas can view an accurate, consistent picture of the IT services available, their details and status. The purpose of Service Catalogue Management (SCM) is to provide a single, consistent source of information on all of the agreed services, and ensure that it is widely available to those who are approved to access it. The key information within the SCM process is that is contained within the Service Catalogue.

The main input for this information comes from the Service Portfolio and the business through either the Business Relationship Management, or the Service Level Management processes.

(iii) ***Service Level Management (SLM).*** The SLM negotiates, agrees, and documents appropriate IT service targets with the business, and then monitors and produces reports on delivery against the agreed levels of service. The purpose of the SLM process is to ensure that all operational services and their performance are measured in a consistent, professional manner throughout the IT organisation, and that the services and the reports produced meet the needs of the business and customers. The main information provided by the SLM process includes Service Level Agreements (SLA), Operational Level Agreements (OLA) and other support agreements, and the production of the Service Improvement Plan (SIP) and the Service Quality Plan. Types of SLA's include:

(a) Service-based: All customers get same deal for same services.

(b) Customer-based: Different customers get different deal (and different cost).

(c) Multi-level: These involve corporate, customer, and service levels and avoid repetition.

(iv) ***Capacity Management.*** The Capacity Management includes business, service, and component capacity management across the service life cycle. The purpose of Capacity Management is to provide a point of focus and management for all capacity and performance related issues, relating to both services and resources, and to match the capacity of IT to the agreed business demands. The Capacity Management Information System (CMIS) is the cornerstone of a successful Capacity Management process. Information contained within the CMIS is stored and analysed by all the sub-processes of Capacity Management for the provision of technical and management reports, including the Capacity Plan.

(v) ***Availability Management.*** The purpose of Availability Management is to provide a point of focus and management for all availability related issues, relating to services, components and resources, ensuring that availability targets in all areas are measured and achieved, and that they match or exceed the current and future agreed needs of the business in a cost-effective manner. There are two key aspects: reactive activities and proactive activities. The Availability Management activities should consider the availability, reliability, maintainability, and serviceability at both service and component level, particularly those supporting Vital Business Functions (VBFs). The Availability Management Information System (AMIS) contains all of the measurements and information required to provide the appropriate information to the business on service levels. The AMIS also assists in the production of the Availability Plan.

(vi) ***IT Service Continuity Management (ITSCM).*** As technology is a core component of most business processes, continued, or high availability of IT is critical to the survival of the business as a whole. This is achieved by introducing risk reduction measures and recovery options. The ongoing maintenance of the recovery capability is essential if it is to remain effective. The purpose of ITSCM is to maintain the appropriate on-going recovery capability within IT services to match the agreed needs, requirements, and timescales

of the business. The ITSCM includes a series of activities throughout the life cycle to ensure that, once service continuity and recovery plans have been developed, they are kept aligned with Business Continuity Plans and business priorities.

(vii) ***Information Security Management (ISM).*** The ISM needs to be considered within the overall corporate governance framework. The corporate governance is the set of responsibilities and practices exercised by the board and executive management with the goal of providing strategic direction, ensuring that the objectives are achieved, ascertaining that the risks are being managed appropriately, and verifying that the enterprise's resources are used effectively. The purpose of the ISM process is to align IT security with business security, and ensure that information security is effectively managed in all service and Service Management activities. It ensures:

(a) Confidentiality: Making sure only authorised users can see data

(b) Integrity: Making sure the data is accurate and not corrupted

(c) Availability: Making sure data is supplied when it is requested

(viii) ***Supplier Management.*** The Supplier Management process ensures that suppliers and the services they provide are managed to support IT service targets and business expectations. The purpose of the Supplier Management process is to obtain value for money from suppliers and to ensure that suppliers perform according to the targets contained within their contracts and agreements, while conforming to all of the terms and conditions.

3. Service Transition: ***The role of Service Transition is to deliver services that are required by the business for operational use.*** The Service Transition delivers this by receiving the Service Design Package from the Service Design stage and delivering to the Operational stage. If business circumstances, assumptions, or requirements have changed since design, then modifications may be required during the Service Transition stage in order to deliver the required service. The Service Transition focuses on implementing all aspects of the service, not just the application and how it is used in 'normal' circumstances. It needs to ensure that the service can operate in foreseeable extreme, or abnormal circumstances, and that support for failure, or errors is available.

The Service Transition is supported by underlying principles that facilitate effective and efficient use of new/changed services. The key principles include:

- Understanding all services, their utility and warranties,
- Establishing a formal policy and common framework for implementation of all required changes,
- Supporting knowledge transfer, decision support and reuse of processes, systems and other elements,
- Anticipating and managing 'course corrections', and
- Ensuring involvement of Service Transition and Service Transition requirements throughout the service life cycle.

Within the Service Transition process, some of the processes most important to Service Transition are whole life cycle processes which, have impact, input, and monitoring, and control

considerations across all life cycle stages. The whole life cycle processes are: Change Management, Service Asset and Configuration Management, Knowledge Management. The processes focused on Service Transition, but not exclusive to the stage are: Transition Planning and Support; Release and Deployment Management; Service Validation and Testing; Evaluation.

(a) **Change Management:** The Change Management ensures that changes are recorded, evaluated, authorised, prioritised, planned, tested, implemented, documented, and reviewed in a controlled manner. The purpose of the Change Management process is to ensure that standardised methods are used for the efficient and prompt handling of all changes that are recorded in the Configuration Management System and that overall business risk is optimised. A Service Change is the addition, modification, or removal of an authorised, planned, or supported service, or service component and its associated documentation. Therefore, change management is relevant across the whole life cycle, applying to all levels of service management—strategic, tactical and operational.

(b) **Service Asset and Configuration Management (SACM):** The SACM supports the business by providing accurate information and control across all assets and relationships that make up an organisation's infrastructure. The purpose of SACM is to identify, control, and account for service assets and configuration items (CI), protecting and ensuring their integrity across the service life cycle. The scope of SACM also extends to non-IT assets and to internal and external service providers, where shared assets need to be controlled.

(c) **Knowledge Management.** The purpose of Knowledge Management is to ensure that the right person has the right knowledge, at the right time to deliver and support the services required by the business. This delivers more efficient services with improved quality; clear and common understanding of the value provided by services; and relevant information that is always available.

(d) **Transition Planning and Support.** The goals of Transition Planning and Support are to: plan and coordinate resources to ensure that the requirements of Service Strategy encoded in Service Design are effectively realised in Service Operations; identify, manage and control the risks of failure and disruption across transition activities. An effective Transition Planning and Support can significantly improve a service provider's ability to handle high volumes of change required to be released across its customer base.

(e) **Release and Deployment Management.** The goal of the Release and Deployment Management process is to assemble and position all aspects of services into production and establish effective use of new, or changed services. An effective release and deployment delivers significant business value by delivering changes at optimised speed, risk and cost, and offering a consistent, appropriate, and auditable implementation of usable and useful business services. The Release and Deployment Management covers the whole assembly and implementation of new/changed services for operational use, from released planning early life support.

(f) **Service Validation and Testing:** The key purpose of service validation and testing is to provide objective evidence that the new/changed service supports the business requirements, including the agreed SLAs. The service is tested explicitly against the utilities

and warranties set out in the service design package, including business functionality, availability, continuity, security, usability, and regression testing.

(g) **Evaluation:** The evaluation considers the input to Service Transition, addressing the relevance of the service design, the transition approach itself, and the suitability of the new, or changed service for the actual operational and business environments encountered and expected.

(h) **Service Transition Stage Operational Activities:** The Service Transition is also the focus for some operational activities. These have wider applicability than Service Transition and comprise—managing communications and commitment across IT Service Management; managing organisational and stakeholder change; stakeholder management; organisation of Service Transition and key roles.

4. Service Operations: ***The purpose of Service Operation is to deliver agreed levels of service to users and customers, and to manage the applications, technology, and infrastructure that support delivery of the services.*** It is only during this stage of the life cycle that services actually deliver value to the business, and it is the responsibility of Service Operation staff to ensure that this value is delivered. It is important for Service Operation to balance conflicting goals:

- internal IT view versus external business view,
- stability versus responsiveness,
- quality of service versus cost of service, and
- reactive versus proactive activities.

(a) **Event Management Process:** ***An event is a change of state that has significance for the management of a configuration item or IT service.*** An event may indicate that something is not functioning correctly, leading to an incident being logged. An event may also indicate normal activity, or a need for routine intervention such as changing a tape. An event management depends on monitoring, but it is different. An event management generates and detects notifications, whilst monitoring checks the status of components even when no events are occurring.

(b) **Incident Management Process:** ***An incident is an unplanned interruption to an IT service, or a reduction in the quality of an IT service. The failure of a configuration item that has not yet impacted service is also an incident.*** The purpose of Incident Management is to restore normal service as quickly as possible, and to minimise the adverse impact on business operations. Incidents are often detected by event management, or by users contacting the service desk. Incidents are categorised to identify who should work on them and for trend analysis, and they are prioritised according to urgency and business impact. An Incident Management tool is essential for recording and managing incident information.

(c) **Request Fulfillment Process:** ***A service request is a request from a user for information or advice, or for a standard change, or for access to an IT service.*** The purpose of Request Fulfillment is to enable users to request and receive standard services; to source and deliver these services; to provide information to users and customers about services

and procedures for obtaining them; and to assist with general information, complaints, and comments. All requests should be logged and tracked.

(d) ***Access Management Process: The purpose of the Access Management process is to provide the rights for users to be able to access a service, or group of services, while preventing access to non-authorised users.*** The Access Management helps to manage confidentiality, availability, and integrity of data and intellectual property. The process includes verifying identity and entitlement, granting access to services, logging and tracking access, and removing or modifying rights when status or roles change.

(e) **Problem Management Process:** ***A problem is a cause of one or more incidents. The cause is not usually known at the time a problem record is created, and the problem management process is responsible for further investigation***. The key objectives of Problem Management are to prevent problems and related incidents from happening, to eliminate recurring incidents and to minimise the impact of incidents that cannot be prevented. The Problem Management includes diagnosing causes of incidents, determining the resolution, and ensuring that the resolution is implemented. The Problem Management also maintains information about problems and the appropriate workarounds and resolutions.

(f) **Common Service Operation Activities:** The Service Operation includes a number of activities that are not part of the five processes described above. These include:

- monitoring and control,
- console management/operations bridge,
- management of the infrastructure, and
- operational aspects of processes from other life cycle stages.

(g) **Service Desk Function:** The Service Desk provides a single central point of contact for all users of IT. The Service Desk usually logs and manages all incidents, service requests and access requests, and provides an interface for all other Service Operation processes and activities.

(h) **Technical Management Function:** The Technical Management includes all people who provide technical expertise and management of the IT infrastructure. The Technical Management helps to plan, implement, and maintain a stable technical infrastructure and ensures that required resources and expertise are in place to design, build, transit, operate, and improve the IT services and supporting technology. The Technical Management is usually organised based on the infrastructure that each team supports.

(i) **Application Management Function:** The Application Management includes all people who provide technical expertise and management of applications. The Application Management works closely with development, but is a distinct function with different roles. The activities carried out by Application Management are similar to those described above for Technical Management. The Application Management is usually organised on the lines of business that each team supports.

(j) **IT Operations Management Function:** The IT Operations Management is responsible for the management and maintenance of the IT infrastructure required to deliver the agreed

level of IT services to the business. It includes two functions: IT Operations Control and Facilities Management.

5. Continual Service Improvement: The ***Continual Service Improvement (CSI) is concerned with maintaining value for customers through the continual evaluation and improvement of the quality of services and the overall maturity of the ITSM service life cycle and underlying processes.*** The CSI combines principles, practices, and methods from quality management, change management, and capability improvement, working to improve each stage in the service life cycle, as well as the current services, processes, and related activities and technology. The CSI is not a new concept, but for most organisations the concept has not moved beyond the discussion stage. For many organisations, CSI becomes a project when something has failed and severely impacted the business. When the issue is resolved the concept is promptly forgotten until the next major failure occurs. The discrete time bound projects are still required, but to be successful CSI must be embedded within the organisational culture and become a routine activity. This is done on a continual basis to address changes in business requirements, technology, and to ensure high quality is maintained.

