Fundamentals of Information Technology

SECOND EDITION

Alexis Leon   Mathews Leon

Fundamentals of
Information Technology
Second Edition

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Information Technology
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To

Rev. Fr. Varghese Muzhuthett

who taught us the fundamentals of good English

Preface

"The number one benefit of information technology is that it empowers people to do what they want to do. It lets people be creative. It lets people be productive. It lets people learn things they did not think they could learn before, and so in a sense it is all about potential."

— Steve Ballmer

Information Technology (IT) is revolutionizing the way in which we live, work, study, learn, play, and do business. The digital revolution has given mankind the ability to treat information with mathematical precision, to transmit it at very high accuracy and to manipulate it at will. Computers and communications are becoming integral parts of our lives.

A few decades back communications used to be between people. But now inanimate objects are getting into the act—books can tell the cash registers how much they cost; identity cards can tell the door lock whether to open or not; automated guided vehicles can tell the host computer where they are in the shop floor, what they are carrying, and when they will be free; missiles can compare the landscape with their own map and hit the target with pin-point precision; on the Internet people engage in lively chats, discussions, and play games even if they are physically in different continents.

The changes mentioned above in the fields of Computer Science and IT add up to what is called the information revolution or IT revolution. To survive in this information world one must keep pace with these changes. As with the first edition, the objective of this book remains the same—provide an introduction to IT. The book deals with the fundamental concepts, technologies and theories as well as advanced concepts and practical applications. The book starts with an introduction to computers and telecommunications and then deals with the latest developments and technologies.

The book is divided into nine units and deals with IT and related topics from the fundamentals to the advanced. The first unit deals with the working of computers, computer peripherals, and the IT basics. Unit II covers the software development process and the different kinds of software that we use in our daily life. Unit III gives an introduction to databases, database architecture, database design, data modeling, and database management systems. The fourth unit gives a comprehensive overview of telecommunications, networks, communications systems, and distributed data processing. Unit V deals with Internet, WWW, intranets, e-mail, e-commerce, web design, web technologies, etc. in great detail. The sixth unit covers a very important area of IT—computer security. Unit VII gives an in-depth coverage of multimedia, multimedia applications, and virtual reality. Unit VIII gives an overview of the emerging technologies in the IT field. The ninth unit gives the practical applications of IT in everyday life—at home, at work, and in education, science, engineering, and medicine. The appendix traces the history of computing from the first century BC to the late 1990s.

The book is written in an easy-to-read and jargon-free style. We have used a lot of images, tables, bulleted lists, etc. to make the reading and comprehension easier, and also to illustrate, familiarize, and demonstrate the capabilities, benefits, and limitations of IT and the related applications. We have used cartoon characters to make the figures interesting and easy to remember. But when you are appearing for the examinations, you should replace the cartoon characters with suitable geometrical shapes. An example of how it could be done is shown as follows. The example shows Figure 17.1 (Database System Architecture) as it appears in the book and how it should be drawn for the examination.

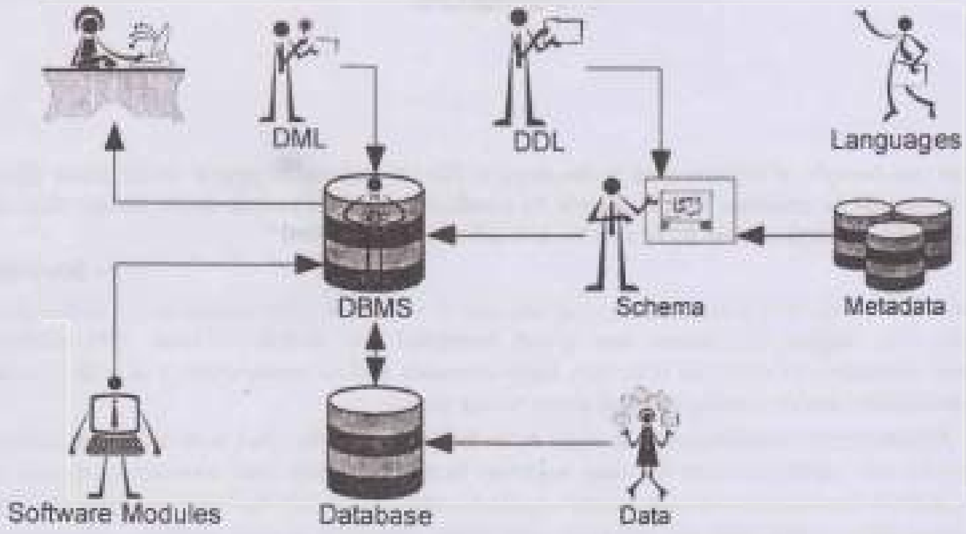

Figure 17.1 Database System Architecture (as in the book)

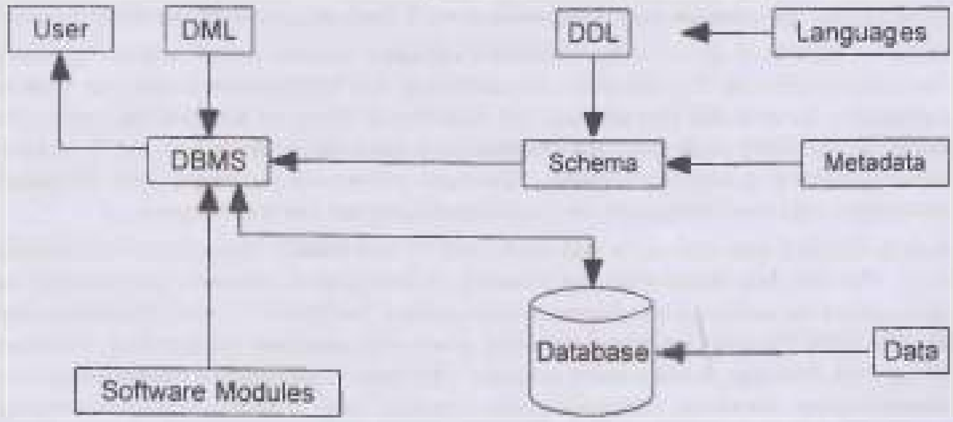

Figure 17.1 Database System Architecture (for exam purposes)

PEDAGOGICAL FEATURES

We have included a lot of pedagogical features in this book. These include more than **1200 review questions** (short answer questions, descriptive type questions, and essay questions) and about **1300 objective type questions** (fill in the blanks, true or false, and multiple choice questions). The answers to the objective questions are given at the end of each chapter. The questions are designed to make your learning easy and effective.

WEB SUPPORT

One of the most important features of this book from the learning and teaching point of view is the companion website of the book. The companion web site is at *http://www.leon-leon.com/it/fit2e/*. The ebsite is designed with the objective of information sharing and offers different ways to learn and are your views with others – students, teachers and professionals.

CKNOWLEDGMENTS

is book is the product of a shared vision. We would like to give our special thanks to the people ho helped to create it. We would like to express our gratitude to **P. K. Madhavan** and the editorial am at Vijay Nicole Imprints Pvt. Ltd. We are also grateful to **Piyush Chawla** and **Sudhanshu Gupta** Vikas Publishing House Pvt. Ltd. for their suggestions and comments. Thanks to our parents **Leon lexander** and **Santhamma Leon** for their love and support.

Finally, we would like to thank our readers. We have incorporated the suggestions and feedback at we received from you and it has definitely helped in making the book more readable and mprehensive. We hope you enjoy reading this book and find it useful. We would love to hear your ews, comments and suggestions. We wish all of you, all the very best in your careers and look rward to meet you in the cyberspace...

Alexis Leon & Mathews Leon

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CHAPTER 01

Introduction to Computers

TOPICS COVERED

- Introduction
- Importance of computers
- Characteristics of computers
- Classification of computers
- What computers can do?
- What computers cannot do?
- Uses of computers

> **Key Points**
>
> ▲ Computer is a machine that performs calculations and processes information with astonishing speed and precision. A computer can take thousands of individual pieces of data and turn them into more usable information—with blinding speed and almost unfailing accuracy.
>
> ▲ The value of computers lies in their ability to perform certain basic tasks quickly and accurately. These tasks include solving numerical problems, storing and retrieving information, creating and displaying documents and pictures, etc.
>
> ▲ All computers have the following common characteristics irrespective of their type and size: word length, speed, storage, accuracy, versatility, automation, and diligence.
>
> ▲ Computers can be classified by their size and power as personal computers, workstations, portable computers, minicomputers, mainframes and supercomputers.
>
> ▲ Computers can help us in solving many complex tasks and improving the quality of our lives. They can help in producing better quality products, help in teaching and assist in eliminating human error. But computers have many limitations like lack of intelligence, lack of reasoning capabilities, etc.
>
> ▲ Computers have become an integral part of our lives and are helping us in improving the standard of living, enhancing the quality of products, providing better healthcare, assisting in teaching and learning, etc.

INTRODUCTION

Computer is a machine that performs calculations and processes information with astonishing speed and precision. A computer can handle vast amounts of information and solve complicated problems. It can take thousands of individual pieces of data and turn them into more usable information—with blinding speed and almost unfailing accuracy. The most powerful computers can perform billions of calculations in a second. A computer is a programmable machine. The two principal characteristics of a computer are:

- It responds to a specific set of instructions in a well-defined manner.
- It can execute a prerecorded list of instructions (a program).

Modern computers are electronic and digital. The actual machinery—wires, transistors, and circuits—is called hardware; the instructions and data are called software.

Computers have changed the way people work. Computers handle many tasks in business, education, manufacturing, transportation, and other fields. Many tedious tasks that required large number of clerical workers are now done by computers. They provide scientists and other researchers with a clearer understanding of nature.

Computers give authors and writers an effective way to create documents. They enable designers and artists to see things that have never been seen before. Computers produce new information so quickly and accurately that they are changing people's views of the world. People can access large electronic databases remotely. For these and other reasons, the computer is one of the most interestin and important machines ever invented. Figure 1.1 shows a multimedia personal computer (PC) fro HP.

Figure 1.1 Multimedia Personal Computer (HP Media Center PC)

IMPORTANCE OF COMPUTERS

Computers are important in a variety of ways. For example, they simplify difficult or time-consumin tasks to an extraordinary degree. They provide businesses, governments, individuals, and institution with an efficient way to manage large amounts of information. Computers also help people t understand things better by allowing them to make models and test theories. The value of computer lies in their ability to perform certain basic tasks quickly and accurately. These tasks include:

- **Solving numerical problems** – One of the most important and most difficult jobs performed by computers is the solution of complicated problems involving numbers. Computers ca solve such problems amazingly quickly.
- **Storing and retrieving information** – People use computers to store unbelievably larg quantities of information. Information stored in a computer is sometimes called a database. Databases can be enormous—for example, a country's entire census might be contained in a single database. A computer can search a huge database quickly to find a specific piece of information. In addition, the information can be changed easily and quickly—often in less than a second. The efficiency with which computers store and retrieve information makes them valuable in a wide range of professions.
- **Creating and displaying documents and pictures** – Computers can store a huge number of words in a way that makes it easy to manipulate them. For this reason, word processing is one of the most important and widespread uses of computers. A word-processing program allows people to type words into a computer to write articles, books, letters, reports, and other kinds of documents. Computers are also important in the publishing industry. For example, most books, magazines, and newspapers are typeset by computers. Computer graphics is the use of

computers to make pictures. It is one of the most fascinating and fastest growing areas of computer usage.

CHARACTERISTICS OF COMPUTERS

All computers have certain common characteristics irrespective of their type and size. Computers are not just adding machines; they are capable of doing complex activities and operations. They can be programmed to do complex, tedious and monotonous tasks. Computers are what they are because of the following characteristics.

Word Length

A digital computer operates on binary digits—0 and 1. It can understand information only in terms of 0s and 1s. A binary digit is called a bit. A group of 8 bits is called a byte. The number of bits that a computer can process at a time in parallel is called its word length. Commonly used word lengths are 8, 16, 32 or 64 bits. Word length is the measure of the computing power of a computer. The longer the word length, the more powerful the computer is. When we talk of a 32-bit computer, it means that its word length is 32 bits.

Speed

Computers can calculate at very high speeds. For example, a microcomputer can execute millions of instructions per second over and over again without any mistake. As the power of the computer increases, the speed also increases. For example, supercomputers can operate at speeds measured in nanoseconds and even in picoseconds—one thousand to one million times faster than microcomputers.

Storage

Computers have main memory and auxiliary memory systems. They can store a large amount of data. With more and more auxiliary storage devices, which are capable of storing huge amounts of data, the storage capacity of a computer is virtually unlimited. The factor that makes computer storage unique is not that it can store vast amount of data, but the fact that it can retrieve the information that the user wants in a few seconds. For example, computer dictionaries are available and the contents of these software versions are the same as that of the printed dictionary. But you can search and find the meaning of a word from the computer version in a matter of seconds, whereas with the traditional dictionary, you have to turn the pages until you get the correct word. So the capability of storing and retrieving huge amounts of data in a fast and efficient manner is one of the important characteristics of computers.

Accuracy

The accuracy of a computer system is very high. Errors in hardware can occur, but error detecting and correcting techniques will prevent false results. In most cases, the errors are due to the human factor rather than the technological flaws. For example, if a program is wrongly coded, the data is corrupted, or the program logic is flawed, then irrespective on which computer you run it, you will always get wrong results. Another area where mistakes can creep in is during data entry. People often make mistakes when data is keyed-in and the computer accepts whatever that is keyed-in. So if a wrong input is given, the output also will be wrong—GIGO (Garbage In Garbage Out).

Versatility

Computers are very versatile machines. They can perform activities ranging from simple calculations to performing complex CAD modeling and simulation to navigating missiles and satellites. In other words, they are capable of performing almost any task, provided the task can be reduced to a series of logical steps. Computers can communicate with other computers and can receive and send data in various forms like text, sound, video, graphics, etc. This ability of computer to communicate to one another has led to the development of computer networks, Internet, WWW and so on. Today, we can send e-mail to people all around the world. We now live in a connected world and all this is possible because of computers and other related technologies.