The CSI defines three key processes for the effective implementation of continual improvement, the Improvement Process, Service Measurement, and Service Reporting.

(a) **Improvement Process:** The improvement process is a seven-step process that covers the steps required to collect meaningful data, analysis of this data to identify trends and issues, presenting the information to management for their prioritisation and agreement, and implement improvements. Each step is driven by the strategic, tactical and operational goals defined during Service Strategy and Service Design:

1. ***Define what should be measured.*** A set of measurements should be defined that fully support the goals of the organisation. The focus should be on identifying what is needed to satisfy the goals fully, without considering, whether the data is currently available.
2. ***Define what can be measured.*** A gap analysis should be conducted between what is, or can be measured today and what is ideally required. The gaps and implications can then be reported to the business, the customers and IT management. It is possible that new tools or customisation will be required at some stage.
3. ***Gather the data.*** This covers monitoring and data collection. A combination of monitoring tools and manual processes should be put in place to collect the data needed for the measurements that have been defined. The quality is the key objective of monitoring for CSI. If a Service Level Agreement is consistently met over time, CSI is also interested in determining whether that level of performance can be sustained at a lower cost, or whether it needs to be upgraded to an even better level of performance.
4. ***Process the data.*** The raw data is processed into the required format, typically providing an end-to-end perspective on the performance of services and/or processes.

5. ***Analyse the data.*** The data analysis transforms the information into knowledge of the events that are affecting the organisation. Once the data is processed into information, the results can be analysed to answer questions such as: Are we meeting targets? Are there any clear trends? Are corrective actions required? What is the cost?
6. ***Present and use the Information.*** The knowledge gained can now be presented in a format that is easy to understand and allows those receiving the information to make strategic, tactical, and operational decisions. The information needs to be provided at the right level and in the right way for the intended audience. Often there is a gap between what IT reports and what is of interest to the business. Although most reports tend to concentrate on areas of poor performance, good news should be reported as well.
7. ***Implement corrective action.*** The knowledge gained is used to optimise, improve, and correct services, processes, and all other supporting activities and technology. The corrective actions required to improve the service should be identified and communicated to the organisation.

(b) **Service Measurement:** There are four basic reasons to monitor and measure, to:

- *validate* previous decisions that have been made,
- *direct* activities in order to meet set targets—this is the reason most prevalent reason for monitoring and measuring,
- *justify* that a course of action is required, with factual evidence, and, or proof
- *intervene* at the appropriate point and take corrective action.

The monitoring and measurement underpins CSI and the Improvement Process, and is an essential part of being able to manage services and processes, and report value to the business. There are three types of metrics that an organisation needs to collect to support CSI activities as well as other process activities.

- *Technology metrics:* often associated with component and application based metrics such as performance, availability.
- *Process metrics:* captured in the form of Critical Success Factors (CSFs), Key Performance Indicators (KPIs) and activity metrics.
- *Service metrics:* the results of the end-to-end service.
- Component/technology metrics are used to compute the service metrics.

An integrated Service Measurement Framework needs to be put in place that defines and collects the required metrics and raw data, and supports the reporting and interpretation of that data.

(c) **Service Reporting:** A significant amount of data is collated and monitored by IT in the daily delivery of quality service to the business, but only a small subset is of real interest and importance to the business. The business likes to see a historical representation of the past period's performance that portrays their experience, but it is more concerned with those historical events that continue to be a threat going forward, and how IT intends

to mitigate against such threats. It is not enough to present reports depicting adherence or otherwise to SLAs. IT needs to build an actionable approach to reporting, i.e., what happened, what IT did, how IT will ensure it does not impact again and how IT is working to improve service delivery generally.

COBIT—AN IT GOVERNANCE TOOL

The COBIT (Control Objectives for Information and Related Technology) is an international open standard that defines requirements for the control, and security of sensitive data and provides a reference framework. COBIT, which provides a reference framework, was introduced in the 1990s by the IT Governance Institute.

The COBIT consists of an executive summary, management guidelines, framework, control objectives, implementation toolset, and audit guidelines. The extensive support is provided, including a list of critical success factors for measuring security program effectiveness and benchmarks for auditing purposes. The COBIT has been revised several times since inception and upgrades are published at regular intervals.

IT governance is defined as the set of processes that ensure the effective and efficient use of IT in enabling an organisation to achieve its goals.

For many enterprises, information, and the technology that supports it, represent their most valuable, but often least understood, assets. The successful enterprises recognise the benefits of information technology and use it to drive their stakeholders' value. These enterprises also understand and manage the associated risks, such as increasing regulatory compliance and critical dependence of many business processes on information technology (IT).

The need for assurance about the value of IT, the management of IT-related risks and increased requirements for control over information are now understood as key elements of enterprise governance. The value, risk and control constitute the core of the IT governance. Furthermore, IT governance integrates and institutionalises good practices to ensure that the enterprise's IT supports the business objectives. IT governance enables the enterprise to take full advantage of its information, thereby maximising benefits, capitalising on opportunities and gaining competitive advantage.

The Control Objectives for Information and related Technology (COBIT®) provides good practices across a domain and process framework and presents activities in a manageable and logical structure. COBIT's good practices represent the consensus of experts. They are strongly focused more on control, less on execution. These practices will help optimise IT-enabled investments, ensure service delivery and provide a measure against which to judge when things do go wrong.

For IT to be successful in delivering against business requirements, management should put an internal control system, or framework in place. The COBIT control framework contributes to these needs by:

- Making a link to the business requirements
- Organising IT activities into a generally accepted process model

- Identifying the major IT resources to be leveraged
- Defining the management control objectives to be considered

The business orientation of COBIT consists of linking business goals to IT goals, providing metrics and maturity models to measure their achievement, and identifying the associated responsibilities of business and IT process owners. The process focus of COBIT is illustrated by a process model that subdivides IT into four domains and 34 processes in line with the responsibility areas of plan, build, run and monitor, providing an end-to-end view of IT. The enterprise architecture concepts help identify the resources essential for process success, i.e., applications, information, infrastructure, and people.

In summary, to provide the information that the enterprise needs to achieve its objectives, IT resources need to be managed by a set of naturally grouped processes. The assessment of process capability based on the COBIT maturity models is a key part of IT governance implementation. After identifying critical IT processes and controls, maturity modeling enables gaps in capability to be identified and demonstrated to management. The action plans can then be developed to bring these processes up to the desired capability target level. Thus, COBIT supports IT governance by providing a framework to ensure that:

- IT is aligned with the business
- IT enables the business and maximises benefits
- IT resources are used responsibly
- IT risks are managed appropriately

IT Governance Focus Areas

These focus areas are explained below and are depicted in Figure 14.2.

- The strategic alignment focuses on ensuring the linkage of business and IT plans; defining, maintaining, and validating the IT value proposition; and aligning IT operations with enterprise operations.
- The value delivery is about executing the value proposition throughout the delivery cycle, ensuring that IT delivers the promised benefits against the strategy, concentrating on optimising costs and proving the intrinsic value of IT.
- The resource management is about the optimal investment in, and the proper management of, critical IT resources: applications, information, infrastructure, and people. The Key issues relate to the optimisation of knowledge and infrastructure.

Figure 14.2 Element of IT Governance using COBIT

- The risk management requires risk awareness by senior corporate officers, a clear understanding of the enterprise's appetite for risk, understanding of compliance requirements, transparency about the significant risks to the enterprise and embedding of risk management responsibilities into the organisation.
- The performance measurement tracks and monitors strategy implementation, project completion, resource usage, process performance, and service delivery, using, for example, balanced scorecards that translate strategy into action to achieve goals measurable beyond conventional accounting.

The performance measurement is essential for IT governance. It is supported by COB IT and includes setting and monitoring measurable objectives of what the IT processes need to deliver (process outcome) and how to deliver it (process capability and performance). Many surveys have identified that the lack of transparency of IT's cost, value, and risks is one of the most important drivers for IT governance.

While the other focus areas contribute, transparency is primarily achieved through performance measurement. These IT governance focus areas describe the topics that executive management needs to address to govern IT within their enterprises. The operational management uses processes to organise and manage ongoing IT activities. The COBIT provides a generic process model that represents all the processes normally found in IT functions, providing a common reference model understandable to operational IT and business managers. The COBIT process model has been mapped to the IT governance focus areas providing a bridge between what operational managers need to execute and what executives wish to govern.

In order to achieve effective governance, executives require that controls be implemented by operational managers within a defined control framework for all IT processes. The COBIT's IT control objectives are organised by IT process; therefore, the framework provides a clear link among IT governance requirements, IT processes, and IT controls.

The COBIT is focused on what is required to achieve adequate management and control of IT, and is positioned at a high level. The COBIT has been aligned and harmonised with other, more detailed, IT standards and good practices. The COBIT acts as an integrator of these different guidance materials, summarising key objectives under one umbrella framework that also links to governance and business requirements. The COSO (Committee of Sponsoring Organisations of the Treadway Commission's (COSO) and similar compliant frameworks) is generally accepted as the internal control framework for enterprises. COBIT is the generally accepted internal control framework for IT.

The COBIT is a framework and supporting tool set that allow managers to bridge the gap with respect to control requirements, technical issues and business risks, and communicate that level of control to stakeholders. The COBIT enables the development of clear policies and good practice for IT control throughout enterprises. The COBIT is continuously kept up to date and harmonised with other standards and guidance.

Hence, COBIT has become the integrator for IT good practices and the umbrella framework for IT governance that helps in understanding and managing the risks and benefits associated with IT. The process structure of COBIT and its high-level, business-oriented approach provide an end-to-end view of IT and the decisions to be made about IT.

The benefits of implementing COBIT as a governance framework over IT include:

- Better alignment, based on a business focus
- A view, understandable to management, of what IT does
- Clear ownership and responsibilities, based on process orientation
- General acceptability with third parties and regulators
- Shared understanding amongst all stakeholders, based on a common language
- Fulfillment of the COSO requirements for the IT control environment

COBIT Framework

The COBIT Mission is to research, develop, publicise, and promote an authoritative, up-to-date, internationally accepted IT governance control framework for adoption by enterprises and day-to-day use by business managers, IT professionals and assurance professional. A control framework for IT governance defines the reasons IT governance is needed, the stakeholders and what it needs to accomplish.

Why COBIT?

Increasingly, top management is realising the significant impact that information can have on the success of the enterprise. The management expects clear understanding of the way IT is operated and the likelihood of its being leveraged successfully for competitive advantage. In particular, top management needs to know if information is being managed by the enterprise so that it is:

- Likely to achieve its objectives
- Resilient enough to learn and adapt
- Judiciously managing the risks it faces
- Appropriately recognising opportunities and acting upon them

The successful enterprises understand the risks and exploit the benefits of IT and find ways to deal with:

- Aligning IT strategy with the business strategy
- Assuring investors and shareholders that a 'standard of due care' around mitigating IT risks is being met by the organisation
- Cascading IT strategy and goals down into the enterprise
- Obtaining value from IT investments
- Providing organisational structures that facilitate the implementation of strategy and goals
- Creating constructive relationships and effective communication between the business and IT, and with external partners
- Measuring IT's performance

The enterprises cannot deliver effectively against these business and governance requirements without adopting and implementing a governance and control framework for IT to:

- Make a link to the business requirements

- Make performance against these requirements transparent
- Organise its activities into a generally accepted process model
- Identify the major resources to be leveraged
- Define the management control objectives to be considered

Furthermore, governance and control frameworks are becoming a part of IT management good practice and are an enabler for establishing IT governance and complying with continually increasing regulatory requirements.

How COBIT Fulfill the Need?

In response to the needs described above, the COBIT framework was created with the main characteristics of being business-focused, process-oriented, controls-based, and measurement-driven.

1. Business-focused: The business orientation is the main theme of COBIT. It is designed not only to be employed by IT service providers, users and auditors, but also, and more important, to provide comprehensive guidance for management and business process owners. Managing and controlling information are at the heart of the COBIT framework and help ensure alignment to business requirements.

(a) COBIT'S Information Controls: In order to satisfy business objectives, information needs to conform to certain control criteria, which COBIT refers to as business requirements for information. Based on the broader quality and security requirements, seven distinct, certainly overlapping, information criteria are defined as follows:

- The effectiveness deals with information being relevant and pertinent to the business process as well as being delivered in a timely, correct, consistent and usable manner.
- The efficiency concerns the provision of information through the optimal (most productive and economical) use of resources.
- The confidentiality concerns the protection of sensitive information from unauthorised disclosure.
- The integrity relates to the accuracy and completeness of information as well as to its validity in accordance with business values and expectations.
- The availability relates to information being available when required by the business process now and in the future. It also concerns the safeguarding of necessary resources and associated capabilities.
- The compliance deals with complying with the laws, regulations and contractual arrangements to which the business process is subject, i.e., externally imposed business criteria as well as internal policies.
- The reliability relates to the provision of appropriate information for management to operate the entity and exercise its fiduciary and governance responsibilities

(b) IT Resource: In order to respond to the business requirements for IT, the enterprise needs to invest in the resources required to create an adequate technical capability for example ERP system to support a business capability resulting in the desired outcome.

The IT resources identified in COBIT can include automated applications, information, infrastructure, and people.

2. Process-oriented: The COBIT defines IT activities in a generic process model within four domains and these domains map to IT's traditional responsibility areas of plan, build, run, and monitor. The COBIT framework provides a reference process model and common language for everyone in an enterprise to view and manage IT activities. Incorporating an operational model and a common language for all parts of the business involved in IT is one of the most important and initial steps toward good governance. It also provides a framework for measuring and monitoring IT performance, communicating with service providers and integrating best management practices. A process model encourages process ownership, enabling responsibilities and accountability to be defined.

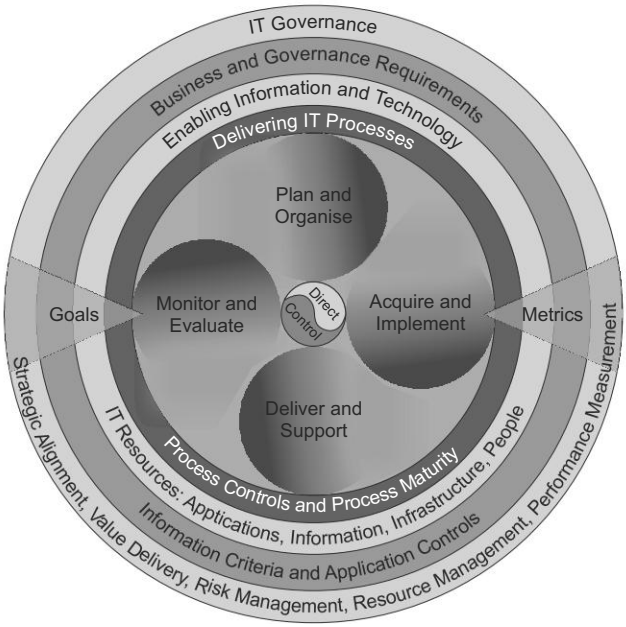

Figure 14.3 COBIT Framework

In order to govern IT effectively, it is important to appreciate the activities and risks within IT that need to be managed. They are usually ordered into the responsibility domains of plan, build, run, and monitor. Within the COBIT framework, these domains (refer Figure 14.3) are called:

- Plan and Organise (PO): Provides direction to solution delivery (AI) and service delivery (DS).
- Acquire and Implement (AI): Provides the solutions and passes them to be turned into services.
- Deliver and Support (DS): Receives the solutions and makes them usable for end users.
- Monitor and Evaluate (ME): Monitors all processes to ensure that the direction provided is followed.

3. Controls-based: The COBIT defines control objectives for all 34 processes, as well as overarching process and application controls. The control is defined as the policies, procedures, practices, and organisational structures designed to provide reasonable assurance that business objectives will be achieved and undesired events will be prevented or detected and corrected. The IT control objectives provide a complete set of high-level requirements to be considered by management for effective control of each IT process. They:

- Are statements of managerial actions to increase value or reduce risk.
- Consist of policies, procedures, practices, and organisational structures.
- Are designed to provide reasonable assurance that business objectives will be achieved and undesired events will be prevented or detected and corrected.

The enterprise management needs to make choices relative to these control objectives by:

- Selecting those that are applicable
- Deciding upon those that will be implemented
- Choosing how to implement them (frequency, span, automation, etc.)
- Accepting the risk of not implementing those that may apply

4. Measurement-driven: A basic need for every enterprise is to understand the status of its own IT systems and to decide what level of management and control the enterprise should provide. In order to decide on the right level, management should ask itself: How far should we go, and is the cost justified by the benefit? Obtaining an objective view of an enterprise's own performance level is not easy. What should be measured and how? The enterprises need to measure where they are and where improvement is required, and implement a management tool kit to monitor this improvement. COBIT deals with these issues by providing:

- Maturity models to enable benchmarking and identification of necessary capability improvements
- Performance goals and metrics for the IT processes, demonstrating how processes meet business and IT goals and are used for measuring internal process performance based on balanced scorecard principles
- Activity goals for enabling effective process performance

COBIT's Acceptability

The COBIT is based on the analysis and harmonisation of existing IT standards and good practices and conforms to generally accepted governance principles. It is positioned at a high level, driven by business requirements, covers the full range of IT activities, and concentrates on what should be achieved rather than how to achieve effective governance, management, and control. Therefore, it acts as an integrator of IT governance practices and appeals to executive management; business and IT management; governance, assurance, and security professionals; and IT audit and control professionals. It is designed to be complementary to, and used together with, other standards, and good practices.

The implementation of good practices should be consistent with the enterprise's governance and control framework, appropriate for the organisation, and integrated with other methods and practices that are being used. The standards and good practices are not a panacea. Their effectiveness depends on how they have been implemented and kept up to date. They are most useful when applied as a set of principles and as a starting point for tailoring specific procedures. In order to avoid practices becoming shelfware, management and staff should understand what to do, how to do it and why it is important.

In order to achieve alignment of good practice to business requirements, it is recommended that COBIT be used at the highest level, providing an overall control framework based on an IT process model that should generically suit every enterprise. The specific practices and standards covering discrete areas can be mapped up to the COBIT framework, thus providing a hierarchy of guidance materials.

ROLES AND RESPONSIBILITIES

The specific roles and responsibilities associated with the management of a successful IT infrastructure includes:

- The Business Relationship Manager (BRM) establishes a strong business relationship with the customer by understanding the customer's business and customer outcomes. The BRMs work closely with the Product Managers to negotiate productive capacity on behalf of customers.
- The Product Manager (PM) takes responsibility for developing and managing services across the life cycle, and have responsibilities for productive capacity, service pipeline, and the services, solutions and packages that are presented in the service catalogues.
- The Chief Sourcing Officer (CSO) is the champion of the sourcing strategy within the organisation, responsible for leading and directing the sourcing office and development of the sourcing strategy in close conjunction with the CIO.
- The Service Design Manager is responsible for the overall coordination and deployment of quality solution designs for services and processes.
- The IT Designer/Architect is responsible for the overall coordination and design of the required technologies, architectures, strategies, designs, and plans.
- The Service Catalogue Manager is responsible for producing and maintaining an accurate Service Catalogue.
- The Service Level Manager is responsible for ensuring that the service quality levels are agreed and met.
- The Availability Manager is responsible for ensuring that all services meet their agreed availability targets.
- The IT Service Continuity Manager is responsible for ensuring that all services can be recovered in line with their agreed business needs, requirements and timescales.
- The Capacity Manager is responsible for ensuring that IT capacity is matched to agreed current and future business demands.
- The Security Manager is responsible for ensuring that IT security is aligned with agreed business security policy risks, impacts and requirements.
- The Supplier Manager is responsible for ensuring that value for money is obtained from all IT suppliers and contracts, and that underpinning contracts and agreements are aligned with the needs of the business.
- The Chief Information Officer and Chief Technology Officers are responsible for overall organisations technology solution are explained in more details in the subsequent paragraphs.

The role of the Chief Information Officer (CIO) is broadly defined as the one responsible for ensuring that the company's information technology investments are aligned with its strategic business objectives.

Chief Information Officer (CIO): In today's economy, business leaders are looking to maximise the effectiveness and productivity of their corporations while minimising resource consumption. The CIO has emerged as the key executive for

information assets, operations, and policy. Moreover, in most businesses, the CIO is responsible for the oversight and management of such office automation tasks as desktop architecture and support, network implementation, software development, and information management. In addition, most CIO responsibilities have expanded beyond the traditional role to include both strategic and tactical duties, as well as corporate policy direction.

Since most businesses are so heavily dependent upon IT, a CIO is forced to work in a political environment. As a result of the expansion of the CIO's traditional role, the job of a CIO has become more stressful, more business oriented, and less hands on. The duties of today's CIOs require a skill set that includes both a strong business background and a core technical background. The CIO is the business executive charged with mapping IT initiatives to the goals of the organisation. In order to accomplish this, a CIO must be a positive leader, an effective communicator (in both listening and speaking), a persuasive negotiator, and a customer oriented individual.

Chief Technology Officer (CTO): As the traditional CIO role has moved away from the hands on technical involvement and into the strategic business operations alignment arena, some companies are supporting the CIO effort by bringing in a CTO. As the right hand of the CIO. In so doing, the CIO is able to align the recommended technologies to the strategic business objectives of the company. This approach establishes the CTO as the technology specialist. As a technology specialist, the CTO should have a skill set not dissimilar to that of the CIO. However, unlike the CIO, the CTO should place more emphasis on a strong technology background and, although important, less on business education.

The CTO is responsible for designing and recommending the appropriate technology solutions to support the policies and directives issued by the CIO.

Most organisation boards consist of the company's top leaders. Each leader represents a unique interest of the company. The CEO represents the driving force of corporate strategy; the CFO represents economic interests, the COO represents logistic interests; and the CIO represents the information technology interests. Each of these interests must be balanced against the others in light of the direction defined by the CEO. The CTO role is a solid investment for most corporations and its value is derived from its functions. Specifically, the CTO, as the right hand of the CIO, provides the company with an executive level subject expert on the issues surrounding the technologies that the CIO must employ in order to achieve the company's strategic objectives.

As per Gartner research there are four types of CIOs:

1. The first type of CIO, still often referred to as CIO, may have responsibility across the enterprise in a demand management role, which is a strategic role focusing on shaping top level business needs and expectations across the enterprise. This type of CIO would not be responsible for delivering on implementation.
2. The second type of CIO, operating at the same level as the first one, is the chief technology officer, or chief infrastructure officer. This executive is responsible for ensuring that the technology based services are delivered in a cost effective way. The responsibilities often include exploiting sourcing opportunities.
3. The third type of CIO is the technology opportunist—an executive responsibility that has grown from the demands of e-business. This is an executive who is heavily involved

in stimulating new business opportunities because of the executive's grasp of emerging technologies and the enterprise business directions.

4. The fourth type, particularly in a multidivisional enterprise, is that of a CIO in charge of a significant business unit within an enterprise. Often, that executive focuses on combining supply and demand roles in a business unit, and is responsible for managing and shaping expectations as well as delivering specific business unit level services.

The Changing Role of the CIO

In the past, economic caution has led many organisations to define the CIO's priorities by what has to be done—reducing cost, ensuring the continuity of the business, maintaining the integrity and security of data, and keeping pace with the changing demands of the business.

Leading market enterprises have recognised the enormous impact that IT can make—not only on growth and responsiveness, but also on process and cost-efficiency. They see beyond technology's traditional role as a support function and a cost saving driver. In these organisations, IT is a business enabler and catalyst for innovation. These organisations recognise that information technology can provide business leverage and be a driver of top line growth. They look to their CIO for the ability to drive this growth. They are using technology to render more efficiency across the business and to enable the business to integrate and exploit new requirements more readily. They are also using technology to provide new distribution channels, understand different ways to segment markets and develop profound new customer insights.