Automation

The level of automation achieved in a computer is phenomenal. It is not a simple calculator where you have to punch in the numbers and press the 'equal to' sign to get the result. Once a task is initiated, computers can proceed on its own till its completion. Computers can be programmed to perform a series of complex tasks involving multiple programs. Computers will perform these things flawlessly. They will execute the programs in the correct sequence, switch on or switch off machines at the appropriate time, monitor the operational parameters, send warning signals or take corrective actions if the parameters exceed the control level, and so on. Computers are capable of these levels of automation, provided they are programmed correctly.

Diligence

Diligence means being constant and earnest in effort and application. Human beings suffer from tiredness, lack of concentration, etc. They have feelings and can become sad, depressed, bored, or negligent and it will reflect on the work they do. Moreover, human beings cannot perform the same or similar tasks over and over again with the same precision, accuracy and enthusiasm as the first time. After some time, people will become bored and tedium will set in. This will affect the performance. Being a machine, a computer does not have any of these human weaknesses. They will not get tired or bored. They will not go into depression or loose concentration. They will perform the tasks that are given to them, irrespective of whether it is interesting, creative, monotonous, or boring, irrespective of whether it is the first time or the millionth time, with exactly the same accuracy and speed.

CLASSIFICATION OF COMPUTERS

Computers can be classified by their size and power as microcomputers, workstations, portable computers, minicomputers, mainframes and supercomputers.

- **Microcomputer** — Microcomputers are small, single-user computers based on a microprocessor. In addition to the microprocessor, these computers have a keyboard for entering data, a monitor for displaying information, and a storage device for saving data. The microcomputers are further classified as personal computers, workstations, portable computers, etc.
- **Minicomputer** — Minicomputer is a multi-user computer capable of supporting ten to hundreds of users simultaneously.
- **Mainframe** — Mainframes are powerful multi-user computers capable of supporting many hundreds of users simultaneously. Mainframes are mainly used by insurance companies, banks, airline and railway reservation systems, etc.
- **Supercomputer** — A supercomputer is an extremely fast computer that can perform hundreds of millions of instructions per second. Most supercomputers are used by government agencies. These machines are for applications requiring very large programs and huge amounts of data that must be processed quickly. Examples of such tasks are weather forecasting, oil exploration, weapons research, and large-scale simulation. The chief difference

between a supercomputer and a mainframe is that a supercomputer channels all its power into executing a few programs as fast as possible, whereas a mainframe uses its power to execute many programs concurrently.

WHAT COMPUTERS CAN DO?

The computer is a truly amazing machine. Few tools let you do so many different tasks as computers do. Whether you want to do stock market analysis, publish a newsletter, design a building or play games, you can do it with a computer. Today, computers are either directly or indirectly influencing almost every aspect of our lives. Wherever human intellect and technology meet, you will find computers. Until the 1970s, computers were expensive and beyond the reach of the common man. But as computers became cheaper, the computers became something that the common man could afford. The computer revolution started only when computers came out from the academic houses and large companies and were within the reach of the common man. Today, computers of all sizes and shapes are used for every purpose imaginable, from selling railway tickets to running microwave ovens. Now we have computers everywhere—we use them at home, in schools, in supermarkets and so on.

Figure 1.2 A Computerized Axial Tomography (CAT) Scanning Machine

In medicine today, computers are used for everything from diagnosing illnesses to monitoring patients during surgery and controlling permanent prostheses. Figure 1.2 shows doctors performing diagnosis using a CAT scan machine. Now, computers have found their way to classrooms and everyone from school children to research students use computers to work for their own intellectual benefit. You will find computers in classrooms, museums and libraries and they are rapidly becoming as essential to the learning process as are books, paper and pens.

Although drafting tables and T-squares are still around, their days may be numbered. An engineer or architect designing a product can be far more productive with a computer than with pencil and paper. In addition to product design, computers are playing an ever-increasing role in manufacturing. Computers are used for everything from production planning to process control. Many manufacturing units are fully automated with industrial robots, automated guided vehicles, etc. where computers control everything. Figure 1.3 shows a fabrication unit that uses computer aided design (CAD) and computer aided engineering (CAE).

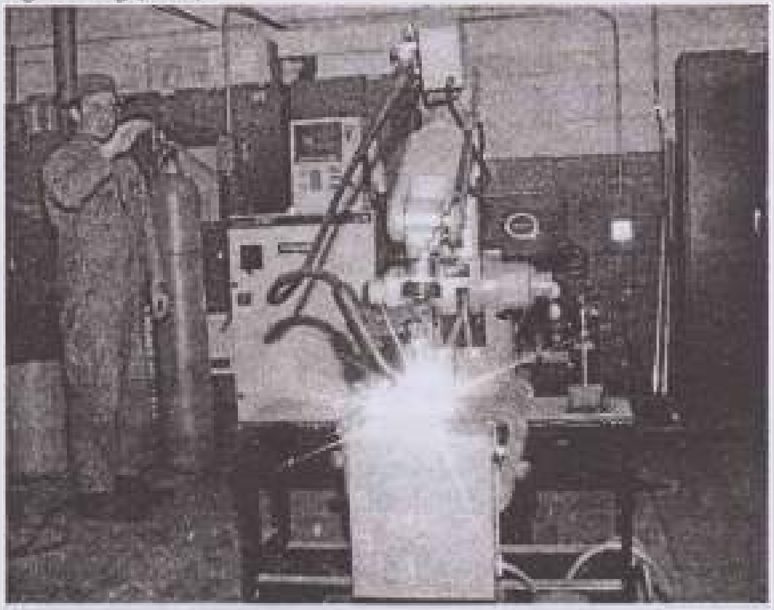

Figure 1.3 A Computer Aided Design and Computer Aided Engineering (CAD/CAE) Facility

In business, computers have become very crucial that we cannot even think how we will be able to survive without them. Businesses use computers for a variety of purposes ranging from decision-making to electronic commerce. Scientists and researchers use computers to develop theories, collect and test data, simulate test environments, and to exchange information electronically with colleagues around the world. Researchers can access databases in distant locations from their desktop. In 1946, ENIAC – the first large-scale computer ever developed was created for the US army. Initially, it was used to compute artillery-shell trajectories for different distances and weather conditions – figures that used to be calculated manually. Today, the military uses computers in a variety of ways – aboard ships, submarines and fighter planes as well as in certain weapons and satellites.

Musicians and singers have teamed up with computers to create an amazing range of instruments and sounds simply by playing a keyboard. The musical instrument digital interface (MIDI) is a system that synchronizes hardware and software that produces electronic tones. Now synthesizers capable of producing the sounds of multiple musical instruments are commonly available. The music concerts and movies all use computers for a variety of purposes ranging from producing astonishing special effects and computer animations to control stage lighting.

Computers have found their way into the household. Most of the household appliances and gadgets have computers in them. The computer which fine tunes the images in your television, automates your washing machine and microwave oven are examples of the computer revolution that is happening.

WHAT COMPUTERS CANNOT DO?

There is no doubt that computers are fulfilling their promise to perform certain tasks better, faster and cheaper. In terms of the analogy with the automobile industry, if the automobile industry had grown like the computer industry, the cost of a Rolls Royce would be around Rs 80 and would run a million miles on a liter of petrol but the size would be that of a match box. Along with fears about computers, there have long been great expectations about how computers would revolutionize our world. But some of the benefits people expected from computers way back in 1950s just have not happened.

Productivity

Computers have not yet met all our expectations as a productivity improvement tool. Sometimes it takes longer to do things with a computer than it would to do them manually. Sometimes it takes too much time to learn how to use an application program that is supposed to increase productivity. But these problems are sorted out with improved user interface design, easy-to-use and easy-to-learn applications, use of wizards, templates, on-line and context-sensitive help facilities, etc.

Reasoning

In 1949 a book entitled *Cybernetics* by Norbert Weiner (Cambridge: MA, MIT Press, 1949) stated that the computer shared similarities with the brain and the human nervous system. Thus, it seems fair to say that in the same way we have built machines to replace human labor, we have also sought to build machines that do certain kind of thinking for us. But computers still lack many of the mental capabilities possessed by a five-year-old child. In other words, computers cannot think. They cannot discriminate or assimilate widely divergent kinds of data, and they have absolutely no capacity for ethical evaluation. These are still powers possessed only by people, and it may be wise to keep things that way.

Errors

Computers do not make errors, people do – either in the way they program computers or in the way they use them. However, computers are extremely finicky machines and often frustratingly literal. This is because they use the principle of logic; for example, 1 must always be equal to 1. If you type "one", the computer would not understand it. Every instruction must be precisely entered. The computer does not allow spelling mistakes or typos. Many of the problems with computers occur because the computer cannot tell the difference between doing something sensible versus something ridiculous. Erasing all its stored data is no different to a computer from adding two numbers. Computers operate logically, but they are incapable of acting prudently and rationally.

USES OF COMPUTERS

In computerized tomography, or the CT scan, a computer uses X-ray data to construct an image of a body part on a screen. Doctors use these images to diagnose diseases and disorders. Sophisticated radar systems use computers to produce detailed pictures, often for military use. Computer graphics also are used to create electronic video games. Terminal monitors or TV screens can display game boards and moving pictures. The player may use a keyboard or some other device, such as a mouse or joystick, to play computer games.

Computers also are used in teaching. Programs that perform computer-aided instruction (CAI) are designed to help students at all levels, from elementary school to the university level. The student sits at a computer terminal. The terminal's screen displays a question for the student to answer. If the answer is wrong or incomplete, the computer may ask the student to try again. It then may supply the correct answer and an explanation. CAI is also used in some adult education programs and as part of the employee-training programs of some corporations.

Computer designers are experimenting with using computer graphics to create virtual reality – an artificial world in which the computer user can seemingly move about and handle objects. One virtual reality system has a headset with two tiny display screens, one screen for each eye. Images on the screens produce a three-dimensional view. Sensing devices contained in a special glove tell the computer when the user moves the fingers or hand. The computer then changes the images to create an illusion, for example, opening a door. The images do not have nearly the detail of what is seen in the actual world. In addition, there is a delay between hand movements and the corresponding changes in the images. However, virtual reality has a variety of applications. These applications range from simple game sets to sophisticated equipment used to control robots.

Figure 1.4 A Computer Aided Design (CAD) System

Computer programs that perform CAD are important in many fields, particularly engineering and architecture. CAD programs create pictures or diagrams of a new object. They then solve equations to predict how the object will work. Engineers and architects use CAD programs to design aircrafts, bridges, buildings, cars, electronic machinery, and many other machines and structures. Computers also can produce pictures by converting information into pictorial form. The pictures can serve a variety of purposes. For example, computers enable business people, economists, and scientists to plot graphs from lists of numbers. Figure 1.4 shows a CAD workstation.

Many complex machines need frequent adjustments to work efficiently. Small computers can be installed inside these machines and programmed to make these adjustments. In modern cars, such embedded (enclosed) computers control certain aspects of operation, such as the mixture of fuel and air entering the engine. Today's commercial airliners and military planes carry computers that help control the aircraft. Embedded computers also control the movements of industrial robots and are used to guide modern weapon systems, such as missiles and field artilleries, to their targets.

Computers can help solve many complicated problems that do not involve numerical equations. Doctors, for example, investigate illnesses, decide on diagnoses, and prescribe treatments. They solve such problems by applying their knowledge and experience, not by solving equations. A branch of computer science called artificial intelligence uses programs that help solve problems by applying human knowledge and experience. Artificial intelligence systems called expert systems enable computers programmed with vast amounts of data to "think" about numerous possibilities—such as diseases that certain symptoms could indicate—and make a decision or diagnosis.

Computers also can be used to communicate information over long distances. They can send information to each other over telephone lines. As a result, computers keep banks, newspapers, and other institutions supplied with up-to-the-minute information. A computer network consists of many computers in separate rooms, buildings, cities, or countries, all connected together. Computer networks allow people to communicate by using electronic mail—a document typed into one computer and "delivered" to another. Such documents generally travel in only a few minutes, even if they are being sent over a long distance.

REVIEW QUESTIONS

Short Answer Questions

1. What is a computer?
2. What are the two principle characteristics of a computer?
3. What do you mean by hardware and software?
4. What are the five characteristics of computers that make them useful?

Descriptive Type Questions

1. Give some uses of the computers?
2. Why is it said that computers have changed the way people work?
3. What are the tasks that computers can perform quickly and accurately?
4. What do you mean by word length of a computer?
5. What do you mean by the speed of a computer?
6. What is so special about the data storage capability of a computer?
7. What do you mean by automation with respect to a computer?
8. What do you mean by diligence with respect to a computer?

Essay Questions

1. Why are computers important?
2. What are the characteristics of computers?
3. How are computers classified?
4. What are the things computers can do? Explain with examples.
5. What are the things that computers cannot do? Explain with examples.
6. What are the uses of computers? Explain with examples.

Fill in the Blanks

1. ________ is a programmable machine.
2. Computers can execute a prerecorded list of instructions called a ________.
3. The actual machinery in a computer is called ________ and the instructions and data are called ________.
4. The characteristics of a computer are ________________________.
5. Computer can be classified by their size and power as ________________, ________.
6. The number of bits that a computer can process at a time in parallel is called its ________.

[Answers: (1) Computer (2) Program (3) Hardware, software (4) Word length, speed, storage, accuracy, versatility, automation and diligence (5) Personal computers, portable computers, workstation, minicomputers, mainframe and supercomputers (6) Word length]

True or False

01. Mainframe is a powerful multi-user computer capable of supporting many hundreds of users simultaneously.
02. A digital computer operates on binary digits – 0 and 1.
03. A microcomputer can execute millions of instructions per second.
04. ENIAC, which is the first large-scale computer ever developed, was created for the US army.
05. Computers are used for everything from production planning to process control.
06. GIGO stands for Garbage In Garbage Out.
07. Computers are not very versatile machines.
08. Computers cannot communicate with other computers and can receive and send data in various forms like text, sound, video, graphics, etc.
09. In medicine today, computers are used for everything from diagnosing illnesses to monitoring patients during surgery and controlling permanent prostheses.
10. Today's commercial airliners and military planes carry computers that help control the aircraft.

[Answers: (1) True (2) True (3) True (4) True (5) True (6) True (7) False (8) False (9) True (10) True]

Multiple Choice

01. A set of prerecorded instructions executed by a computer is called ______.
    (1) Action (2) Hardware (3) Program (4) None of the above
02. The actual machinery in a computer is called __________.
    (1) Machinery (2) Software (3) Hardware (4) None of the above
03. The major components of a computer are ______.
    (1) Memory (2) I/O Devices (3) CPU (4) All of the above
04. Which is the component that allows the computer to permanently retain large amounts of data?
    (1) CPU (2) Mass storage device (3) Memory (4) None of the above
05. Which of the following is characteristic of a computer?
    (1) Word length (2) Accuracy (3) Speed (4) All of the above
06. Which of the following is an extremely fast computer that can perform hundreds of billions of instructions per second?
    (1) PC (2) Supercomputer (3) Workstation (4) None of the above
07. A group of 8 bits is called a ______.
    (1) Bite (2) Byte (3) Octbits (4) None of the above
08. The number of bits that a computer can process at a time in parallel is called ______.
    (1) Word length (2) Accuracy (3) Speed (4) None of the above
09. The first large-scale computer ever developed is ______.
    (1) IBM701 (2) EDIVAC (3) Mark II (4) ENIAC
10. A system that synchronizes hardware and software to produce electronic tones is a ______.
    (1) Synthesizer (2) Toner (3) PlainTalk (4) MIDI

[Answers: (1) Program (2) Hardware (3) All of the above (4) Mass storage device (5) All of the above (6) Supercomputer (7) Byte (8) Word length (9) ENIAC (10) MIDI]

CHAPTER 02

Five Generations of Modern Computers

TOPICS COVERED

- Introduction
- First generation computers
- Second generation computers
- Third generation computers
- Fourth generation computers
- Fifth generation computers

INTRODUCTION

Computers are truly amazing machines. We have seen the history of computers in the previous section and their evolution of computers from mechanical devices to the complex and sophisticated devices they are now. We have also seen how computers became more and more accessible and easy to use. Even though the developments that paved the way for the creation of computers started very early in the history of mankind, computers in the true sense began to appear from 1940 onwards.

Based on the period of development and the features incorporated, the computers are classified into different generations—from first generation to fifth generation computers. The classification and the time periods are given below:

1. First Generation Computers (1945–1955)
2. Second Generation Computers (1957–1963)

Key Points

▲ Based on the period of development and the features incorporated, the computers are classified into different generations—from first generation to fifth generation computers.

▲ First generation computers (1945–1955) were made-to-order for specific tasks. Each computer had a different binary-coded program called a machine language that told it how to operate. The computers used vacuum tubes and magnetic drums for data storage.

▲ Second generation computers (1956–1963) used vacuum tubes with transistors and machine language with assembly language. They also contained all the components we associate with the modern day computer: printers, tape storage, disk storage, memory, operating systems, and stored programs. Throughout the early 1960's, there were a number of commercially successful second-generation computers used in businesses, universities, and government.

▲ Third generation computers (1964–1971) replaced transistors with integrated circuits (ICs). These computers could be used for both scientific and nonscientific applications. These computers allowed the use of an operating system that allowed machines to run many different programs at once with a central program that monitored and coordinated the computer's memory.

▲ Fourth generation computers (1972 onwards) were characterized by their smaller size, the processor (chip) and more processing power. This era also marked the introduction and popularity of the personal computer (PC) and also the popularity of Internet and WWW. The size of the computers shrank and the processing power increased. The computers became easier to operate with new operating systems that supported graphical user interfaces (GUIs), operation.

▲ Fifth generation computers aim to be able to solve highly complex problems that require reasoning, intelligence and expertise when solved by people.

3. Third Generation Computers (1964–1971)
4. Fourth Generation Computers (1972 Onwards)
5. Fifth Generation Computers (Present and Future)

FIRST GENERATION COMPUTERS (1945-1955)

In 1946 two engineers at the University of Pennsylvania, John Presper Eckert (1919–1995) and John W. Mauchly (1907–1980), built the first digital computer using parts called vacuum tubes. They named their new invention ENIAC. Consisting of 18,000 vacuum tubes, 70,000 resistors and 5 million soldered joints, the computer was such a massive piece of machinery that it consumed 160 kilowatts of electrical power, enough energy to light an entire section of Philadelphia. ENIAC, unlike Colossus and Mark I, was a general-purpose computer that computed at speeds 1,000 times faster than Mark I.

In the mid-1940s John Von Neumann (1903–1957) joined the University of Pennsylvania team, initiating concepts in computer design that remained central to computer engineering for the next 40 years. Von Neumann designed the Electronic Discrete Variable Automatic Computer (EDVAC) in 1945 with a memory to hold both a stored program as well as data. This "stored memory" technique as well as the "conditional control transfer," that allowed the computer to be stopped at any point and then resumed, allowed for greater versatility in computer programming. The key element to the Von Neumann architecture was the central processing unit, which allowed all computer functions to be coordinated through a single source. In 1951, UNIVAC I (Universal Automatic Computer), built by Remington Rand, became one of the first commercially available computers to take advantage of these advances. Both the U.S. Census Bureau and General Electric owned UNIVACs. One of UNIVAC's impressive early achievements was predicting the winner of the 1952 presidential election, Dwight D. Eisenhower.

First generation computers were characterized by the fact that operating instructions were made-to-order for the specific task for which the computer was to be used. Each computer had a different binary-coded program called a machine language that told it how to operate. This made the computer difficult to program and limited its versatility and speed. Other distinctive features of first generation computers were the use of vacuum tubes (responsible for their breathtaking size) and magnetic drums for data storage.

SECOND GENERATION COMPUTERS (1956-1963)

By 1948, the invention of the transistor greatly changed the computer's development. The transistor replaced the large, cumbersome vacuum tube in televisions, radios and computers. As a result, the size of electronic machinery has been shrinking ever since. The transistor was at work in the computer by 1955. Coupled with early advances in magnetic-core memory, transistors led to second generation computers that were smaller, faster, more reliable and more energy-efficient than their predecessors. The first large-scale machines to take advantage of this transistor technology were early supercomputers: Stretch by IBM and LARC by Sperry-Rand. These computers, both developed for atomic energy laboratories, could handle an enormous amount of data, a capability much in demand by atomic scientists. The machines were too costly and powerful for the business sector's computing needs which limited their attractiveness. Only two LARCs were ever installed: one at the Lawrence Radiation Labs in Livermore, California, for which the computer was named (Livermore Atomic Research Computer) and the other at the U.S. Navy Research and Development Center in Washington, D.C.

Second generation computers replaced machine language with assembly language, allowing abbreviated programming codes to replace long, difficult binary codes. Throughout the early 1960's

There were a number of commercially successful second generation computers used in businesses, universities, and government from companies such as Burroughs, Control Data, Honeywell, IBM, Sperry-Rand, and others. These second generation computers were also of solid state design, and contained transistors in place of vacuum tubes. They also contained all the components we associate with the modern day computer: printers, tape storage, disk storage, memory, operating systems, and stored programs. One important example was the IBM 1401, which was universally accepted throughout the industry, and is considered by many to be the Model T of the computer industry. By 1965, most large businesses routinely processed financial information using second generation computers.

It was the stored program and programming language that gave computers the flexibility to finally be cost effective and productive for business use. The stored program concept meant that instructions to run a computer for a specific function (known as a program) were held inside the computer's memory, and could quickly be replaced by a different set of instructions for a different function. A computer could print customer invoices and minutes later design products or calculate pay cheques. More sophisticated high-level languages such as COBOL (Common Business-Oriented Language) and FORTRAN (Formula Translator) came into common use during this time, and have expanded to the current day. These languages replaced cryptic binary machine code with words, sentences, and mathematical formulae, making it much easier to program a computer. New types of careers (programmer, analyst, and computer systems expert) and the entire software industry began with second generation computers. Paralleling the development of second-generation system was the creation of a new industry, built around the idea of integrating transistors and other components into circuits that could be placed on small chips of silicon. Since many of the early companies were located in the Santa Clara Valley, in Palo Alto, the region became universally known as Silicon Valley.

THIRD GENERATION COMPUTERS (1964-1971)

Though transistors were clearly an improvement over the vacuum tube, they still generated a great deal of heat, which damaged the computer's sensitive internal parts. The quartz rock eliminated this problem. Jack Kilby, an engineer with Texas Instruments, developed the integrated circuit (IC) in 1958. The IC combined three electronic components onto a small silicon disc, which was made from quartz. Scientists later managed to fit even more components on a single chip, called a semiconductor. As a result, computers became ever smaller as more components were squeezed onto the chip. Second generation systems were rather specialized. They were designed to process either scientific or non-scientific applications, but they were not meant to do well in both environments. That situation changed in 1964 when IBM announced a third generation of computing hardware—its System/360 family of mainframe computers. Each processor in this family had a large set of built-in instructions that it could execute. Some of these instructions were particularly useful in scientific processing, while others were more suited to record-keeping applications. Thus, the 360 line could be used efficiently in both environments. Another third-generation development included the use of an operating system that allowed machines to run many different programs at once with a central program that monitored and coordinated the computer's memory.

FOURTH GENERATION COMPUTERS (1972 ONWARDS)

After the integrated circuits, the size of the computers reduced considerably. Large-scale integration (LSI) could fit hundreds of components onto one chip. By the 1980s, very large scale integration (VLSI) squeezed hundreds of thousands of components onto a chip. Ultra-large scale integration (ULSI) increased that number into the millions. The ability to fit so much onto an area about half the size of one-rupee coin helped diminish the size and price of computers. It also increased their powe efficiency and reliability. The Intel 4004 chip, developed in 1971, took the integrated circuit one ste further by locating all the components of a computer (central processing unit, memory, and input an output controls) on a minuscule chip. Whereas previously the integrated circuit had had to b manufactured to fit a special purpose, now one microprocessor could be manufactured and the programmed to meet any number of demands. Soon everyday household items such as microwav ovens, television sets and automobiles with electronic fuel injection incorporated microprocessors.

Such condensed power allowed everyday people to harness the computer's power. They were n longer developed exclusively for large businesses or government contracts. By the mid-1970 computer manufacturers sought to bring computers to general consumers. These minicomputers cam complete with user-friendly software packages that offered even non-technical users an array c applications, most popularly word processing and spreadsheet programs. Pioneers in this field we Commodore, Radio Shack and Apple Computers. In the early 1980s, arcade video games such as Pa Man and home video game systems such as the Atari 2600 ignited consumer interest for mo sophisticated programmable home computers.

In 1981, IBM introduced its personal computer (PC) for use in the homes, offices and schools. Th 1980s saw an expansion in computer use in all three arenas as clones of the IBM PC made the person computer even more affordable. The number of personal computers in use jumped from 2 million i 1981 to 5.5 million in 1982. Ten years later, 65 million PCs were being used. Computers continued the trend toward a smaller size, working their way down from desktop to laptop computers (which coul fit inside a briefcase) to palmtop (able to fit inside a breast pocket). In direct competition with IBM PC was Apple's Macintosh line, introduced in 1984. Notable for its user-friendly design, the Macinto offered an operating system that allowed users to move screen icons (Graphical User Interface or GU instead of typing instructions. Users controlled the screen cursor using a mouse, a device th mimicked the movement of one's hand on the computer screen.

As computers became more widespread in the workplace, new ways to harness their potenti developed. As smaller computers became more powerful, they could be linked together, or networke to share memory space, software, information and communicate with each other. As opposed mainframe computer, which was one powerful computer that shared time with many terminals f many applications, networked computers allowed individual computers to form electronic co-op Using either direct wiring, called a Local Area Network (LAN), or telephone lines, these networ could reach enormous proportions. A global web of computer circuitry, the Internet, for example, lin computers worldwide into a single network of information.

With the popularity of Internet and WWW and with the advent of mobile computing, everyon can access the data he needs from anywhere. This integration of desktop computing, Internet an mobile devices is revolutionizing the world of computing radically. These new technologies an devices allow one to stay connected always irrespective of the location.

FIFTH GENERATION COMPUTERS (PRESENT AND FUTURE)

Defining the fifth generation of computers is somewhat difficult because the field is in its infancy. Th most famous example of a fifth generation computer is the fictional HAL9000 from Arthur C. Clark novel, 2001: *A Space Odyssey*. HAL performed all of the functions currently envisioned for real-life fi generation computers. With artificial intelligence, HAL could reason well enough to ho conversations with its human operators, use visual input, and learn from its own experienc (Unfortunately, HAL was a little too human and had a psychotic breakdown, commandeering spaceship and killing most humans on board.)

Though the wayward HAL9000 may be far from the reach of real-life computer designers, many of its functions are not. Using recent engineering advances, computers may be able to accept spoken word instructions and imitate human reasoning. The ability to translate a foreign language is also a major goal of fifth generation computers. This feat seemed a simple objective at first, but appeared much more difficult when programmers realized that human understanding relies as much on context and meaning as it does on the simple translation of words.

Many advances in the science of computer design and technology are coming together to enable the creation of fifth generation computers. Two such engineering advances are **parallel processing**, which replaces Von Neumann's single central processing unit design with a system harnessing the power of many CPUs to work as one. Another advance is **superconductor technology**, which allows the flow of electricity with little or no resistance, greatly improving the speed of information flow. The other technologies that are part of the fifth generation computers are mega chips and Artificial Intelligence (AI). Fifth generation computers will use **super large-scale integrated (SLSI) chips** that will help in the development of a microprocessor millions of electronic components in a single chip. The fifth generation computers will require large storage capacity. Mega chips are supposed to enable the computer to approximate its memory to that of human beings. AI refers to a series of related technologies that tries to simulate and reproduce human behavior—think, speaking, and reasoning. Some of the technologies are expert systems, natural language processing, speech recognition, vision, etc. Great progress has been made in most of these areas.