The CIO in these kinds of organisations plays a critical role in resolving issues for the benefit of the future. The CIO has to ensure continuous improvement of the existing IT asset base, making current systems effective and manageable. But the role now extends far beyond being a technologist. The progressive CIOs are providing inputs for the strategic direction of their organisations, focusing on ways to align IT with business needs and unlock more value from business and IT investments. Within a growth agenda, they are helping to map out the gaps between IT and business today, taking advantage of new approaches that reconcile and overcome these differences and identifying, where IT can create the business value of tomorrow.

The history of IT development has been piecemeal and proprietary. It is rare that an enterprise can obtain a full view of its whole IT infrastructure, as it is frequently divided into discrete environments, with ownership of pieces dispersed throughout the organisation. In turn, this makes it difficult to tune IT response and to truly support the business. Furthermore, enterprise IT environments are often characterised by inefficient vertically aligned application and data centre silos. Under pressure to cut their costs, CIOs have been restructuring the IT infrastructure, organisation and the provisioning of IT services. These changes have taken place in the past few years in a step-wise manner, starting with the optimisation of resources (such as server consolidation) within the individual data centres, leading to consolidation of IT services delivery centres into optimised in-house shared services organisations.

However, many organisations have been disappointed in the actual savings realised from shared services approaches, finding instead that for even the largest companies it is difficult, if not impossible, to achieve sufficient IT scale and prowess to deliver anticipated benefits. The shared services also by their very nature provide a homogenous level of IT service across the company,

while in reality, organisations demand a far more granular and individualised level of service delivery. For example, an emerging market, or new start up division would not require, nor could their margins afford, the level of service demanded by an established arm of the business.

Although, the new platforms may indeed be less costly to maintain, offer Web based delivery, facilitate legacy integration and enable new capabilities and business processes, their adoption will require CIOs to be creative in finding new sources of funding. Failing to do so will mean running the risk of being left behind and losing competitive advantage. The resource capabilities will also play a huge role. As CIOs assess their organisation's overall skill set, they must determine if existing staff is adequately trained to apply and manage new technologies across the extended enterprise and on a global scale.

The net result is that CIOs today are challenged to find creative ways to do more with less—to make those critical infrastructure improvements required to meet changing business needs while keeping day-to-day operations running smoothly. Too often, the costs of maintaining critical legacy systems results in siphon off of funds and remaining people earmarked for the development of new, innovative, and business enabling capabilities as requested by the CEO.

Key Characteristics of a CIO

- Well honed CXO level capabilities.
- Able to create a vision for the organisation with a clear understanding of the role of IT in business strategy and operating model innovations.
- Externally, focused on developing networks of equivalent executives across industries.
- Internally, focused on building links and relationships across multiple and complex areas of the business with a cross enterprise view.
- The communications are focused on enterprise-wide benefits, based on deployment of multiple levers, eg IT, business processes, vendor relationships.
- The execution includes IT and business areas not directly related to IT to an equal extent
- A natural at networking, curious about the total enterprise, innovative, has entrepreneurial spirit and great at building relationships.

Key Challenges for CIO's

The CIOs are under increasing pressure to show a rapid return on any IT investments they make, pushing them to look for alternatives that will reduce the financial burden and accelerate the time to value. Even the well-conceived IT projects can be difficult to execute, involving more time and resources than originally expected. While these projects may be designed to solve a particular business issue, they can fall short due to rapid changes in technology and a company's lack of technology skills.

A new IT model is required to address the IT legacies that hinder business growth and flexibility—one that is designed to lower the total cost of ownership of hardware and software, reduce the cost of IT operations and prepare the organisation to take advantage of advancements such as wireless communications, Voice over IP (VoIP), radio frequency identification (RFID), speech recognition, service oriented architecture (SOA), Web services, autonomic computing, cloud computing, big data analytics and grid technologies. The operational efficiency and

a flexible infrastructure are fundamental elements of this new model. It requires a shift to an open operating environment, where all the component parts are fluid and able to change when business conditions change. It requires processes and information that are integrated up and down the supply chain, so that real-time transaction processing, data mining, and decision support are possible within and across company lines. An organisation that can function On Demand Business—can take advantage of new technology advancements. It can implement technologies that are aligned to its business strategies, and it has the resources available to innovate and grow.

The CIOs are automating everyday tasks and improving the quality and speed of server management. They are pooling and optimising servers and other IT resources across business units. By improving resource utilisation and simplifying IT management, they are reducing the need for additional capital investments and reducing their IT costs. The CIOs are also carefully weighing their IT service delivery options. They are asking whether outsourcing IT is a viable option for their company, or whether leveraging a few key vendor-managed services is the way to go. They are taking a candid look at in-house resources and deciding whether they have the necessary skills to handle new technologies internally.

In addition to more flexible delivery models, CIOs are also seeing greater flexibility in vendor pricing for IT services as they look to steer clear of rigid pricing structures that offer monthly predictability without the ability to adjust to changing business needs. In many cases, fixed fees have given way to variable forms of pricing, based on everything from IT capacity consumption to revenue realised. The pricing based on relevant business measures, such as number of users, number of courses completed or revenue realised, is winning strong favour with executive decision-makers. It ties IT spending directly to business results, helping CIOs forge the alignment between business and IT. This offers CIOs an added advantage as they take new IT initiatives forward to CEOs and CFOs. By tying the organisation's IT costs to specified business outcomes instead of infrastructure performance, or other IT related measures, business metric based pricing makes it easier for company leaders to see the return on their IT investment. It can also help simplify and speed future IT spending decisions.

The key to successfully deploying these new deliveries and pricing models lies in understanding, which areas of IT are the levers of growth and which are critical but non-differentiating. By breaking down the IT organisation into discrete building blocks—the people, processes, and infrastructure that perform a single function—CIOs can target the investment areas that have the potential to quickly deliver the greatest return, and those which can be handed off to a lower cost, more efficient partner. For CIOs, this means a mindset of running IT as a business, and employing the same kinds of analytical and management tools that their business line peers are using.

The primary purpose of an IT component is to provide technology enabled business services. These technology enabled services can be in support of internal business activities, or they can be externalised to support consumer serving activities, such as websites. A component based management method provides a collaborative environment to assess the current IT organisation, identify gaps between IT capability and business strategy, and build a roadmap to a desired future state, either from a business, or IT perspective. Using the component map as a tool for analysing the IT organisation and infrastructure, CIOs can begin to see which activities are differentiating and which are not; which carry the highest and lowest costs; and how effectively the organisation

performs the activities within each of the IT components. The result is clear visibility into how strongly IT investments are aligned with IT and business strategic priorities. This approach supports decisions to optimise the IT portfolio, develop new sourcing strategies, prioritise investments, design the organisation and enable innovation that matters for the business.

The emerging needs for e-business are also changing the way in which executive managers perceive the CIO and the CIO's place in the executive boardroom. As a result, enterprises are placing executives with significant IT responsibilities at higher levels of executive decision-making.

BUSINESS CONTINUITY PLANNING

In today's interconnected economy, organisations are more vulnerable than ever to the possibility of technical difficulties disrupting business. Any disaster, from floods, or fire to viruses and cyber terrorism, can affect the availability, integrity and confidentiality of information that is critical to business. ***The primary objective of Business Continuity Planning (BCP) is to manage the risks for an organisation in the event that all or part of its operations and/or information systems services are rendered unusable and aid the organisation to recover from the effect of such events.***

The business continuity planning (BCP) describes the processes and procedures an organisation puts in place to ensure that essential functions can continue during and after a disaster.

The business continuity planning refers to the process of developing advance arrangements and procedures that enable an organisation to respond to an interruption in such a manner that critical business functions continue with planned levels of interruption, or essential change. In simpler terms, BCP is the act of proactively strategising a method to prevent, if possible, and manage the consequences of a disaster, limiting the consequences to the extent that a business can absorb the impact.

The term BCP refers to the complete process of business continuity planning; it includes *inter alia* business, technological, human, and regulatory aspects. The BCP defines the roles and responsibilities and identifies the critical information technology application programs, operating systems, networks, personnel, facilities, data files, hardware, and time frames needed to assure high availability and system reliability based on the business impact analysis. A BCP is a comprehensive statement of consistent actions to be taken before, during and after a disaster. Ideally, BCP enables a business to continue operations in the event of a disruption and survive a disastrous interruption to critical information systems.

The business continuity planning involves the development of an enterprise wide BCP and the prioritisation of business objectives and critical operations that are essential for recovery. This enterprise wide framework should consider how every critical process, business unit, department, and system will respond to disruptions and the relative recovery solutions that are to be implemented. This framework should include a plan for short-term and long-term recovery operations. Without an enterprise wide BCP that considers all critical elements of the entire business, an institution may not be able to resume customer service at an acceptable level. Management should also prioritise business objectives and critical operations that are essential for survival of the institution since the restoration of all business units may not be feasible because of cost, logistics, and other unforeseen circumstances.

Need for BCP

The drivers of BCP should take into consideration natural disasters, internal security breach, and even the terrorism. Every organisation is at risk from potential disasters (natural or man made):

Natural disasters such as tornadoes, floods, blizzards, earthquakes, tsunami, fire

- Terrorism
- Accidents
- Sabotage
- Power and energy disruptions
- Communications, transportation, safety and service sector failure
- Environmental disasters such as pollution and hazardous materials spills
- Cyber attacks and hacker activity.

What really is at risk is the organisational revenue loss; data loss; business reputation loss; and quality of life or life itself. So it is important to:

- Protect your business and your customers
- Protect your government and your citizens
- So, how important is your data?
- How important is your customer?
- How important is your government?
- Have you initiated BCP in your organisation?

Creating and maintaining a BCP helps ensure that an organisation has the resources and information needed to deal with these emergencies.

The business continuity planning process involves the recovery, resumption, and maintenance of the entire business, not just the technology component. While the restoration of IT systems and electronic data is important, recovery of these systems and data will not always be enough to restore business operations. The business continuity planning involves the development of an enterprise-wide BCP and the prioritisation of business objectives and critical operations that are essential for recovery. This enterprise wide framework should consider how every critical process, business unit, department, and system will respond to disruptions and recovery solutions that should be implemented. This framework should include a plan for short-term and long-term recovery operations. Without an enterprise wide BCP that considers all critical elements of the entire business, an institution may not be able to resume customer service at an acceptable level. The management should also prioritise business objectives and critical operations that are essential for survival of the institution since the restoration of all business units may not be feasible because of cost, logistics, and other unforeseen circumstances.

What are being addressed as part of BCP?

- Security of (end) systems
  - Examples: Databases, files in a host, records, operating system, accounting information, logs, etc.

- Security of information in transit over a network
  - Examples: Confidential e-mails, file transfers, record transfers, e-commerce transactions, online banking, authorisation messages, etc.
- Security of data grid in case of natural disaster

Components of BCP

The IT component of BCP defines the response and recovery process that assures the availability of IT operations, reintegration of procedures, applications, operations, systems, data storage, networks, and facilities that are critical to supporting the business process.

The business continuity planning process should include regular updates with the BCP. The BCP should be updated based on changes in business processes, audit recommendations, and lessons learned from testing. The changes in business processes include technological advancements that allow faster and more efficient processing, thereby, reducing acceptable business process recovery periods. In response to competitive and customer demands, many organisations are moving toward shorter recovery periods and designing technology recovery solutions into business processes. These technological advances underscore the importance of maintaining a current, enterprise wide BCP.

The Disaster Recovery Plan (DRP) is a key component of BCP and refers to the technological aspect of BCP—the advance planning and preparations necessary to minimise loss and ensure continuity of critical business functions in the event of a disaster. The DRP comprises consistent actions to be undertaken prior to, during and subsequent to a disaster. A sound DRP is built from a comprehensive planning process, involving all of the enterprise business processes. The disaster recovery strategies include the use of alternate sites (hot, warm, and cold sites), redundant data centres, reciprocal agreements, telecommunication links, disaster insurance, business impact analyses, and legal liabilities.

Additional industry practices that are commonly used to maintain a current BCP include:

- Integrating business continuity planning into every business decision
- Incorporating BCP maintenance responsibilities in applicable employee job descriptions and personnel evaluations
- Assigning the responsibility for periodic review of the BCP to a planning coordinator, department, group, or committee
- Performing regular audits and annual, or more frequent, tests of the BCP.