Computers today have some attributes of fifth generation computers. For example, expert systems assist doctors in making diagnoses by applying the problem-solving steps a doctor might use in assessing a patient's needs. It will take several more years of development before expert systems are in widespread use.

Fifth generation computers aim to solve highly complex problems that require reasoning, intelligence, and expertise. They are intended to be able to cope with large subsets of natural languages, and draw on very large knowledge bases. In spite of their complexity, fifth generation computers are being designed to be used by people who are not necessarily computer experts. In order to achieve these very ambitious aims, fifth generation computers will not have a single processor or a small number of tightly coupled processors as computers do today. Fifth generation computers are designed to contain a large number of processors, grouped into three major subsystems—a knowledge base system, an inference mechanism and an intelligent user interface.

The **knowledge base system** has a very large store of knowledge with a set of processors, which access and update it. It is likely that knowledge bases will evolve from current work in relational databases. Operations on knowledge bases require the manipulation of large numbers of individual elements; this manipulation will be done in parallel by the arrays of knowledge processing elements. The **inference mechanism** draws reasoned conclusions from the knowledge base. Much of its processing will be drawing logical inferences of '**If <condition> then <action>**' variety. Accordingly, the processing power of fifth generation computers is expressed in logical inferences per second (lips). The target is in the range 50 to 1000 million lips (compared with a current performance of 10 to 100 thousand lips). Most of this improved performance is planned to be achieved via highly parallel architectures, such as the data-flow and graph reduction architectures.

The **intelligent user interface** is the point of contact between a fifth generation computer and its users. Many of these will be based on communication in a large subset of a natural language. Others will make extensive use of advanced graphics, including image processing. The intention is to build a user interface, which is close to the natural way of thinking of the user, rather than close to the way of working of the computer, as is the case with contemporary user interfaces.

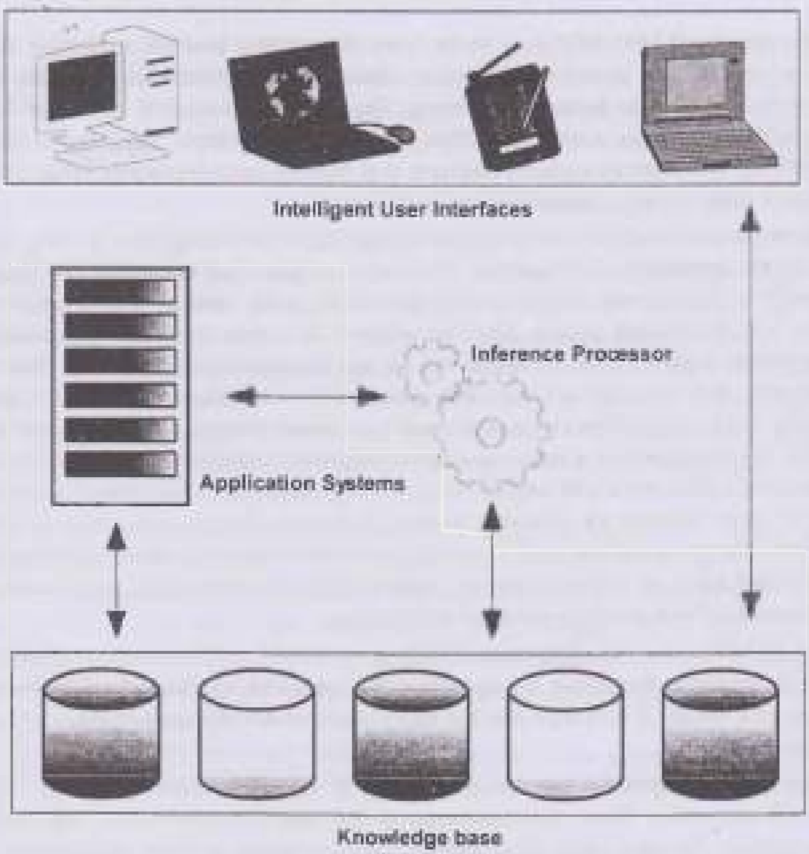

Figure 2.1 Schematic Representation of a Fifth Generation Computer

In conclusion we can say the fifth generation development projects are the main thrust o computer development for the coming years. Large sums of money, and the time and energy of som of the leading IT experts in the world are being devoted to the work. The risks are very high, sinc many of the principles on which fifth generation computers are to be built did not exist five year before the start of the projects. However, the risks of withdrawing from the work are even higher. It i quite clear that if any national or regional group achieves a significant lead in the development of fift generation computers, that group will be the dominant force in information technology at least unt the turn of the century.

REVIEW QUESTIONS

Short Answer Questions

01. How are computers classified according period of development and features incorporated?
02. Which is the first digital computer and who built it?
03. Who designed EDVAC?
04. What does EDVAC mean?
05. What are the advantages of stored memory and control transfer?
06. What is the key element to the Von Neumann architecture?

[illegible]. Name two supercomputers that used transistor technology?
[illegible]. Who invented the Integrated Circuit?
[illegible]. What are LSI, VLSI, and ULSI? How did they affect the computing industry?
[illegible]. Name few companies who started the personal computer boom.
[illegible]. What are the main technologies that shape the design and development of fifth generation computers?
[illegible]. What are the problems that the fifth generation computers aim to solve?

Descriptive Type Questions

[illegible]. Describe the features and capabilities of first generation computers.
[illegible]. What were the features, capabilities and limitations of ENIAC?
[illegible]. What was the contribution of John Von Neumann to the field of computing?
[illegible]. Name a few companies that developed the first commercially available computers.
[illegible]. Describe the features and capabilities of second generation computers.
[illegible]. How was the size of the second generation computers reduced?
[illegible]. What were the factors that enabled the second generation computers to become smaller, faster and powerful?
[illegible]. What were the major differences of second generation computers from their first generation counterparts?
[illegible]. What was the impact of the use of programming languages in computing?
[illegible]. Describe the features and capabilities of third generation computers.
[illegible]. How did the invention of the integrated circuit affect the computer industry?
[illegible]. How were third generation computers different from their predecessors?
[illegible]. Describe the features and capabilities of fourth generation computers.
[illegible]. How did the use of LSI, VLSI, and ULSI affect the computing industry?
[illegible]. What were the factors that led to the popularity and widespread use of computers?
[illegible]. Who were the pioneers of the personal computer market?
[illegible]. What was the role of Internet and WWW in the development and use of computers?
[illegible]. Describe the features and capabilities of fifth generation computers.
[illegible]. What are SLSI chips and how do they help in the design of fifth generation computers?
[illegible]. Explain the design of a fifth generation computer with the help of a diagram.

Essay Questions

[illegible]. Explain the origin, development, features, technologies used, capabilities and limitations of first generation computers.
[illegible]. Explain the origin, development, features, technologies used, capabilities and limitations of second generation computers.
[illegible]. Explain the origin, development, features, technologies used, capabilities and limitations of third generation computers.
[illegible]. Explain the origin, development, features, technologies used, capabilities and limitations of fourth generation computers.
[illegible]. Explain the origin, development, features, technologies used, capabilities and limitations of fifth generation computers.

Fill in the Blanks

01. In ________ two engineers ________ and ________, built the first digital computer using pa called ________.
02. The name of the first digital computer is ________.
03. ________ designed the Electronic Discrete Variable Automatic Computer (EDVAC).
04. ________built by Remington Rand became one of the first commercially available computers.
05. The second-generation computers contained ________ in place of vacuum tubes.
06. ________ developed the Integrated Circuit (IC).
07. The use of operating systems in computer was introduced in the ________ generation compute
08. In 1981 ________ introduced its personal computer (PC) for use in the homes, offices and schoo
09. Two engineering advances that are coming together to enable the creation of fifth-generati computers are ________ and ________.
10. ________ computers aim to solve highly complex problems, ones, which require reasoni intelligence, and expertise.

[Answers: (1) 1946, Jhon Presper Eckert, John W. Mauchly (2) ENICAC (3) John Von Neumann (UNIVAC-I (5) Transistors (6) Jack Kilby (7) Third (8) IBM (9) Parallel processing, supercondu technology (10) Fifth generation]

True or False

01. ENIAC consisted of 18,000 vacuum tubes, 70,000 resistors, 5 million soldered joints and consum 160 kilowatts of electrical power.
02. ENIAC was a general-purpose computer that computed at speeds 1,000 times faster than Mark I.
03. The key element to the John Neumann architecture was the parallel-processing unit.
04. One of UNIVAC's impressive early achievements was predicting the winner of the 1952 U Presidential election, Dwight D. Eisenhower.
05. Second generation computers replaced machine language with assembly language.
06. Third generation computers replaced transistors with vacuum tubes.
07. Since many of the early companies were located in the Santa Clara Valley, in Palo Alto, the reg became universally known as Silicon Valley.
08. The IC combined three electronic components onto a small silicon disc, which was made fr quartz.
09. IBM introduced the first personal computer.
10. The processing power of fifth generation computers is expressed in logical inferences per seco (lips).

[Answers: (1) True (2) True (3) False (4) True (5) True (6) False (7) True (8) True (9) True (10) True]

Multiple Choice

01. Which of the following period is the first generation of computing?
(1) 1945–1955 (2) 1956–1963 (3) 1964–1971 (4) None of the above
02. Which of the following is the first general purpose computer?
(1) Mark I (2) ENIAC (3) IBM132 (4) Apple II
03. Which of the following period is the second generation of computing?
(1) 1945–1955 (2) 1956–1963 (3) 1964–1971 (4) None of the above
04. Which of the following is the key element of John Neumann architecture?
(1) Multitasking (2) Multithreading (3) Parallel Processing (4) Central Processing

5. Who invented the Integrated Circuit?
   (1) Thomas Watson (2) John Neumann (3) Kim Philby (4) Jack Kilby
6. Which one of the following is the early supercomputer that used transistor?
   (1) IBM Stretch (2) EDIVAC (3) Mark IV (4) None of the above
7. IBM's System/360 is an example of _________ generation computer.
   (1) First (2) Second (3) Third (4) Fourth
8. LSI stands for ___________.
   (1) Light Sensitive Instrument (2) Large-scale Integration (3) Logical Sample Integration (4) None of the above
9. The first personal computer was introduced by __________.
   (1) IBM (2) Commodore (3) Apple (4) None of the above
10. Fifth-generation computers are capable of ___________.
   (1) Language Translation (2) Language Processing (3) Decision Making (4) All of the above

[Answers: (1) 1945-1955 (2) ENIAC (3) 1956-1963 (4) Central Processing (5) Jack Kilby (6) IBM Stretch (7) Third generation computers (8) Large-scale Integration (9) IBM (10) All of the above]

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CHAPTER 03

Classification of Digital Computer Systems

TOPICS COVERED

- Introduction
- Microcomputers
- Minicomputers
- Mainframes
- Supercomputers
- Network Computers

INTRODUCTION

Computer systems are classified as microcomputers, minicomputers, mainframes and supercomputers. You have probably already begun learning how to use a microcomputer. Do you think the day might come when you will be using larger computers? The answer is a definite 'Yes'—even if you have never seen them. The reason is that microcomputers are often linked by communications lines to large computers. These large computers process great amount of data. Thus it is worth learning about the various categories of computers and what functions each category serves. We will describe them from the smallest to the largest: microcomputers, minicomputers, mainframes, an[d] supercomputers.

> **Key Points**
>
> ▲ Computer systems are classified as microcomputers, minicomputers, mainframes and supercomputers.
>
> ▲ Microcomputers are small, single user systems that provide a simple processor and just a few input/output devices. Microcomputers can be further classified as personal computers (PCs), workstations, desktops, servers, laptops, notebooks, subnotebooks, personal digital assistants (PDAs), etc. each referring to the physical usage of the machines.
>
> ▲ A minicomputer is a computer of a size intermediate between a microcomputer and a mainframe. Typically, minicomputers have been stand-alone computers sold to small and mid-size businesses for general business applications and to large enterprises for department-level operations.
>
> ▲ A mainframe is a high-performance computer used for large-scale computing purposes that require greater availability and security than a smaller-scale machine can offer.
>
> ▲ A supercomputer is a computer that performs at or near the currently highest operational rate for computers. A supercomputer is typically used for scientific and engineering applications that must handle very large databases or do a great amount of computation (or both).
>
> ▲ A network computer (NC) is a concept from Oracle and Sun Microsystems that describes a low-cost personal computer for business networks that would be configured with only essential equipment and managed centrally.

MICROCOMPUTERS

Microcomputers are small, single user systems that provide a simple processor and just a few input/output devices. The microcomputer is also known as the "Personal Computer." The name "Personal Computer" is largely related to IBM, which introduced and marketed the first widely available, commercialized microcomputer named the "**IBM PC**" where PC stood for Personal Computer. As the most dominant microcomputer in the introduction of microcomputers the IBM PC became the standard against which all microcomputers were compared and the branding that IBM created, the "PC" helped provide a name for the industry it grew.

Figure 3.1 Typical Microcomputer (HP Pavilion Elite m9000)

The category is termed "micro" because the fundamental component that allowed the categories development was the CPU created on a single chip (so this technology was affordable in comparison to the mini/mainframe) created with the introduction of 'microprocessors.' The lower costs in the development and production of the CPU and various components of the microcomputer allowed microcomputers to become a broad market general-purpose computer.

The general appeal or focus of microcomputers on the individual's enjoyment and productivity has been a key factor in the microcomputer developments and enhancements over the years. Where other computers were used by a broad group of people within an organization, the microcomputer was often used by a single person for single activities.

While larger systems were focused on the productivity of the whole department or organization, the microcomputer was often only effective for a single individual's work. One example of how Microcomputers differ is in the use of games. Many of the microcomputers contain games because that is what people like to do after working hard.

Microcomputers can be grouped into five smaller groups—workstations, desktops, servers, laptops and notebooks—each referring to the physical usage of the machines and not necessarily the power. Workstations generally refer to machines used for intensive calculations on designs such as architecture and buildings. Desktops generally refer to machines used by business people for word processing, spreadsheet applications, accounting, presentations, etc. and are physically placed onto a desk. The laptop and the notebook are portable machines. Notebooks and laptops can work on batteries allowing the user to work with it during travel, and in places computers are not generally available.

Personal Computers (PCs)

Until recently, PCs were desktop or portable machines. These machines ran comparatively easy-to-use applications software such as the word processors, spreadsheets, etc. They were usually easier to use and more affordable than workstations. However, they had less sophisticated video display screens, operating systems, and networking capabilities.

Figure 3.2 Personal Computer (Compaq Presario)

Most important, they did not have the processing power that workstations did. Examples of personal computers are Dell Vostro, Compaq Presario, etc.

Workstations

Workstations are, again, until recently, expensive, powerful machines used by engineers, scientists, and other professionals who processed a lot of data. People who need to run complex programs and display both work in progress and results graphically also use workstations.

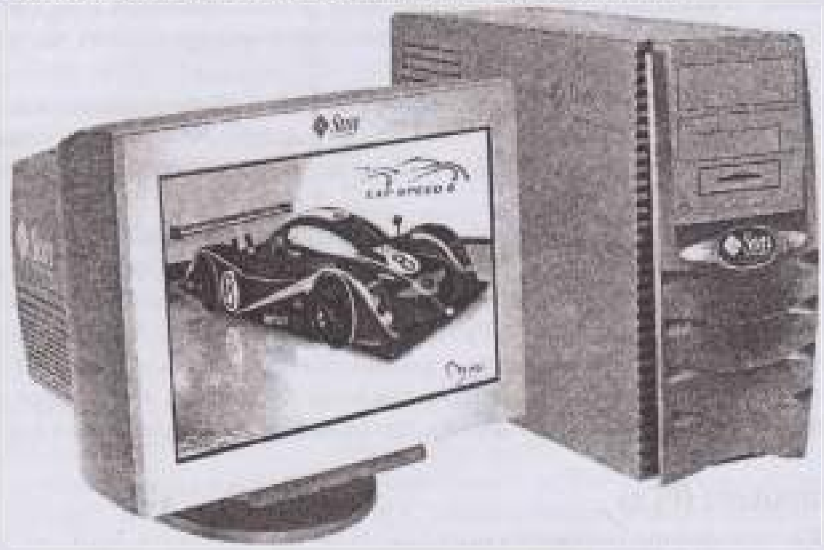


Figure 3.3 Workstation (Sun Blade 2000 Workstation)

Workstations use sophisticated display screens featuring high-resolution color graphics and operating systems such as UNIX that permitted multitasking. Workstations also use powerful networking links to other computers. The most significant distinguishing factor, however, is the powerful processor, which could churn out results much faster than the PCs. The more powerful workstations are called super-micros. Examples of well-known workstations are those made by Sun, Apollo, Hewlett-Packard, NeXT and IBM. However, the distinction between PCs and Workstations is now blurring. The principal reason is that microprocessors used in PCs are now as powerful as many of those used in workstations. More powerful microprocessors and increased graphics and communications capabilities now let end users run software that previously ran only on more powerful machines.

Portable Computers

Personal computing market is seeing the miniaturization phenomena. Now, computers are becoming smaller yet more powerful. One type of PC that is rapidly growing in popularity is the portable computer, which can be easily carried around. There are three categories of portable computers: laptop or notebook PCs, subnotebooks and Personal Digital Assistants.

- **Laptops/Notebooks** — Laptops may be either AC-powered, battery-powered, or both. These computers are ideal for users who have to work away from their offices. The user of these computers might be an executive on the move, a student, a journalist, a salesperson, etc. These computers combine the power of the PC with mobility. An example is Dell Inspiron.
- **Subnotebooks** — Subnotebooks are for frequent flyers and life-on-the-road professionals. Subnotebook users give up a full display screen and keyboard in exchange for less weight. These computers fit easily into any briefcase. They typically have an external floppy disk drive and monochrome monitor, although of late color models are available. An example of a color subnotebook is HCL's MiLeap.

Figure 3.4 Laptop, Subnotebook and PDA

- **Personal Digital Assistants (PDAs)** — PDAs are much smaller than the subnotebooks. They combine pen input, writing recognition, personal organizational tools, and communication capabilities in a very small package. Typical users are executives, businessmen, etc. who use these machines for their day-to-day activities — scheduling, organizing, etc. An example of a PDA is RIM's BlackBerry.

MINICOMPUTERS

Minicomputers, also known as mid-range computers were first developed as special-purpo mainframe computers. They were used, for instance, to control machines in a manufacturing un However, now they are widely used as general-purpose computers. Thus the line between minis a mainframes has blurred and is constantly changing. Indeed, the more powerful minicomputer mode are called super-minis. Also, the increasing power of microcomputer workstations has made it hard to distinguish between minis and microcomputers.

Minicomputers work well in what are known as Distributed Data Processing (DDP). That is, company's processing power is decentralized, or distributed across different computers. An examp of such computer architecture is the Client/Server model, in which end users can process at their ow microcomputers. End users can also access and share the resources of the server, which usually is minicomputer. For example, an executive could use the server to search the company's centraliz database and retrieve selected data. The data could then be analyzed using a spreadsheet on th executive's microcomputer.

Faster than the microcomputer with access to more storage space and more input and outp devices, the minicomputer is used when large groups need access to data simultaneously. Th minicomputer can do this because the hardware is designed for plugging in more devices, and th CPU and support chips that are designed for this kind of work than the microcomputers.

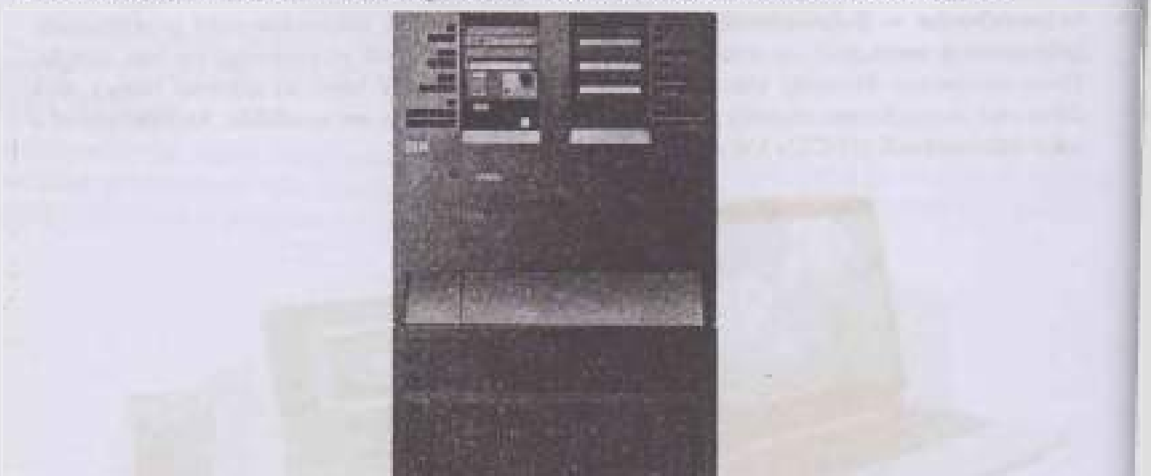


Figure 3.5 Minicomputer (IBM AS/400)

For example, large supermarkets around the world need to have their cash register send s information to the same computer (so that the data is collected in one place). This work requires m input devices (cash registers) and output devices (screens) than the microcomputer was designe have access to. Some organizations, operate the local supermarket using local area networks microcomputers, but tie the various supermarkets together to the central office to a minicomputer. minicomputer is also required to work when the entire sales people key in sales information at same time, this requires a powerful machine that can work with all the input devices at the same tir

Minicomputers are used by medium sized business and small sites of large organizations. They are also used in factories to control automated assembly lines, manufacturing, process control, etc. where numerous equipment have to be coordinated and operated in time-critical sequence, such as a car manufacturing plant, or chemical plant, minicomputers are found to coordinate the many peripheral devices, collate and assess input from many other peripheral devices. The microcomputer is inadequate in processing power and peripheral connections to complete the work and mainframe computers are too expensive for the job to be cost-effective.

An important measure for minicomputers and mainframes is the reliability of the machine as it generally has to operate 24 hours where every minute of operation is important to the company. A minute of downtime, where the computer is not functioning correctly, is calculated in lost money for organizations. Microcomputers have not been manufactured nor warranted for critical operations and many microcomputer manufacturers explicitly state in their promotional material that the microcomputers are not designed nor intended for critical operations.

Popular makers of minicomputers include Digital Equipment Corporation (DEC) that built the popular VAX minicomputer used in universities, banks and engineering firms. IBM also creates a very popular minicomputer range with a branding of the AS/400. Hewlett Packard has a popular minicomputer range branded the HP9000.

MAINFRAMES

Mainframe computers can process several million program instructions per second. Large organizations rely on these room-size systems to handle large programs with lots of data. Mainframes are mostly used by insurance companies, banks, airline and railway reservation systems, etc.

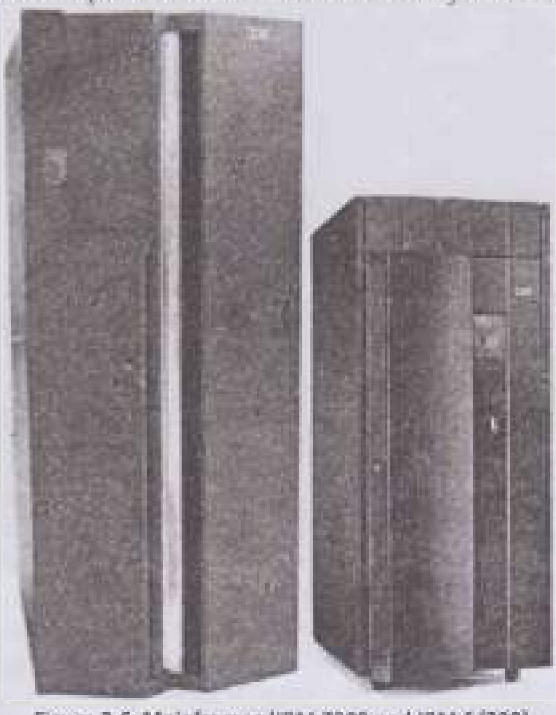


Figure 3.6 Mainframes (IBM Z800 and IBM S/390)

Mainframes have even more access to storage space and to input/output devices. To work with these extra devices mainframes also have more powerful 'processors'. This power is useful and required by large corporations who have large amounts of data to process. For example, large international banks that have millions of customer accounts to update regularly will need very powerful machines to process this data. These large banks would have a mainframe to maintain their customer account records (like their bank book, account balance, how much they withdrew, deposited, etc.) so that the customer can approach any of the branches to withdraw or deposit money. So a person who has a bank account in Chennai can take a trip to US, go to the branch in New York, to withdraw money.

Another power of mainframes is that they are designed to connect input/output devices that span vast distances. Like the above example, to connect devices that can be as far away from each other as Chennai and New York. The powerful hardware and CPU chips that can support the above work can also be used for making complex calculations, and designs.

The most popular maker of mainframes is International Business Machines (IBM). Some of the popular IBM mainframe models are 3090, ES/9000, S/390, Z800, etc.

SUPERCOMPUTERS

Supercomputers are the fastest calculating devices ever invented. A desktop microcomputer processes data and instructions in millionths of a second, or microseconds. A supercomputer, by contrast, can operate at speeds measured in nanoseconds and even in picoseconds—one thousand to one million times as fast as microcomputers.

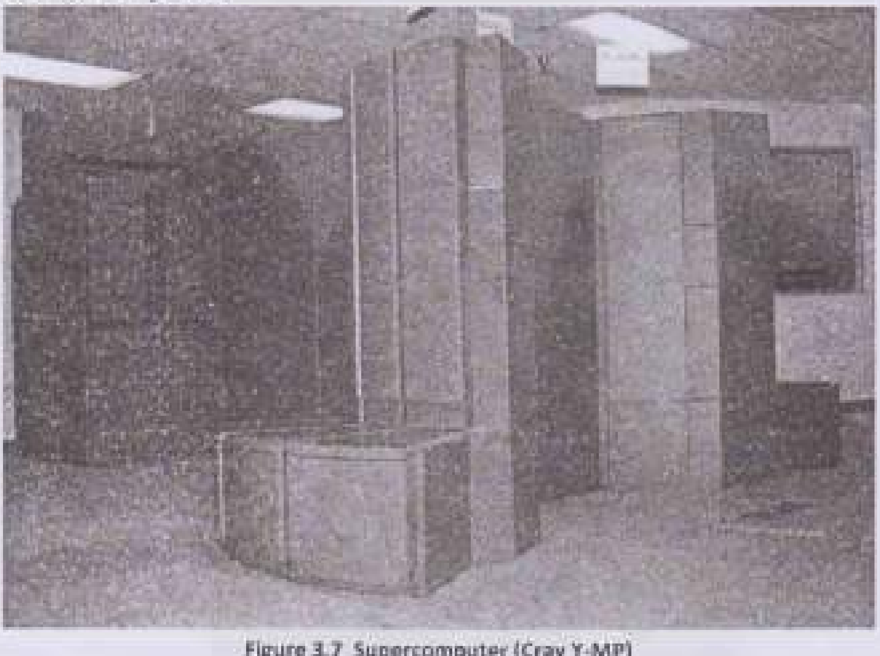


Figure 3.7 Supercomputer (Cray Y-MP)

Most supercomputers are used by government agencies. These machines are for applications requiring very large programs and huge amounts of data that must be processed quickly. Examples of such task are weather forecasting, oil exploration, weapons research, and large-scale simulation. The chief difference between a supercomputer and a mainframe is that a supercomputer channels all its power into executing a few programs as fast as possible, whereas a mainframe uses its power to execute many programs concurrently. For example, Y-MP/C90 made by Cray Research Inc. can perform as many as 2.1 billion mathematical calculations per second. More powerful supercomputers use a technology called massively parallel processing. These supercomputers consist of thousands of integrated microprocessors. One massively parallel computer built by Intel Corporation is capable of performing 8.6 billion mathematical calculations per second.