The number of organisations have adopted a cyclical, process oriented approach to business continuity planning. This process oriented approach includes four steps, which are explained in the following paragraphs. While this approach is reflected as two steps, the business continuity planning process actually represents a continuous cycle that should evolve over time, based on changes in potential threats, business operations, audit recommendations, and test results. In addition, this process should include each critical business function and the technology that supports it. The four steps are:

1. Business Impact Analysis (BIA): The first step in the business continuity process is the development of a BIA. ***The BIA involves the identification of critical business functions and***

workflow, determines the qualitative and quantitative impact of a disruption, and prioritises recovery time objectives (RTOs). The amount of time and resources needed to complete the BIA will depend on the size and complexity of the organisation. The BIA should include a work flow analysis that involves an assessment and prioritisation of those business functions and processes that must be recovered. The work flow analysis should be a dynamic process that identifies the interdependencies between critical operations, departments, personnel, and services. The identification of these interdependencies, as part of the BIA, should assist management in determining the priority of business functions and processes and the overall effect on recovery timelines.

- The goal of BIA is obtain formal agreement with senior management on the Maximum Tolerable Downtime (MTD) for each time critical business resource fails. Maximum tolerable downtime (MTD) is also known as MAO (Maximum Allowable Outage).
- The quantifies loss due to business outage (financial, extra cost of recovery, embarrassment).

Once business functions and processes have been assessed and prioritised, the BIA should identify the potential impact of uncontrolled, non-specific events on these business functions and processes. The non-specific events should be identified so that management can concentrate on the impact of various disruptions instead of specific threats that may never affect operations. At the same time, management should never ignore potential risks that are evident like flood prone areas. In addition to identifying the impact of non-specific events on business functions and processes, the BIA should also consider the impact of legal and regulatory requirements.

The BIA should also estimate the maximum allowable outage (MAO) for critical business functions and processes and the acceptable level of losses (data, operations, financial, reputation, and market share) associated with this estimated downtime. As part of this analysis, management should decide how long its systems can operate before the loss becomes too great and how much data the organisation can afford to lose and still survive. The results of this step will assist institution management in establishing RTOs, and recovery of the critical path, which represents those business processes, or systems that must receive the highest priority during recovery. These recovery objectives should be considered simultaneously to determine more accurately the total downtime. In addition, these recovery objectives require management to determine which essential personnel, technologies, facilities, communications systems, vital records, and data must be recovered and what processing sequence should be followed so that activities that fall directly on the critical path receive the highest priority. One of the advantages of analysing allowable downtime and recovery objectives is the potential support it may provide for the funding needs of a specific recovery solution based on the losses identified and the importance of certain business functions and processes.

This phase may initially prioritise business processes based on their importance to the organisational achievement of strategic goals and the maintenance of safe and sound practices. However, this prioritisation should be revisited once the business processes are modelled against various threat scenarios so that a comprehensive BCP can be developed. The BIA phases can be summarized as:

- Choose information gathering methods (surveys, interviews, software tools)
- Assign MTDs
- Rank critical business functions by MTDs
- Report recovery options
- Obtain management approval

Once the BIA is complete, it should be evaluated during the risk assessment process and incorporated into, and tested as part of, the BCP. The BIA should be reviewed by the board and senior management periodically and updated to reflect significant changes in business operations, audit recommendations, and lessons learnt during the testing process. In addition, a copy of the BIA should be maintained at an offsite location so that it is easily accessible when needed.

2. Risk Assessment: The risk assessment step is critical and has significant bearing on whether business continuity planning efforts will be successful. ***The Risk assessment involves the process of identifying the potential risks to the organisation, assessing the critical functions necessary for the organisation to continue business operations, defining controls in place to reduce exposure, and evaluating the cost of such controls.*** A risk benefit analysis—the outcome of the risk assessment—elaborates the potential threats and the related exposure together with the contingency and mitigation action required, and concludes by describing the benefits arising out of covering the risks.

The organisations should develop realistic threat scenarios that may potentially disrupt business processes and their ability to meet user expectations—internal, business partners, or customers. The threats can take any forms, including malicious activity, natural and technical disasters, and pandemic incidents. Additionally, the magnitude of the business disruption should reflect a wide variety of threat scenarios based upon practical experiences and potential circumstances and events. If the threat scenarios are not comprehensive, the resulting BCP may be too basic and omit reasonable steps that are needed for a timely recovery after a disruption.

The threat scenarios should consider the severity of the disaster, which is based upon the impact and the probability of business disruptions resulting from identified threats. The threats may range from those with a high probability of occurrence and low impact to the organisation, to those with a low probability of occurrence and high impact on the organisation, such as terrorist attacks. Through the use of non-specific, all risk planning, the BCP may be more flexible and adaptable to all types of disruptions. While assessing the probability of a disruption, organisation and its technology service providers should consider the geographic location of all facilities, their susceptibility to threats, and the proximity to critical infrastructures like power grids, nuclear power plants, etc.

After analysing the impact, probability, and the resulting severity of identified threats, the organisation can prioritise business processes and estimate how they may be disrupted under various threat scenarios. The resulting probability of occurrence may be based on a rating system of high, medium, and low. The organisations may perform 'Gap analysis', which is a methodical comparison of what types of policies and procedures the business should implement to recover, resume, and maintain normal business operations, versus what the existing BCP provides. The difference between the two, highlights additional risk exposure that management should address when developing the BCP.

The steps in risk assessment process can be summarised as:

- Evaluating the BIA assumptions using various threat scenarios;
- Analysing threats based upon the impact to the institution, its customers, and the financial market it serves;
- Prioritising potential business disruptions based upon their severity, which is determined by their impact on operations and the probability of occurrence; and
- Performing a 'gap analysis' that compares the existing BCP to the policies and procedures that should be implemented based on prioritised.

Hindustan Times: Rock Solid Gateway

One of the oldest and largest media houses in India, the Hindustan Times Group owns and runs two of the largest newspapers in India—the *Hindustan Times* in English and the *Hindustan* in Hindi. With networking and IT playing a critical role in its daily operations as well in its growth, it is obvious that protection of IT assets from malicious attacks and threats will always be of paramount importance for the Group.

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Challenges

- The HT wanted to prevent their internal environment against external attacks, like Operating System vulnerabilities, viruses, worms, and unauthorised intrusion.
- The company's operations across 15 locations posed another challenge.

Solution

- ASIC based architecture design.
- Multi-level Unified Threat Management.

Benefits

- Prevention of threats from virus and worms.
- Check on intrusion threats and remove vulnerabilities from entering the internal environment
- Attacks handled at the gateway level.
- Better utilisation of Internet resources.

Source: *Dataquest*, Feb 28, 2007, Vol. XXV No. 04

(To read the complete case example visit www.mhhe.com/behl2e)

3. Risk Management: The risk management is an important step in the business continuity planning process. It is defined as the process of identifying, assessing, and reducing risk to an acceptable level through the development, implementation, and maintenance of a written, enterprise wide BCP.

All organisations should develop a BCP that documents business continuity strategies and procedures to recover, resume, and maintain all critical business functions and processes. Some organisations may choose to develop their BCP internally, while others may choose to outsource the development and maintenance of their BCP. While outsourcing BCP development may be

a viable option, the board and management are ultimately responsible for implementing and maintaining a comprehensive BCP.

When outsourcing BCP development, management should ensure that the chosen service provider has the expertise required to analyse the business needs of the organisation. The service provider should also be able to design executable strategies that are relevant to the organisational risk environment, create education and training programmes necessary to achieve successful deployment of the BCP, and integrate necessary changes so that the BCP is properly updated.

A well-written BCP should describe the various types of events that could prompt the formal declaration of a disaster and the process for invoking the BCP. It should also describe the responsibilities and procedures to be followed by each continuity team, have current contact lists of critical personnel, address communication processes for internal and external stakeholders, identify relocation strategies to alternate facilities, and include procedures for approving unanticipated expenses.

The BCP should specifically describe the immediate steps to be taken during a disruption in order to maintain the safety of personnel and minimise the damage incurred by the organisation. The BCP should include procedures to execute the plan's priorities for critical versus non-critical functions, services, and processes. The specific procedures to follow for recovery of each critical business function should be developed so that employees understand their role in the recovery process and can implement the BCP in a timely manner.

The BIA and risk assessment should be integrated into the written BCP by incorporating identified changes in internal and external conditions and the impact of various threats that could potentially disrupt operations rather than on specific events that may never occur. The potential impact of various threats includes the following:

- Critical personnel are unavailable and they cannot be contacted,
- Critical buildings, facilities, or geographic regions are not accessible,
- Equipment (hardware) has malfunctioned or is destroyed,
- Software and data are not accessible or are corrupted,
- Third party services are not available,
- Utilities are not available (power, telecommunications, etc.),
- Liquidity needs cannot be met, and
- Vital records are not available.

When developing the BCP, one should carefully indicate the assumptions on which the BCP is based. The organisation should not assume a disaster will be limited to a single facility, or a small geographic area. Additionally, one should not assume they will be able to gain access to facilities or that critical personnel will be available immediately after the disruption.

An effective BCP coordinates across its components, identifies potential process, or system dependencies, and mitigates the risks from interdependencies. The activation of a continuity plan and restoration of business in the event of an emergency depends on the successful interaction of these various components. The overall strength and effectiveness of a BCP can be decreased by its weakest component. The internal components that should be addressed in the BCP to ensure adequate recovery of business operations may include interdependencies between various

departments, business functions, and personnel within the institution. These interdependencies can also include single points of failure with internal telecommunications and computer systems. The external components that can negatively affect the timely recovery of business operations should be addressed in the BCP, these may include interdependencies with telecommunications providers, service providers, customers, business partners, and suppliers.

The management should develop comprehensive mitigation strategies to resolve potential problems that may result from internal and external interdependencies. The mitigation strategies will depend upon the results of the BIA and risk assessment, but should always ensure that processing priorities can be adequately implemented and that business operations can be resumed in a timely manner.

Once the BCP is complete, the viability of the plan must be assessed as part of the risk monitoring and testing step, which involves the development, execution, evaluation, and assessment of a testing programme. The testing programme is then used to update the BCP based on issues identified as part of the testing process.

4. Risk Monitoring and Testing: The risk monitoring and testing is the final step in the cyclical business continuity planning process. The risk monitoring and testing ensures that the business continuity planning process remains viable. The risk monitoring and testing is necessary to ensure that the business continuity planning process remains viable through the incorporation of the BIA and risk assessment into an enterprise wide BCP and testing programme.

The following principles should be addressed in the business continuity testing programme of all organisations, regardless of whether they rely on service providers, or process their work internally:

- Roles and responsibilities for implementation and evaluation of the testing programme should be specifically defined,
- The BIA and risk assessment should serve as the foundation of the testing programme, as well as the BCP that it validates,
- The breadth and depth of testing activities should be commensurate with the importance of the business process,
- Enterprise wide testing should be conducted at least annually, or more frequently, depending on changes in the operating environment,
- Testing should be viewed as a continuously evolving cycle, and organisation should work towards a more comprehensive and integrated programme that incorporates the testing of various interdependencies,
- Institutions should demonstrate, through testing, that their business continuity arrangements have the ability to sustain the business until permanent operations are reestablished,
- The testing programme should be reviewed by an independent party, and
- Test results should be compared against the BCP to identify any gaps between the testing programme and business continuity guidelines, with notable revisions incorporated into the testing programme or the BCP, as deemed necessary.

A key challenge for management is to develop a testing programme that provides a high degree of assurance for the continuity of critical business processes, including supporting infrastructure, systems, and applications, without compromising production environments. Therefore, a robust testing programme should incorporate roles and responsibilities; a testing policy that includes testing strategies and test planning; the execution, evaluation, independent assessment, and reporting of test results; and updates to the BCP and testing programme.

Testing Strategies: The testing policy should include enterprise wide testing strategies that establish expectations for individual business lines across the testing life cycle of planning, execution, measurement, reporting, and test process improvement. The testing strategy should include the following:

- Expectations for business lines and support functions to demonstrate the achievement of business continuity test objectives consistent with the BIA and risk assessment;
- A description of the depth and breadth of testing to be accomplished;
- The involvement of staff, technology, and facilities;
- Expectations for testing internal and external interdependencies;
- An evaluation of the reasonableness of assumptions used in developing the testing strategy.