NETWORK COMPUTERS

Network computers are computers with minimal memory, disk storage and processor power designed to connect to a network, especially the Internet. The idea behind network computers is that many users who are connected to a network do not need all the computer power they get from a typical personal computer. Instead, they can rely on the power of the network servers. This is really a variation on an old idea—diskless workstations—which are computers that contain memory and a processor but no disk storage. Instead, they rely on a server to store data. Network computers take this idea one step further by also minimizing the amount of memory and processor power required by the workstation.

Figure 3.8 Network Computer (Sun JavaSation)

Network computers designed to connect to the Internet are sometimes called Internet boxes, Net PCs, and Internet appliances. Oracle Corporation and Sun Microsystems are leading the crusade for network computers and have even created a Network Computer Reference Profile that defines exactly what a network computer is. According to this profile, a network computer has from 4 to 64 MB of RAM, an 8 MB ROM card, a Smartcard slot, infrared and network interfaces, a parallel port, and a pair of PS/2-compatible I/O ports.

REVIEW QUESTIONS

Short Answer Questions

01. How are computer systems classified?
02. Give a few examples of microcomputers.
03. Give a few examples of personal computers and workstations.

04. Give some examples of portable computers.
05. How are portable computers classified?
06. Who use minicomputers?
07. What are the typical uses of the mainframes?
08. What are the typical applications where supercomputers are used?
09. Give some examples of supercomputers.
10. Give some examples of network computers.

Descriptive Type Questions

01. What are microcomputers? How are they further classified?
02. What are personal computers and what are their features?
03. How is a workstation different from a PC?
04. What are portable computers and how are they classified and what are their features?
05. What are minicomputers?
06. What are their typical applications?
07. How does the minicomputer differ from the microcomputer?
08. What are mainframes?
09. What are supercomputers?
10. How are supercomputers different from other computer systems?
11. What are network computers?
12. What are the advantages and limitations of network computers?

Essay Questions

01. Explain the features, components, processing power, uses, etc. of a microcomputer.
02. Explain the features, components, processing power, uses, etc. of a minicomputer.
03. Explain the features, components, processing power, uses, etc. of mainframes.
04. Explain the features, components, processing power, uses, etc. of a supercomputer.
05. Explain the features, components, processing power, uses, etc. of a network computer.

Fill in the Blanks

01. The four categories of digital computers are _________, _________, _________ and _________.
02. _________ is the smallest among the portable computers.
03. HCL MiLeap is a _________.
04. Powerful supercomputers use _________ technology.
05. A trillionth of a second is called _________.

[**Answers:** (1) microcomputer, minicomputer, mainframe and supercomputer (2) PDAs (3) Subnotebook (4) Massively parallel processing (5) Picosecond]

True or False

01. Dell Inspiron is a supercomputer.
02. Executives who are on the move use laptops.
03. The more powerful workstations are called super-micros.
04. PDA stands for Portable Digital Assistant.
05. Supercomputers can operate at speeds thousand to million times as fast as microcomputers.

[**Answers:** (1) False (2) True (3) True (4) True (5) True]

Multiple Choice

01. Cray Y-MP/C90 is a __________.
    (1) Microcomputer (2) Minicomputer (3) Mainframe (4) Supercomputer
02. DDP stands for ______________.
    (1) Direct Database Processing (2) Distributed Data Processing (3) Distributed Database Protection (4) Direct Data Processing
03. Which of the following is a portable computer?
    (1) Laptops (2) Subnotebooks (3) PDAs (4) All of the above
04. Microsecond is ____________.
    (1) Thousandth of a second (2) Millionth of a second (3) Billionth of a second (4) None of the above
05. IBM S/390 is a ______________.
    (1) Microcomputer (2) Minicomputer (3) Mainframe (4) Supercomputer

[Answers: (1) Supercomputer (2) Distributed Data Processing (3) All of the above (4) Millionth of a second (5) Mainframe]

C H A P T E R 0 4

Anatomy of a Digital Computer

TOPICS COVERED

- ▲ Introduction
- ▲ Parts of a computer

Key Points

▲ A computer system consists of hardware, software programs, data which the computer converts into informati and people or users.

▲ Hardware consists of interconnected electronic devices th control everything the computer does. Software refers to sets electronic instructions that tell the hardware what to do. D refers to the raw facts the computer can manipulate. The f component of the computer system is the person who uses computer.

▲ All general purpose computers require the follow components: CPU, memory, input device, output device mass storage device.

▲ The CPU or processor is the component that actu executes instructions. Memory enables a computer to store, least temporarily, data and programs. An input is the cond through which data and instructions enter a computer. T output device lets you see what the computer has accomplish Mass storage device allow a computer to permanently r large amounts of data.

INTRODUCTION

In Chapter 3, we saw the different types of computers—personal computers, portable computers, workstations, minicomputers, mainframes, supercomputers, etc. These computers vary in size, shape, processing power, storage capability, intended use, etc. Despite the difference in size and use, all these computers have several characteristics in common. Any computer must be part of a system.

A computer system consists of the following four components:

- ▲ Hardware
- ▲ Software or programs
- ▲ Data which the computer converts into information
- ▲ People or users

The term **hardware** refers to that part of the computer you can touch. It consists of interconne electronic devices that control everything the computer does. When people talk about the comp they usually mean the hardware.

Software refers to sets of electronic instructions that tell the hardware what to do. These set instructions are also known as programs and each of them has a specific purpose. For example, will use a word processing program to create text documents such as letters, memos, reports, Microsoft Word and WordPerfect are two populer word processing programs. Similarly if you wa create a presentation, you will use presentation software like Microsoft PowerPoint or Lotus Free Graphics. Data refers to the raw facts the computer can manipulate. Data consists of letters, num sounds and images. However, no matter what kind of data is entered into a computer, the comp converts it into numbers. Consequently, computerized data is digital, meaning it has been reduc converted to digits or numbers. The final component of the computer system is the person who uses the computer – the user.

Figure 4.1 Computer System

PARTS OF A COMPUTER

All general-purpose computers require the following hardware components:

- **Central processing unit (CPU) or processor** – The CPU or processor is the "brain" of the computer; it is the component that actually executes instructions.
- **Memory** – Memory enables a computer to store, at least temporarily, data and programs.
- **Input device** – An input device usually is a keyboard or a mouse. It is the conduit through which data and instructions enter a computer.
- **Output device** – The typical output devices are display screens (monitors), printer, or other such devices that lets you see what the computer has accomplished.
- **Mass storage device** – These devices allow a computer to permanently retain large amounts of data. Common mass storage devices include disk drives and tape drives.

Processor or CPU

The complex procedure that transforms raw data into useful information is called **processing**. To perform this transformation, the computer uses two components – the processor and memory. The processor is like the brain of the computer, the part that organizes and carries out instructions that come from either the user or the software. In a personal computer, the processor consists of one or more microprocessors, which are silvers of silicon or other materials etched with many tiny electronic circuits. The microprocessor is plugged into a circuit board – a rigid rectangular card containing the circuitry that connects the processor to other hardware.

The circuit board to which the microprocessor is connected is called the **motherboard**. In some powerful computers, the processors consist of many chips and the circuit boards on which they are mounted. The term central processing unit (CPU) refers to a computer's processing hardware, whether it consists of a single chip or several circuit boards. This critical part of the computer occupies an amazingly small space in the computer.

Figure 4.2 Processors (Intel Core™ 2 Duo and Core™ 2 Extreme Quad-core)

Memory

Memory is the computer's electronic scratchpad. Programs are loaded into and run from memory. Data used by the programs is also loaded into the memory for fast access. The most common type of memory is called **random access memory**, or **RAM** (see Figure 4.3). As a result, the term memory is commonly used to mean RAM. The most important thing to remember about RAM is that it is volatile, so it needs a constant supply of power.

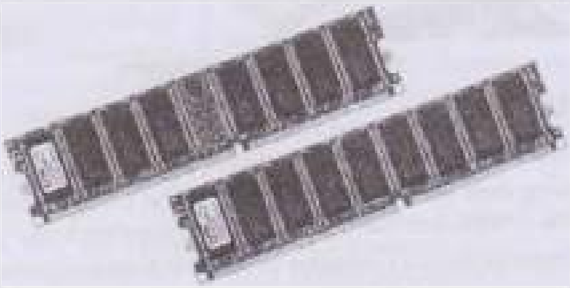


Figure 4.3 RAM

When you turn off a computer, everything in the RAM disappears. This is why you have to save everything you are working on to a storage device. One of the most important factors affecting the speed and power of a computer is the amount of RAM. Generally, the more RAM a computer has, the more it can do. The most common measurement unit for describing a computer's memory is the **byte**—the amount of memory it takes to store a single character. When people talk about memory, the numbers are often so large that it is useful to use a shortened term to describe the value:

- Kilobyte (KB) – 1024 bytes
- Megabyte (MB) – 1024 KB
- Gigabytes (GB) – 1024 MB

Today's personal computers commonly have 512 MB to 2 GB of RAM.

Input Devices

Input devices are a means for the user to interact with the computer. In other words computers receive instructions from the user through the input devices (see Figures 4.4(a) and 4.4(b)). The most common input device is the keyboard. The keyboard accepts letters, numbers, special characters and commands from the user and transmits it to the computer. A mouse is another input device that allows the user to point and click on the buttons and menu items instead of using the keyboard. Some other input devices are microphone (for voice commands), joysticks, rumble pads, racing wheels (for playing games), trackballs (pointing and drawing on the screen), scanners, digital cameras, etc.

Figure 4.4(a) Keyboard, Mouse, Desktop Microphones, Headset Microphone

Figure 4.4(b) Gaming Devices (Joystick, Rumble Pad, Racing Wheel)

Output Devices

The computer communicates with the user via the output devices. The function of the output device is to present processed data to the user. The common output devices are monitors, printers, and speakers.

Figure 4.5 Output Devices (Monitor, Printer, Speakers)

The computer sends information to the monitor when the user only wants to see them. It sen output to the printer when the user needs a paper copy (also called hard copy). Speakers are o devices used for producing sound. There are some devices like touch screens, modems, etc. that both input and output devices. The most common output devices are shown in Figure 4.5.

Storage Devices

Even though it is possible to operate a computer with the processor, memory, input and o devices, to be really useful, it also needs a place to keep programs and data. The purpose of the st devices is to hold the program and data files when the computer is not using them. Storage devic different from the memory (RAM) in many ways. First, the storage devices are non-volatile. Th or programs stored in the storage devices will not be lost even if the power fails.

Figure 4.6 Storage Devices (Floppy disks, Hard disk, and Optical disk)

Second, the capacity of the storage devices is much higher. For example, a high-end pe computer will usually have 256 or 512 MB of RAM. But the capacity of the storage device (hard will usually be 60 or 80GB. Third, the storage devices are cheaper than memory. The cost of 25 RAM and 60 GB hard disk will be almost the same. The common storage devices are hard d floppy disks and optical disks. The other mass storage devices are magnetic tape, zip disks, jaz d super disks, magneto optical (MO) disks, etc.

REVIEW QUESTIONS

Short Answer Questions

01. What are the different types of computers?
02. What do you mean by hardware?
03. What is software? Give few examples of software packages.
04. What are the parts of a computer?
05. What do you mean by CPU?
06. What is memory?
07. What is an input device? Give some examples.
08. What is an output device? Give some examples.
09. What is a mass storage device? Give some examples.
10. What do you mean by RAM?

Descriptive Type Questions

01. What are the components of a computer system?

- What do you mean by data? What is its use?
- What is a processor and what are its functions?
- What is memory and what are its functions?
- How does the amount of RAM affect the performance of the computer?
- What are input devices and what are their functions? Explain with examples.
- What are output devices and what are their functions? Explain with examples.
- What are mass storage devices and what are their functions? Explain with examples.

Essay Questions

- Explain the components of a computer system with examples.
- Explain the parts of a computer with examples.

Fill in the Blanks

- _________ is the computer component that executes instructions.
- _________ allows a computer to permanently retain large amounts of data.
- _________ enables a computer to store data and programs temporarily.
- _________ is the conduit through which data and instructions enter a computer.
- The major components of a computer system are ________, ________, ________ and ________.
- Keyboard and mouse are _________ devices.
- _________ is the output device to which the computer sends information when the user only wants to see it.
- RAM stands for _________.
- Hard disk is a _________ device.
- Zip disk is used for _________.

[Answers: (1) CPU (2) Mass storage devices (3) Memory (4) Input device (5) Hardware, software, data and user (6) Input (7) Monitor (8) Random Access Memory (9) Storage (10) Storing data/programs]

True or False

- User is a very important part of the computer system.
- Hardware is also called program.
- When an application is running the required programs and data are loaded to the memory.
- The circuit board to which the microprocessor is connected is called the motherboard.
- Monitor is an input device.
- Touch screen is an input/output device.
- Keyboard and mouse are input devices.
- Zip disk is a volatile storage device.
- Hard disk is a storage device that is present in all computers.
- It is possible to operate a computer with the processor, memory, input and output devices.

[Answers: (1) True (2) False (3) True (4) True (5) False (6) True (7) True (8) False (9) True (10) True]

Multiple Choice

- What are the components of a computer system?
  (1) Hardware (2) Software (3) Data (4) All of the above
- ________ consists of interconnected electronic devices that control everything the computer does.
  (1) Hardware (2) Software (3) Data (4) Users
- ________ refers to sets of electronic instructions that tell the hardware what to do.
  (1) Hardware (2) Software (3) Data (4) Users

04. Which part is called the brain of the computer?
(1) Hard disk (2) CPU (3) ALU (4) Memory
05. Which of the following are the hardware components of a general purpose computer?
(1) CPU and memory (2) Input and output devices (3) Mass storage device (4) All of the above
06. The complex procedure that transforms raw data into useful information is called ____________
(1) Parsing (2) Powering (3) Processing (4) All of the above
07. RAM stands for ____________.
(1) Raid Applicable Memory (2) Random Access Memory (3) Radio Activated Memory (4) None of the above
08. 1 Gigabyte is ______________.
(1) 1024 bytes (2) 1024 KB (3) 1024 MB (4) None of the above
09. Which of the following is not an input device?
(1) Keyboard and mouse (2) Microphone (3) Racing wheel (4) Monitor
10. Which of the following is not an output device?
(1) Trackball (2) Monitor (3) Printer (4) Speaker

[Answers: (1) All of the above (2) Hardware (3) Software (4) CPU (5) All of the above (6) Processing (7) Random Access Memory (8) 1024 MB (9) Monitor (10) Trackball]

C H A P T E R 0 5

Computer Architecture

TOPICS COVERED

- Introduction
- First electronic computers
- Low-level languages
- High-level languages
- First commercial computers
- Inside a computer system
- Peripheral devices
- Speeding up the system
- Memory cache
- CISC and RISC

> **Key Points**
>
> ▲ Even though people began to work on machines that would automate the computing tasks as early as the 17th century, the first electronic computers were built in the 1940s.But these—Mark I, ENIAC, EDSAC, etc.—were huge machines and their capabilities were limited.
>
> ▲ The Von Neumann Architecture has become the standard for modern computer systems. In a typical Von Neumann system, instructions and data are mixed together in the same memory, often with data following immediately after an instruction.
>
> ▲ Von Neumann systems deal with their machine language instructions—0s and 1s. To make programming easier assembly language was developed in the 1950s. Assembly language uses mnemonic codes (such as ADD for addition) that are easier to learn and remember than machine language's numeric codes. To make programming easier and machine independent high-level languages like FORTRAN, ALGOL, COBOL, LISP, Pascal, etc. were developed.
>
> ▲ The first commercial computer (UNIVAC) was developed in 1951. These machines were faster, more capable and could be used to solve business problems.
>
> ▲ In order to increase the speed of computers many strategies were used including CISC (Complex Instruction Set Computer) and RISC (Reduced Instruction Set Computers).

INTRODUCTION

The parts of the computer as we now know it did not appear all at once in one machine created by one person. Starting in the 17th century, many people began to work on machines that would automate tasks, with results that we still use (in one form or another) today.

For example, a machine for adding (and carrying over) numbers mechanically, using meshed gears, was developed by Blaise Pascal (see Figure 5.1), a 17th century mathematician and philosopher; later in the century, another philosopher added automatic multiplication, and division to the machine. And punch cards encoded with instructions to a machine came from the weaving industry.

One of the great successes and failures in the development towards the computer was the early 19th century "Babbage's Folly," a machine that was supposed to be an automatic mechanical calculator—but that never worked. Charles Babbage could not overcome mechanical problems in trying to build his machine. What was successful about the machine is the idea Babbage had on how the machine would process information. Babbage divided his machine into three parts: the store, the mill and the control. The store is what we now call memory.

Babbage proposed that his machine have two stores, one for holding the numbers (data) to be worked on, the other (the "control store") for holding the instructions that told what was to happen to the data (Babbage envisioned these two stores being on punched cards). The "mill" is the part of the machine that performs the instructions on the data, and the "control" oversaw the movement of data and instructions into and out of the two stores into and out of the mill to a mechanical printer.

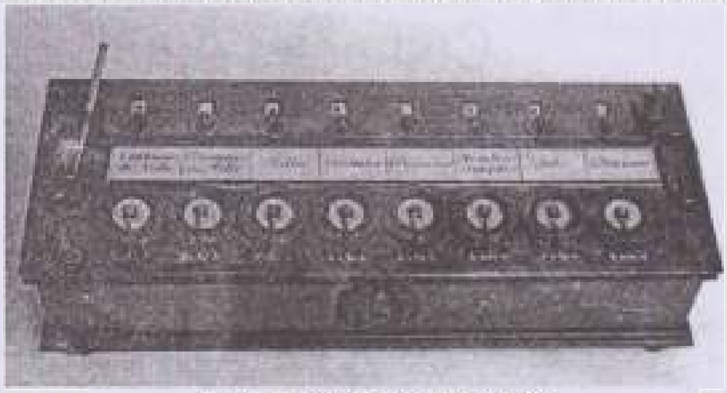


Figure 5.1 Pascal's Pascaline (1642)

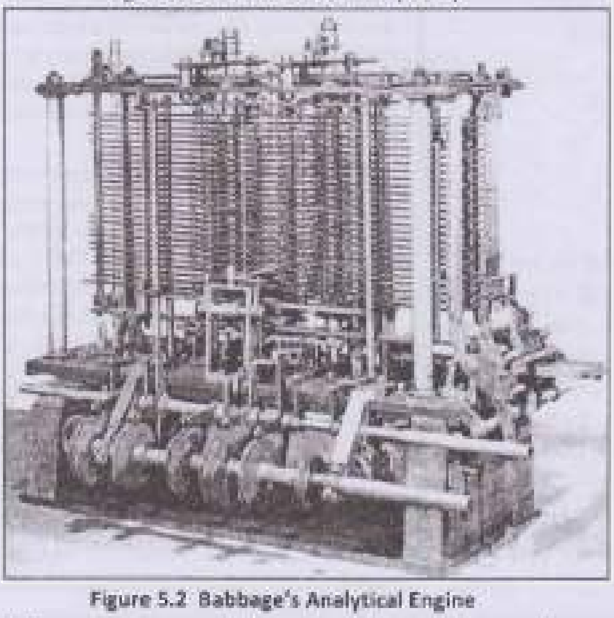


Figure 5.2 Babbage's Analytical Engine

Babbage's design would have used punched cards similar to the one shown above, with differ formats for the data cards and the control cards. Each pattern of holes in a data card would represe number, while each hole in a control card would represent one possible action that the mill could ta

Such a design would have a very simple instruction set, limited to such operations as "g number from the current data card", "add 1 to the current number", "subtract 1 from the cu number", "go to the next control card", "go to the next data card", and so on. But Babbage's mach remained only a dream, as the proposed mechanism was just too complex for the craftsmen of time. The first mechanical calculator—the first commercial adding machine—was not produced fin until 1885, by William Seward Burroughs. And even though Burroughs' machine used a diffe design, Babbage's ideas would still see the light of day. Babbage's ideas about the structurin information within a device were used, finally, with some success in the early 20th century, w something better would soon emerge. The performance of the computers of the 1940s really impro In fractions of seconds they performed calculations that would have required weeks from teams humans with adding machines. But they were also huge machines, requiring rooms of their own major air-conditioning systems to keep their circuitry from overheating. Programming them was sl and complicated and each machine was a unique device, programs could not be used on differ computers. From the 1940s to the 1960s, computer designers worked at changing computers: th wanted smaller machines, machines with interchangeable and easier-to-write programs; they wan more memory, more speed and more power.

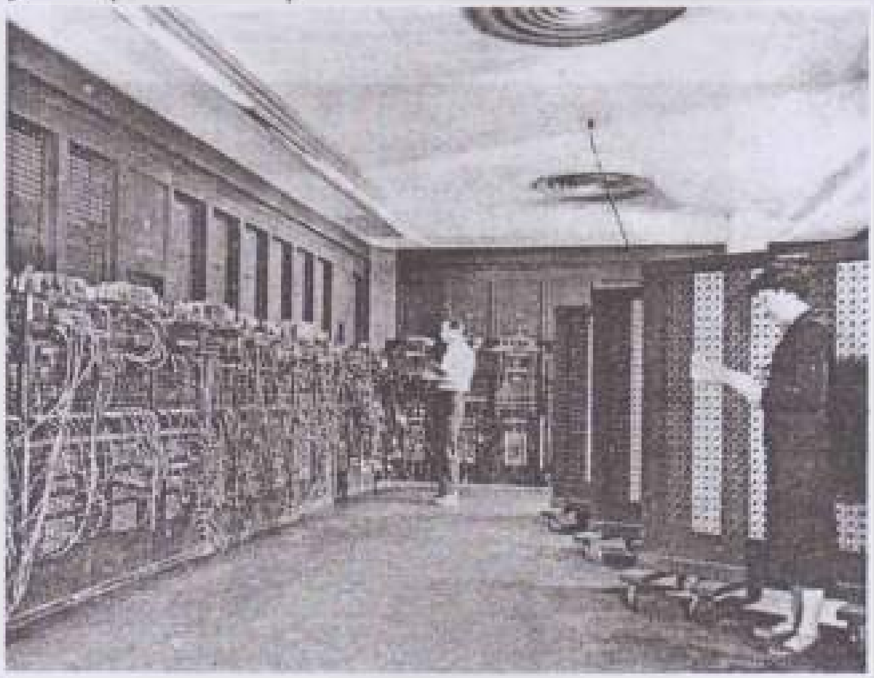


Figure 5.4 ENIAC

A major problem with early computers was the size of their components, which made computers big, slow, hot, and heavy. In the late 1950s transistors—1/200th the size of a vacuum tub came into use. They generated considerably less heat than vacuum tubes, and, because electricity to travel over a much shorter distance within them, were much faster: they could handle up to 100, instructions per second.

Computer memory also changed. Cathode Ray Tubes, which stored information as charges their faces, were tried for a while, but were eventually replaced by magnetic core storage. Movem of information into and out of such storage is comparatively slow, but offered the most reliability the time. These speed issues will re-surface later when we examine the CISC and RISC comp architecture. The logical programs that ran the original computers were fed into the computers w the computers operated—rolls of paper were punched to encode the 0's and 1's the electr machines could read, and then run through the machine, or banks of switches were thrown into patterns of 0's and 1's. The data the computer worked on, on the other hand, was inside the machi The ENIAC's ring counters, for example, were a physical representation of the numbers the progr were to manipulate.

In the mid-1940s, John Von Neumann showed that a computer's instructions could be represented in the same language used for the data. Instructions and data could then be stored together within the computer. The first computer to have this Von Neumann architecture was the Electronic Discrete Variable Automatic Computer (EDSAC), which became operational in 1952. The Von Neumann architecture has become the standard for modern computer systems; most computers since then have been variants of this architecture.

Figure 5.5 Vacuum Tube and Transistor

In a typical Von Neumann system, instructions and data are mixed together in the same memory, often with data following immediately after an instruction. Instructions are just numbers, and are not distinguishable from data. These instructions are known as the machine language of the system. Combining instructions and data in the same memory has several advantages, including:

- **Efficient use of memory** – You have one large block that can be used any way you want instead of two smaller blocks.
- **Computers can handle instructions as easily as data** – Since instructions and data are stored together, moving blocks of instructions (i.e. programs) around becomes simple.
- **Ease of loading programs into memory** – Just reads the instructions and data from disk or other long-term storage and then executes the newly-read information.

Combining instructions and data in the same memory also has some disadvantages:

- **Data can overwrite instructions** – Without special hardware precautions (called memory protection), an incorrect write to memory could overwrite some instructions. Since Von Neumann systems do not distinguish between instructions and data, the computer would attempt to execute the data as instructions, usually with an undesired result.
- **Limited bandwidth** – Storing instructions and data together means they both follow the same path to get to the processor. This Von Neumann Bottleneck means that the processor has to trade off between executing a large number of instructions per second and reading in a large amount of data at the same time.

Later, in the CISC and RISC sections of this chapter, we will see how modern designers are overcoming some of the problems in the Von Neumann Architecture.

LOW-LEVEL LANGUAGES

While Von Neumann systems deal easily with their machine language instructions, machine language is not an easy language for programmers to write and read. In the 1950s, assembly language was developed. Assembly language uses mnemonic codes (such as ADD for addition) that are easier to learn and remember than machine language's numeric codes. In assembly language, each instructi has a one-to-one correspondence to a machine language instruction. Assembly languages require t use of assemblers, programs that translate assembly language into machine language. Since ea processor has a unique set of machine language instructions, it also has its own assembler. This me that an assembly language program can only be written for one particular type of machine.

Machine language and assembly language are called low-level languages. Assembly langua helped programmers by allowing them to think using the name of each instruction instead of binary representation. Still, writing even a simple program in such a low-level language requir large number of very simple instructions. This makes writing most assembly language progra time-consuming task. Even though some programmers developed large libraries of pre-wri routines they could call on, it did not take away the basic problem—the programmer still had to w a significant amount of assembly language to connect the routines together, and the program was s only suitable for one type of machine. Something better was needed.

HIGH-LEVEL LANGUAGES

Solving the problems of assembly language would require a new kind of computer language—a h level language where the programmer could state the problem to be solved in a more "natural" a machine-independent form. Such languages would allow a programmer to think in terms of ho solve a particular problem rather than having to think about how to translate the problem into a t a particular machine can understand. For example, "A = B + C" is easier to write than "MOV @A, ADD @B, R1; MOV R1, @C". The first expression is more abstract, and makes fewer assumptions a the machine on which it will run. High-level languages were developed during the mid 1950s. The f such language was FORTRAN, followed by ALGOL, COBOL, and LISP. Modern high-level lang include Pascal, C, C++, Smalltalk, etc.

The high-level languages require compilers—programs that translate the high-level source c into the machine language of a particular computer (also known as object code.) Each source c instruction might correspond to several machine language instructions. Compilers give high-l language programmers several advantages over assembly language programmers:

- High-level languages are not tied to any particular computer, which means that prog written on one computer could be run on another by re-compiling the source for the n machine.
- Programmers who learn a particular high-level language on one system typically can use t language on another system.
- Optimizing compilers can generate code, which is as efficient as the best assembly lan programmers. In fact, since a compiler does not tire, it may generate better code overall t talented assembly-language programmer.