LeasePlan: Towards a Secured Environment

LeasePlan is a Gurgaon-based vehicle leasing and fleet management company with nearly 9,500 vehicles. It faced the problem of a growing number of users connecting to LeasePlan applications through various devices (PDAs, laptops, office desktops) and through the Internet. Also, remote access had to be strictly based on different roles and the responsibilities the users were entrusted with.

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Challenges

- Unable to provide transport solutions to customers on real time basis across the country
- Existence of multiple devices
- Compliance requirements
- Need to control user access based on roles and responsibilities

Solutions

- Citrix Access Suite for Centralised Application Management
- Using Citrix Presentation Server, all branches are connected with virtualised access to applications
- VSNL was the VPN service provider

Benefits

- Hardware costs go down by 50 per cent with significant increase in uptime
- Centralised management eases IT administration
- Enhanced security boosts efficiency
- Access based on the types of devices as well as users' roles and responsibilities
- No IT support personnel stationed at any of the branches

Source: *Dataquest*, 28 Feb, 2007, Vol. XXV No. 04

(To read the complete case example visit www.mhhe.com/behl2e)

The testing strategies should include the testing scope and objectives, which clearly define what functions, systems, or processes are going to be tested and what will constitute a successful test. The objective of a testing programme is to ensure that the business continuity planning process is accurate, relevant, and viable under adverse conditions. Therefore, the business continuity planning process should be tested at least annually, with more frequent testing required when significant changes have occurred in business operations.

(a) Test Planning. The testing policy should also include test planning, which is based on the predefined testing scope and objectives established as part of management's testing strategies. The test planning includes test plan review procedures and the development of various testing scenarios and methods. The management should evaluate the risks and merits of various types of testing scenarios and develop test plans based on identified recovery needs. The test plans should identify quantifiable measurements of each test objective and should be reviewed prior to the test to ensure they can be implemented as designed. The test scenarios should include a variety of threats, event types, and crisis management situations and should vary from isolated system failures to wide scale disruptions.

(b) Testing Methods. The testing methods can vary from simple to complex depending on the preparation and resources required. Each bears its own characteristics, objectives, and benefits. The testing methods include both business recovery and disaster recovery exercises. The business recovery exercises primarily focus on testing business line operations, while disaster recovery exercises focus on testing the continuity of technology components, including systems, networks, applications, and data.

The examples of testing methods in order of increasing complexity include:

- ***Structured Walk Through Test.*** A structured walk-through test is considered a preliminary step in the overall testing process and may be used as an effective training tool; however, it is not a preferred testing method. Its primary objective is to ensure that critical personnel from all areas are familiar with the BCP and that the plan accurately reflects the organisational ability to recover from a disaster.
- ***Simulation Test.*** A simulation test is somewhat more involved than a structured walk-through test because the participants choose a specific event scenario and apply the BCP to it. However, this test also represents a preliminary step in the overall testing process that may be used for training employees, but it is not a preferred testing methodology.
- ***Functional Drill Test.*** The functional drill or parallel testing is the first type of test that involves the actual mobilisation of personnel to other sites in an attempt to establish communications and perform actual recovery processing as set forth in the BCP. The goal is to determine whether critical systems can be recovered at the alternate processing site and if employees can actually deploy the procedures defined in the BCP.
- ***Full Interruption Test.*** The full interruption test is the most comprehensive type of test. In a full scale test, a real life emergency is simulated as closely as possible. Therefore, comprehensive planning should be a prerequisite to this type of test to ensure that business operations are not negatively affected. The organisation implements all or portions of its BCP by processing data and transactions using back up media at the recovery site.

Roles and Responsibilities for BCP

The board and senior management are responsible for establishing and reviewing an enterprise wide testing programme. Once the programme is established, they direct the following groups to develop, implement, and evaluate the institution's business continuity testing programme.

- Business line management, which has ownership and accountability for the testing of business operations;
- IT management, which has ownership and accountability for testing recovery of the institution's information technology systems, infrastructure, and telecommunications;
- Crisis management, which has ownership and accountability for testing the institution's event management processes;
- Facilities management, which has ownership and accountability for testing the operational readiness of the institution's physical plant and equipment, environmental controls, and physical security; and
- The internal auditor (or IS auditor), who has the responsibility for evaluating the overall quality of the testing programme and the test results.

IS Auditor: Some organisations involve IS auditor in the design, development, implementation, or maintenance of any process related to the BCP and are assigned to an audit engagement, the independence of the IS auditor may be impaired. In the event of any possible conflict of interest, the same should be explicitly communicated to the organisation and the organisation's concurrence should be obtained in writing before accepting the assignment. The IS auditor should refer to appropriate guidelines to deal with such circumstances.

The IS auditor should provide reasonable assurance that the auditor has the required knowledge and skill to carry out the review of the BCP and its components. The IS auditor should be competent to determine whether the BCP is in line with the organisation's needs. The IS auditor should have adequate knowledge to review the aspects related to the BCP. Where expert inputs are necessary, appropriate inputs should be obtained from external professional resources. The fact that external expert resources would be used should be communicated to the organisation in writing.

A BCP review is essentially enterprise specific, and for the review to be effective, the IS auditor must, at the outset, gain an overall understanding of the business environment, including an understanding of the organisation's mission, statutory, or regulatory requirements peculiar to the organisation, business objectives, relevant business processes, information requirements for those processes, the strategic value of IS and the extent to which it is aligned with the overall strategy of the enterprise/organisation.

The IS auditor should undertake the development of a BCP or policies, testing and recovery plans, only if the IS auditor has the necessary knowledge, competence, skills and resources. The IS auditor should refer to appropriate guidelines to deal with such circumstances. The IS auditor should formulate the audit approach in such a way that the scope and objectives of the review could be fulfilled in an objective and professional manner. The audit approach depends upon the phase of the BCP in the organisation. The approach should consider that the BCP review is a team effort that includes active and stable members as well as discussions with user groups.

The approach should be appropriately documented and identify the requirements of external expert inputs, if appropriate. The critical areas, such as prioritisation of business processes and technologies and results of a risk assessment, should provide reasonable assurance that the plan is effectively implemented as required. Depending on the organisational practices, the IS auditor may obtain the concurrence of the organisation for the BCP audit plan and approach.

Performance of BCP Review

The aspects to be reviewed and the review process should be decided, taking into account the intended scope and objective of the review as well as the approach defined as part of the planning process. In general, the study of available documentation (such as BCP, DRP, BIA, and business risk analysis, and enterprise risk management framework) should be used appropriately in gathering, analysing and interpreting the data. While all of this information may not be readily available, there must be at least a basic risk assessment analysis that defines critical business processes together with IT-based risks. The main areas of risk of a BCP should include previously detected BCP weaknesses and changes introduced in the systems environment—such as applications, equipment, communications, process, and people since the last BCP test.

In order to identify changes in the systems environment, the IS auditor should interview the organisation's personnel and service providers, as well as analyse spending records and reports, inspect IT premises, review hardware and software inventories, and use specialised software to analyse appropriate data. The IS auditor should consider in the review each of the following phases of testing:

- Pre-test—A set of actions required to set the stage for the actual test
- Test—The real action of BCP test
- Post-test—The cleanup of group activities
- Post invocation review—The review of actions following the real invocation of the plan

The test plan objectives should be reviewed to verify whether the test plan accomplishes the following:

- Verifies the completeness and precision of the BCP,
- Evaluates the performance of the personnel involved in the BCP,
- Appraises the training and awareness of the teams,
- Evaluates coordination between BCP teams, disaster recovery teams, external vendors and service providers,
- Measures the ability and capacity of the backup site to meet the organisation's requirements,
- Assesses retrieval capability of vital records,
- Evaluates the state and quantity of equipment and supplies that have been relocated to the recovery site, and
- Measures the overall performance of the operational and processing activity of the organisation.

The BCP testing should be designed carefully to avoid disruption to the business processes. The appropriate areas of BCP testing should be identified as part of the annual review of risk, and duplication of efforts should be avoided.

In reviewing a post-event scenario, the IS auditor should verify:

- The cause and nature of disruption,
- The extent of damage to personnel, infrastructure and equipment,
- The severity of impact,
- Mitigation exercises in process,
- Services affected,
- Records damaged,
- Salvageable items,
- Items that can be repaired, restored and/or replaced,
- Insurance claims,
- Processes affected,
- Time to restore the IT process, and
- Action plan, restoration teams, roles and responsibilities.

The inferences and recommendations should be based on an objective analysis and interpretation of the data. The appropriate audit trails should be maintained for the data gathered, analysis made, inferences arrived at and corrective actions recommended. The observations and recommendations should be validated with the organisation, as appropriate, before finalising the report.

BCP Related Policies and Processes

The following policies, standards, and processes should be integrated into the business continuity planning process:

1. **Security Standards:** The security standards should be an integral part of the entire business continuity planning process. During a disaster, security becomes very important due to potential changes in the working environment, personnel, and equipment. Consequently, different security risks will emerge that should be considered during the risk assessment process. Ultimately, mitigating strategies should incorporate the various risks identified to ensure that adequate security controls are in place if an event triggers the implementation of the BCP. Additionally, security standards should be incorporated into the BCP training and testing programme.
2. **Project Management:** The project management should incorporate business continuity considerations. The evaluating of business continuity needs during the planning stages of a project will allow management to determine compliance with business continuity requirements prior to implementation and to make adjustments in acquisition or development plans accordingly. In addition, advance project planning facilitates the development of a more robust system that supports the institutions' business strategy and business continuity objectives.

3. **Change Control Policies:** In order to maintain the viability of the BCP, change control policies should address potential changes in the operating environment. When a change is made in an application, operating system, or utility in the production environment, a methodology should exist to ensure that all backup copies of those systems are also updated. In addition, if a new, or changed system is implemented and results in new hardware, new capacity requirements, or other technology changes, management should ensure that the BCP is updated and the recovery site can support the new production environment. The change control policies should also allow for changes to be implemented quickly in the event of an emergency; however, these changes should still be properly monitored and documented.
4. **Data Synchronisation Processes:** The data synchronisation processes should include business continuity considerations due to the potential challenges that emerge when dealing with an active environment. The larger, or more complex an institution is the more difficult synchronisation can become. If backup copies are produced as of the close of a business day and a disruption occurs relatively late the next business day, all the transactions that took place after the backup copies were made would have to be recreated, perhaps manually, in order to synchronise the recovery site with the primary site. In some situations, the data latency may be seconds, minutes, or even hours; therefore, reconciliation procedures should be established to ensure that post-disaster data is accurate. Additionally, testing of contingency arrangements is critical to ensure that data can be synchronised with the primary work environment within a reasonable amount of time.
5. **Crisis Management:** The business continuity planning should include the development of a crisis management team and crisis management process. The crisis management team is typically responsible for the actual declaration of an event, and its duties internally are to implement the BCP and externally to deal with outside agencies, government offices, and emergency communications. The team should include a cross-section of individuals from various departments throughout the financial institution, including senior management (decision-making), facilities management (locations and safety), human resources (personnel issues and travel), marketing (media contact), finance/accounting (funds disbursement and financial decisions), and any other area appropriate for the institution.
6. **Incident Response:** Every organisation should develop an incident response policy that is properly integrated into the business continuity planning process. A security incident represents the attempted, or successful unauthorised access, use, modification, or destruction of information systems, or customer data. If unauthorised access occurs, the computer systems could potentially fail and confidential information could be compromised. In the event of a security incident, management must decide how to properly protect information systems and confidential data while also maintaining business continuity. The management's ultimate goal should be to minimise damage to the institution and its customers through containment of the incident and proper restoration of information systems. A key element of incident response involves assigning responsibility for evaluating, responding, and managing security incidents and developing guidelines for employees to follow regarding escalation and reporting procedures. The management

should determine who will be responsible for declaring an incident and restoring affected computer systems once the incident is resolved.

7. **Remote Access:** The remote access policies and standards should be established as an important part of BCP implementation. In the event of a disaster, personnel may be able to work from a remote location and vendors may be allowed remote access to backup facilities. As such, remote access guidelines should be developed addressing acceptable configuration and software requirements for certain remote devices that may introduce security risks. The remote access policies should address various security guidelines including prior management approval requirements, controls for third party access, and virus controls.
8. **Employee Training:** The organisations should provide business continuity training for personnel to ensure that all parties are aware of their primary and backup responsibilities should a disaster occur. The key employees should be involved in the business continuity development process as well as periodic tests and training exercises. The training programme should incorporate enterprise wide training as well as specific training for individual business units. The employees should be aware of the conditions, which call for implementing all, or parts of the BCP; who is responsible for implementing the BCP for business units; and what to do if these key employees are not available at the time of a disaster. The cross training should be used to anticipate restoring operations in the absence of key employees.
9. **Notification Standards:** The formal notification standards should be developed and integrated with the business continuity planning process. The various communication methods, such as satellite phones, cell phones, e-mail, or two-way radios, can be used to promptly notify employees and relevant third parties of a disaster situation. The comprehensive notification standards should address the maintenance and distribution of contact lists that include primary phone numbers, emergency phone numbers, e-mail addresses, and physical addresses of institution personnel, vendors, emergency services, transportation companies, and regulatory agencies. As part of this process, employee evacuation plans should be documented to ensure that financial institution management knows, where employees plan to relocate and how to contact employees during an emergency.
10. **Insurance:** The insurance is an important component of the business continuity planning process. While insurance is not a substitute for an effective BCP, it may allow management to recover losses that cannot be completely prevented and expenses related to recovering from a disaster. Generally, insurance coverage is obtained for risks that cannot be entirely controlled, yet represent a potential for financial loss, or other disastrous consequences.

SUMMARY

✦ It is being increasingly recognised that information is the most important strategic resource that any organisation has to manage. The key to collection, analysis, production, and distribution of information within an organisation is the quality of the IT Services provided to the business.

It is essential that we recognise that IT Services are crucial, strategic, organisational assets, and therefore, organisations must invest appropriate resources into the support, delivery, and management of these critical IT Services and the IT systems that support them. However, these aspects of IT are often overlooked, or only superficially addressed within many organisations.

- The key issues facing many of today's senior Business Managers and IT Managers are: IT and business strategic planning; integrating and aligning IT and business goals; implementing continual improvement; measuring IT effectiveness and efficiency in organisations; Optimising costs and the total cost of ownership (TCO); achieving and demonstrating return on investment (ROI); demonstrating the business value of IT; developing business and IT partnerships and relationships; using IT to gain competitive advantage; managing constant business and IT change; and demonstrating appropriate IT governance.
- The challenges for IT managers are to coordinate and work in partnership with business to deliver high quality IT services. This has to be achieved while adopting a more business and customer oriented approach to delivering services and cost optimisation.
- The primary objective of Service Management is to ensure that the IT services are aligned to business needs and actively support them. It is imperative that the IT services support the business processes, but it is also increasingly important that IT acts as an agent for change to facilitate business transformation.
- All organisations that use IT depend on IT to be successful. If IT processes and IT services are implemented, managed, and supported in an appropriate way, the business will be more successful, suffer less disruption and loss of productive hours, reduce costs, increase revenue, improve public relations and achieve its business objectives.
- Many organisations still see IT service management as being predominantly a technology issue. ITIL promotes a much more 'joined up', 'end-to-end' approach to IT service management replacing the 'technology silos' and isolated 'islands of excellence'. The focus of IT management has been changing for some time and in the future, management will be even less focused on technology and still more integrated with the overall needs of the business management and processes. The new management systems are already starting to evolve and will continue to evolve over the next few years. This development will accelerate, as the management standards for the exchange of management information between tools are more fully defined. In essence, management systems will become:
  - more focused on business needs,
  - more closely integrated with the business processes,
  - less dependent on specific technology and more 'service centric', and
  - more integrated with other management tools and processes as the management standards evolve.
- This will allow 'joined up', 'end-to-end' IT service management processes to be developed that will replace the 'technical silos' and isolated 'islands of excellence' that have previously existed within IT organisations. This will only happen if we adopt practices and architectures that are focused on business needs and business processes. The ITIL framework gives a sound basis for achieving all of this once management tools and interfaces evolve to fully support them.
- The benefits of ITIL includes increased user and customer satisfaction with IT services; improved service availability, directly leading to increased business profits and revenue; financial savings from reduced rework, less time, improved resource management and usage; additional time to market for new products and services, and improved decision-making with optimal risk.
- The IT Service Life Cycle Stages include service strategy, service design, service transition, service operation, and continuous service improvement.

- The specific roles and responsibilities associated with the management of a successful IT infrastructure, includes: Business Relationship Manager (BRM); Product Manager (PM); Chief Sourcing Officer (CSO); Service Design Manager; IT Designer/Architect; Service Catalogue Manager; Service Level Manager; Availability Manager; IT Service Continuity Manager; Capacity Manager; Security Manager; and Supplier Manager. Over and above, the organisations have CIOs and CTOs.
- The role of the Chief Information Officer (CIO) is broadly defined as the one responsible for ensuring that the company's information technology investments are aligned with its strategic business objectives. To this end, the CIO has emerged as the key executive for information assets, operations, and policy. The CTO is responsible for designing and recommending the appropriate technology solutions to support the policies and directives issued by the CIO. In so doing, the CIO is able to align the recommended technologies to the strategic business objectives of the company. This approach establishes the CTO as the technology specialist.
- The COBIT (Control Objectives for Information and Related Technology) is an international open standard that defines requirements for the control and security of sensitive data and provides a reference framework.
- For IT to be successful in delivering against business requirements, management should put an internal control system, or framework in place. The COBIT control framework contributes to these needs by: Making a link to the business requirements; Organising IT activities into a generally accepted process model; Identifying the major IT resources to be leveraged; and Defining the management control objectives to be considered.
- The COBIT framework was created with the main characteristics of being business-focused, process-oriented, controls-based, and measurement-driven.
- The changes in business processes and technology increased terrorism concerns, recent catastrophic natural disasters, and the threat of a pandemic have focused even greater attention on the need for effective business continuity planning. Consequently, these issues should be given greater consideration in the business continuity planning process.
- The business continuity planning process should include the recovery, resumption, and maintenance of all aspects of the business, not just recovery of the technology components. The business continuity planning involves the development of an enterprise wide BCP and the prioritisation of business objectives and critical operations that are essential for recovery. The business continuity planning should include regular updates to the BCP based on changes in business processes, audit recommendations, and lessons learned from testing; and business continuity planning represents a cyclical, process-oriented approach that includes a business impact analysis (BIA), a risk assessment, risk management, and risk monitoring and testing.
- The business continuity planning process should include regular updates to the BCP. The BCP should be updated based on changes in business processes, audit recommendations, and lessons learned from testing. The changes in business processes include technological advancements that allow faster and more efficient processing, thereby reducing acceptable business process recovery periods. In response to competitive and customer demands, many financial institutions are moving toward shorter recovery periods and designing technology recovery solutions into business processes. These technological advances underscore the importance of maintaining a current, enterprise wide BCP.
- When critical services and products cannot be delivered, consequences can be severe. All organisations are at risk and may face potential disaster if they are not prepared. A business continuity planning is a tool that allows organisations to not only monitor risk, but also continuously deliver products and services despite any disruptions. In summary, the following factors represent critical aspects of an effective business continuity planning process:

- The effectiveness of business continuity planning depends upon the involvement of the board and senior management
- The business continuity planning involves a continuous, process-oriented approach that includes a BIA, a risk assessment, risk management, and risk monitoring and testing
- A thorough BIA and risk assessment should form the foundation of a comprehensive BCP
- The BCP and testing programme should be developed on an enterprise wide basis
- The effectiveness of the BCP should be validated through annual, or more frequent testing.
- The BCP and test programme should be thoroughly documented, evaluated by institution management, independently reviewed by an internal and/or external audit function, and reported to the board
- The BCP and test programme should be updated to reflect and respond to changes in the institution and gaps identified during continuity testing; and in addition to BCP, other financial institution policies, standards, and processes should be integrated with the business continuity planning process.

KEY TERMS

Business Continuity Planning (BCP)
Business Impact Analysis (BIA)
Business Service Management
Business Strategic Planning
Capacity Management
Change Management
Chief Information Officer
Chief Technology Officer
Continual Service Improvement
Control Objectives for Information and Related Technology (COBIT)
Critical Success Factors
Demand Management
Disaster Recovery Planning
Event Management Process
Incident Management Process
Information Security Management
Information Technology Infrastructure Library (ITIL)
Information Technology Service Management
Infrastructure Management
IT Governance
IT Infrastructure Management
IT Maturity Model
IT Service Continuity Management
Knowledge Management
Performance Measurement
Resource Management
Return on Investment (ROI)
Risk Assessment
Risk Management
Risk Monitoring and Testing
Service Catalogue Management
Service Design
Service Level Agreements (SLA)
Service Level Management
Service Management
Service Measurement
Service Operation
Service Portfolio Management
Service Reporting
Service Strategy
Service Transition
Total Cost of Ownership

SELF-STUDY QUESTIONS

1. _____is a business approach to ensure critical business functions are maintained, or restored in a timely manner, in the event of material disruptions arising from internal or external events.
   (a) Business continuity management (BCM)
   (b) Disaster Management
   (c) ITIL
   (d) COBIT

2. _____is a set of specialised organisational capabilities for providing value to customers in the form of services.
   (a) Service Transition (b) Service Management
   (c) Service Strategy (d) Service Operation
3. Which one of the following is NOT part of IT Service Life Cycle Stages?
   (a) Service Strategy (b) Service Transition
   (c) Service Operation (d) Critical Success Factors
4. The purpose of _____ is to deliver agreed levels of service to users and customers, and to manage the applications, technology, and infrastructure that support delivery of the services.
   (a) Service Transition (b) Service Management
   (c) Service Strategy (d) Service Operation
5. _____ consists of an executive summary, management guidelines, framework, control objectives, implementation toolset, and audit guidelines.
   (a) Business continuity management (BCM) (b) Disaster Management
   (c) ITIL (d) COBIT
6. The Strategic Alignment, Value Delivery, Resource Management, Risk Management, and Performance Measurement are focus areas of _____.
7. This executive is responsible for ensuring that the technology based services are delivered in a cost effective way.
   (a) CEO (b) CIO (c) CTO (d) CFO
8. _____ refers to the process of developing advance arrangements and procedures that enable an organisation to respond to an interruption in such a manner that critical business functions continue with planned levels of interruption or essential change.
   (a) Business continuity planning (b) Six Sigma
   (c) ITIL (d) COBIT
9. _____ is a key component of BCP and refers to the technological aspect of BCP—the advance planning and preparations necessary to minimise loss and ensure continuity of critical business functions in the event of a disaster.
   (a) Business continuity management (BCM) (b) Disaster Management
   (c) ITIL (d) COBIT
10. The goal of _____ is obtain formal agreement with senior management on the Maximum Tolerable Downtime (MTD) for each time critical business resource fails.

REVIEW QUESTIONS

1. What do you understand by IT Infrastructure management? Why does the organisation need that?
2. How IT service management is different from IT management? Who is responsible for addressing this in an organisation?
3. Define the role of CIO and how is it different from that of CTO.
4. What do you mean by Business Continuity Planning? How it is different from Disaster Management?

5. What is the relevance of BCP in terms of IT?
6. Determine management's consideration of newly identified threats and vulnerabilities to the organisation's business continuity process.
7. Establish the scope of the examination by focusing on those factors that present the greatest degree of risk to the manufacturing, or service organisation.
8. List and describe the major components of BCP.
9. Review the BIA and risk assessment to determine whether the prioritisation of business functions is adequate in your organisation.
10. What are the different test strategies for successful implementation of BCP?

QUESTIONS FOR DISCUSSION

1. Why organisations need to integrate their IT infrastructure?
2. Most organisations have legacy systems and also the ERP systems. What are the challenges these kind of organisations face?
3. Identify the role of IS auditor. Why organisations need to hire them?
4. For a service organisation, who should be part of BCP team?
5. BCP projects are to handled by the IT teams. Justify.

APPLICATION EXERCISES

1. Determine, whether the senior management has ensured that integral groups are involved in the business continuity process within your organisation. Determine, whether they have established an enterprise wide BCP and testing programme that addresses and validates the continuity of the organisation's mission critical operations.
2. Determine, whether the work flow analysis was performed to ensure that all departments and business processes, as well as their related interdependencies, were included in the BIA and risk assessment.
3. Identify the role of CIO in BCP implementation in an organisation. What role the IS auditor performs in building BCP?
4. Determine whether the BIA identifies maximum allowable downtime for critical business functions, acceptable levels of data loss and backlogged transactions, recovery time objectives (RTOs), and recovery point objectives (RPOs).
5. If the organisation is relying on in house systems at separate physical locations for recovery, what kind of equipment is capable of independently processing all critical applications?
6. If the organisation is relying on outside facilities for recovery, determine the kind of facilities the organisation should provide.
7. How the recovery process is to be handled if the disaster conditions occur simultaneously at multiple locations?
8. Determine, whether the BCP addresses communications and connectivity with technology service providers (TSPs) in the event of a disruption at the organisation.
9. What testing strategy should be adapted to addresses the need for enterprise wide testing and testing with significant third parties?

10. What testing strategy addresses the documentation requirements for all facets of the continuity testing programme, including test scenarios, plans, scripts, results, and reporting?

GROUP PROJECTS

1. Select an organisation and determine whether appropriate risk management over the business continuity process is in place. You must evaluate this in the following terms:

   Determine whether adequate risk mitigation strategies have been considered for:

   - Alternate locations and capacity for:
     - Data centres and computer operations;
     - Back room operations;
     - Work locations for business functions;
     - Telecommunications and remote computing.
   - Backup of:
     - Data;
     - Operating systems;
     - Applications;
     - Utility programmes;
     - Telecommunications.
   - Secure and up to date off site storage of:
     - Backup media;
     - Supplies;
     - BCP;
     - System documentation (e.g. topologies; inventory listing; firewall, router, and network configurations; operating procedures);
   - Alternate power supplies (e.g. uninterruptible power source, backup generators);
   - Recovery of data (e.g. backlogged transactions, reconciliation procedures);
   - Preparation for return to normal operations once the permanent facilities are available.

2. Select an organisation and verify that appropriate policies, standards, and processes address business continuity planning issues including:
   - Security;
     - Project management;
     - Change control process;
     - Data synchronisation, backup, and recovery;
     - Crises management (responsibility for disaster declaration and dealing with outside parties);
     - Incident response;
     - Remote access;
     - Employee training;
     - Notification standards (employees, customers, regulators, vendors, service providers);
     - Insurance; and
     - Government and community coordination.

Caselets

1. Security System at CRISIL

The CRISIL is India's leading ratings, research, and risk, and policy advisory company. Until recently, the company was having trouble ensuring that its stringent internal guidelines on data confidentiality were adhered to, as more and more employees globally tried to get access to data from remote locations.

The CRISIL is a part of Standards and Poor (S and P), a global provider of independent credit ratings, indices, risk evaluation, investment research, and data. It faced security challenges because of access of data by users across the globe. The CRISIL needed a solution that enabled its employees to securely access business applications remotely. The authentication of employees beyond a simple username and password was a priority. Most organisations use passwords as a common form of authentication, making themselves vulnerable to intruders. In addition, they are also vulnerable to hacking by various methods such as keystroke monitoring, social engineering techniques or brute force attacks.

As most of the data accessed was confidential, another level of authentication through a different access medium was the need of the hour. While email could be accessed by a simple web based access, the CRISIL decided that for business applications, a stronger level of security was needed to help protect its network, as well as help meet increasing regulatory requirements.

The CRISIL started looking at various security options to add another level of authentication. The organisation looked at popular options such as digital certificates and VPNs. While the first option was ruled out due to hindrances of software installation at the client side, VPNs were ruled out as they required a particular port to be opened, which would have made CRISIL's internal network vulnerable.

The CRISIL with the help of local integrator, SK International, decided to implement a combined solution from Citrix and RSA Security's secure mobile and remote access solution. The company chose the solution because of its portability, ease of use and its overall security protection. It also gave CRISIL the assurance and security necessary to open its networks to outsiders, while at the same time, extending to its employees the resources needed to work and collaborate more efficiently.

The RSA SecurID two factor authentication solution requires the user to key in a passcode, a combination of a PIN (something the user knows) and a one-time password generated by the RSA SecurID token (something the user has). The passcode is extremely difficult for an intruder to detect, as it changes every 60 seconds, creating a unique identity for the user that is valid only for that particular period of time. The technology is platform independent, which ensures mobility. The user can access applications securely from any Internet-enabled terminal, using an RSA SecurID authenticator and the Citrix Secure Gateway.

The RSA Security's integration with Citrix helped enforce security at three levels—(1) the standard user name/password level, (2) domain level authentication, which is provided by the Citrix Secure Gateway, and (3) the user name and passcode.

"One of the biggest challenges in security is identity management, which we have successfully dealt with using RSA Security's secure mobile and remote access solution," says Hiren Shah, chief technology officer at CRISIL. "The solution has provided us with a means to securely provide access to business applications both reliably and cost effectively."

Questions for Discussion

1. What are the key challenges being faced by CRISIL?
2. Why CRISIL needs to implement the security system?
3. Do they have any BCP? If yes, list the features.
4. If you need to review the BCP of CRISIL, how would you go about doing that?

Source: *Dataquest*, 28 Feb, 2007, Vol. XXV No. 04

2. Securing Information Systems

Time and again, we have seen how critical security is to an enterprise. The security market has seen a steady growth this year too, despite the recession. the strong and continuing growth of networks and increasing security threats are driving the growth in demand for comprehensive network security solutions in India. Though the Firewall still is the most dominant, emerging technologies such as SSL VPN and IDS/IPS are gaining momentum too, along with other integrated solutions that offer multiple functionalities on a single platform. Here are a few examples of how Symantec is helping consumers and organisations across verticals in securing and managing their information-driven world.

ICICI BANK

As ICICI bank operates in global markets; security is a major business concern. They selected several Symantec technologies and services to address their requirements in this area. First, for endpoint security, they rolled out Symantec Endpoint Protection 11.0. In addition to enhanced efficiencies and IT staff productivity gains, including a 10% improvement in IT staff productivity improvements, the bank expects to save $250,000 in lower software licensing (compared to the solution prior to this).

Second, ICICI bank added Symantec Security Information Manager for centralised security management. They augmented the solution with Symantec DeepSight Threat Management System for proactive, real-time threat reports. The solution provides the team with automated log monitoring, which is projected to cut the time spent monitoring and managing the security environment in half and to reduce the time required to complete audits by 30%. ICICI bank has also implemented Symantec Mail Security appliances that reduce spam and dramatically slashed false positives. The projected results include annual savings of approximately 1,250 work days, or 10,000 hours employees previously spent managing spam.

HDFC BANK

In Feb 2008, Symantec announced that HDFC Bank, India's leading global bank has entered into a $7.4 mn, three-year strategic enterprise level agreement for IT compliance, enterprise security and storage management solutions. Under the agreement, Symantec is also providing HDFC Bank with consulting and implementation services. HDFC Bank entered into this deal with Symantec to further enhance the banks security posture, ensure that data is protected and available; and also to help facilitate their compliance and corporate governance programs to increase customer confidence.

The bank has a network of 754 branches and 1,906 ATMs across 327 towns and cities in India. Owing to exponential data growth and the need to comply with an ever-expanding number of laws and regulations, HDFC expanded its relationship with Symantec to help minimise risk and maximise the efficiency of its IT organisation.

The Symantec is now providing HDFC with a comprehensive set of security and storage solutions and services:

- IT Compliance Solution will help HDFC Bank automate and standardise processes for compliance with laws, regulations and frameworks including SOX, Basel II, COBIT, ITIL and ISO 27001.
- Security Information Manager will provide HDFC Bank the ability to automate incident management and event correlation across all security devices, network devices, applications, servers, operating systems, and databases.
- The Mail Security and Database Security solutions enable the bank to secure their messaging environment and protect sensitive information. The final layer of solution will be focused around protecting critical network endpoints of HDFC Bank with the integrated endpoint protection and network access control solutions.
- Together, Veritas NetBackup, Veritas Volume Replicator and Veritas Storage Foundation will help HDFC improve efficiency, protect information and minimise server downtime at critical branches of the bank.

NATIONAL COMMODITY AND DERIVATIVES EXCHANGE

When backup operations threatened to implode due to burgeoning data volumes, NCDEX standardised

the exchanges backup-and-recovery infrastructure on Veritas NetBackup. This helped it decrease backup and recovery time by nearly 80% from twenty hours to six hours. The team also designed and implemented a disaster recovery solution, built on Veritas data center management solutions, which allow NCDEX to replicate data from its primary to secondary data center locations as well as fail applications over in real-time, increasing hardware efficiency and ensuring maximum availability for business-critical applications. As a result, NCDEX has saved more than $200,000 through hardware cost avoidance and increased system availability for business critical applications to 99.9%.

WIPRO

Wipro implemented a compliance solution based on Symantec software to automate and ensure IT compliance while optimising email archiving and discovery, which on completion expected to reduce audit preparation time by 20-30 %. Standardizing on Veritas Data Center Foundation for the management of storage, servers and application performance, Wipro improved employee productivity by nearly 30% and reduced email storage requirements by 20%. With improvements in the data center, Wipro has been able to accelerate the data backup process, cutting the backup window in half.

TATA CONSULTANCY SERVICES

Tata Consultancy Services decided to consolidate backup and recovery and security monitoring and reporting using Symantec products. The centralised backup and recovery environment is producing significant business value for TCS, including savings in tape drive costs, an improvement in backup success rates, and an improvement in IT staff productivity resulting from a 40% reduction in the time spent managing backups. A Symantec Elite Program agreement for NetBackup provides TCS with greater flexibility and reduces the amount of time to provision new data center servers.

For threat protection and management on endpoints, the TCS team relies on Symantec AntiVirus Enterprise Edition and Symantec Enterprise Security Manager. The combination allows TCS to proactively monitor and manage their threat landscape, helping to reduce the number of security impacts to the TCS IT environment.

RELIANCE COMMUNICATIONS

Reliance Communications standardized backup and recovery operations on Veritas NetBackup, which allows it to use the most cost-effective server and storage hardware platforms as well as operating systems to support 50% annual data growth. The solution has helped improve IT backup staff productivity by an estimated 78% and is proving scalable, handling weekly backup volume of more than 150 terabytes.

Working with Symantec Consulting Services, Reliance added Veritas Storage Foundation for Oracle RAC, to support the company's PhoneGen application (electronic recharging/OTAF process) for mobile subscribers, through which significant revenue streams are generated. The solution has improved application availability to 99.99%.

TVS

The top priority of the TVS Group was to deliver tangible business value back to both organisations—TVS Motor Company and Sundaram-Clayton. Their past experience of deploying Symantec on various instances, over the past few years, had been quite satisfactory. TVS had a disparate server environment scattered across multiple locations in India, they standardised backup and this has been restored on Symantec Backup Exec Data for more than twenty servers. It is now backed up on a regular basis with an estimated success rate having improved by a minimum of 10%.

In the case of endpoint security and messaging security, the team upgraded to Symantec Endpoint Protection 11.0 and Symantec Mail Security. Prior to when the solution was rolled out, four dedicated full-time employees, who were previously assigned the task of managing issues related to spam, are now dedicated to other more business-critical initiatives. In addition, spam was reduced to less than 1% of all email and false positives are virtually non-existent. The time employees spend dealing with spam email saves each employee approximately ten minutes per workday.

Source: *Dataquest,* May, 2009

Questions for Discussion

1. What are the key challenges being faced by the companies in the case and what are their threat areas?
2. Do they have any BCP? If yes, list the features.
3. How some of these companies are trying to cover their security threats.

Answers to Self Study Questions

1. (a)	2. (b)	3. (d)	4. (d)
5. (d)	6. IT Governance using COBIT		7. (c)
8. (a)	9. (b)	10. BIA	

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