FIRST COMMERCIAL COMPUTERS

The first machine that had commercial applications came out in 1951—Universal Automatic Com (UNIVAC)—when two of them were installed. Eventually 48 of the UNIVACs were sold. UN was the first computer to handle both numerical and alphabetic information with equal ease. UNIVAC was a vacuum tube computer, and its input was through magnetic tape; storage magnetic tapes or a magnetic drum. The IBM 701 came out in 1953, and was designed exclusive business applications. It too was a vacuum tube computer, with a card reader and cardpunch un input and output, and eventually 19 were sold.

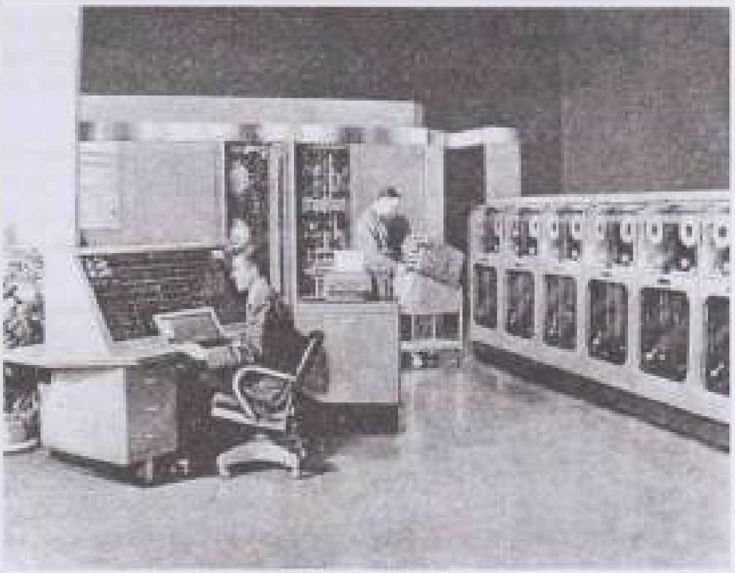


Figure 5.6 UNIVAC

The speed of these machines was limited by the speed of memory, which usually took several hundred milliseconds for a relay to open or close. The processing units in these machines were about [illegible] times faster than the core memory, but still, addition time was several hundred microseconds and multiplication time a few milliseconds. With the developments in programming and hardware through the 1950s and 1960s, computers were made faster and more powerful. They were the IBM 704/709 (tubes) and 7040/7090 (transistors) "scientific" computers, and the IBM 1401 "commercial" computers. The UNIVAC machine developed eventually into the UNIVAC 1108, and DEC ame out with the PDP-10.

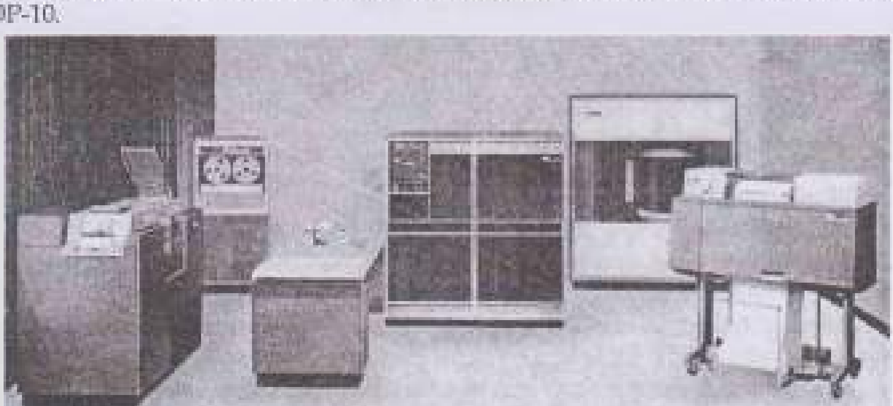


Figure 5.7 IBM 1401

Designers tried to make each of these machines as powerful as possible, given the technology available, but not so complex that they would lose speed or would be difficult to program. Within these machines designers tried out new ways of arranging memory—How many registers should there

- The Arithmetic Logic Unit (ALU) performs basic arithmetic, including addition, subtractio multiplication, and division of two numbers.
- The Register Bank contains a set of memory cells internal to the processor. Each cell typically as wide as the processor's data bus (1 "word"). The processor can read and wri data values into these locations much more quickly than it can access external memory.
- The Condition Code Register contains a set of bits which indicates whether the result of th last command was "greater than zero", "equal to zero", or "less than zero".
- The Program Counter contains the address of the instruction being executed.

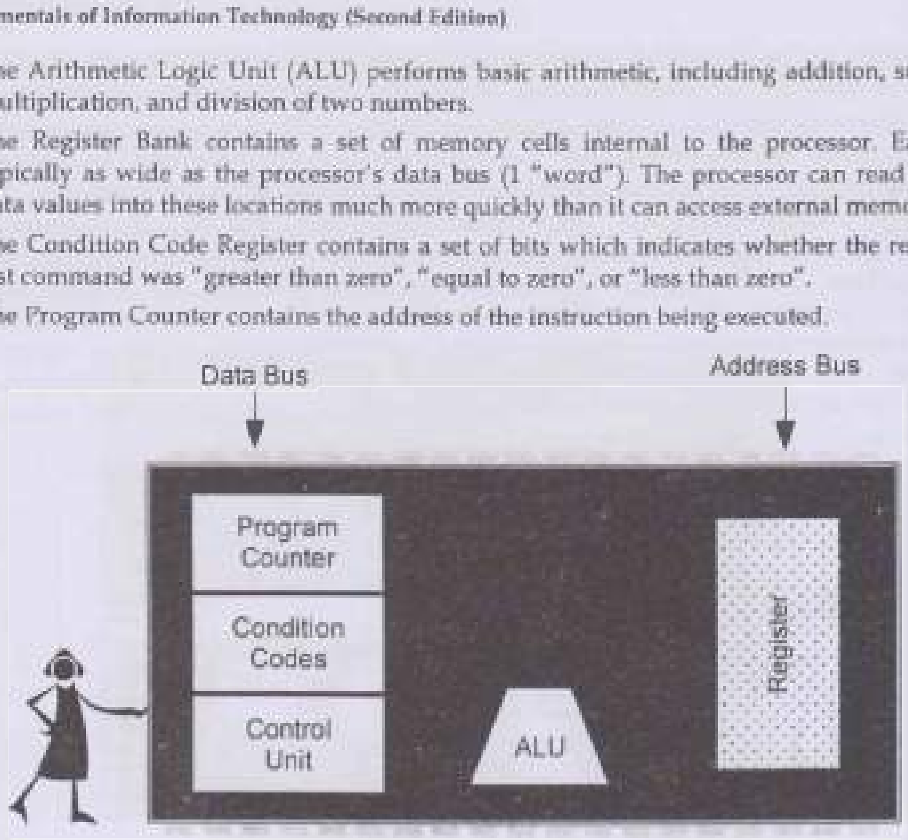


Figure 5.10 Inside the Processor

Let us take a look at what happens when we run a simple program in this processor. The exam assembly language program below counts from 1 to 10, placing the result in memory location 0. chose to write the result to location zero because printing the result or sending it to another periph could involve a long series of instructions.

```
     PUT 1 INTO Register 1
     PUT 4 INTO Register 2
LOOP: COMPARE Register 1 WITH Register 2
     IF EQUAL BRANCH TO "END"
           ADD 1 TO Register 1
     BRANCH TO "LOOP"
END:   STOP
```

The first two instructions initialize, or set up, registers 1 and 2. Register 1 is the loop counter, will contain a value between 1 and 10. Register 2 contains the ending value for the loop—the counter is tested against this value to determine when the loop should end. Instructions 3-7 (fr label 'LOOP': to the "BRANCH TO "LOOP"" instruction) make up the body of the loop:

- Instruction 3 begins the loop by writing the loop counter into memory location zero.
- Instruction 4 compares the loop counter and the ending value. It does this by subtracti second value from the first and then comparing the result to zero. (In this case, the subtr would be "Register 1 - Register 2").

If the result of the subtraction is zero, then the two values are equivalent and the "EQUAL" bit is set to TRUE in the condition code register. If the result is greater than zero, the "GREATER THAN" bit would be set. Similarly, if the result is less than zero, the "LESS THAN" bit would be set.

- Instruction 5 tests the "EQUAL" bit in the condition code register and, if the bit is set, branches to the final instruction (denoted by the label "END"). Otherwise, it "falls through" to the next instruction.

Taken together, instructions 4 and 5 determine if the loop should end or repeat again.

- Instruction 6 is executed if the "end of loop" test fails, and increments the loop counter by one.
- Instruction 7 sends the processor back to the start of the loop.

The last instruction (labeled "END") tells the processor to stop when the loop ends.

A similar high-level language program might read:

```
FOR I = 1 TO 10
  PRINT I
END
```

This program actually implements a simple "for loop", that is a repeating part of a program which counts up or down between two numbers

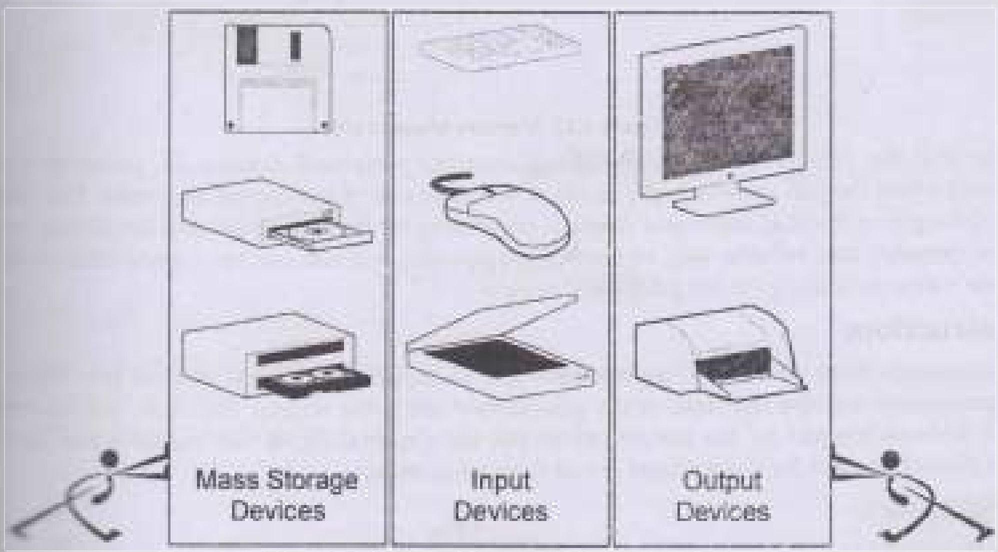


Figure 5.11 Input, Output and Storage Devices

PERIPHERAL DEVICES

The last part of our hypothetical system is the peripheral devices (also known simply as "peripherals"). Computer system's peripherals communicate with the "outside world" or hold information over the long term. Peripherals fall into several basic classes:

- Mass storage devices such as hard disks, "floppy" disks, CD-ROMs, and tape drives.
- Input devices such as the mouse, keyboard, trackball, scanner, microphone, and video camera.
- Output devices such as display screens, printers, and the speaker.

The computer designer has several options when designing peripherals into a system, inclu
such techniques as Memory-Mapped I/O, using special I/O instructions within the main process
using separate I/O processors.

Memory-Mapped I/O

Memory-Mapped I/O makes the peripheral look like a block of RAM (in an address range sep
from the main memory) to the main processor. If the processor writes a value into one of
addresses, the information is sent out to the peripheral. In a similar fashion, if the processor reads
one of these addresses, some information is read from the peripheral and delivered to the process

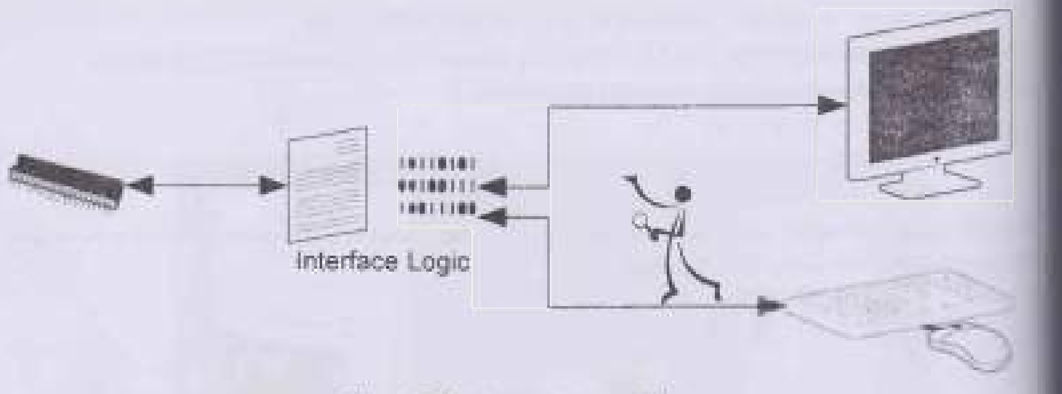


Figure 5.12 Memory-Mapped I/O

Note that the processor is in direct control over the peripheral devices, i.e. information is
transferred when the processor actually reads or writes to one of the special addresses. This tech
is used throughout the Macintosh and Apple II computers for the serial ports and the display scre
is an inexpensive and reliable way to control peripherals, but can use up a good deal of the
processor's time in waiting for the peripheral devices.

I/O Instructions

Some processors have special I/O instructions just to support peripheral devices (see Figure 5
These processors transfer the data to the peripherals using the regular data bus, but have eith
separate address bus just for the peripherals or put out a special signal that indicates that the cu
address should be used for a peripheral rather than for memory.

I/O Processors

The most efficient way to connect peripheral devices to a system is through the use of I/O proce
(see Figure 5.14). These are separate devices, which read and write to the peripherals without tying
the main processor. For example, in a machine such as the Quadra 900 which uses separate
processors for the serial ports, the main processor puts the data to be sent into a block of RAM
then sends the serial I/O processor a request to write that data. The I/O processor then reads each
from the specified area of memory and sends the information over the serial port while the
processor continues executing its own program.

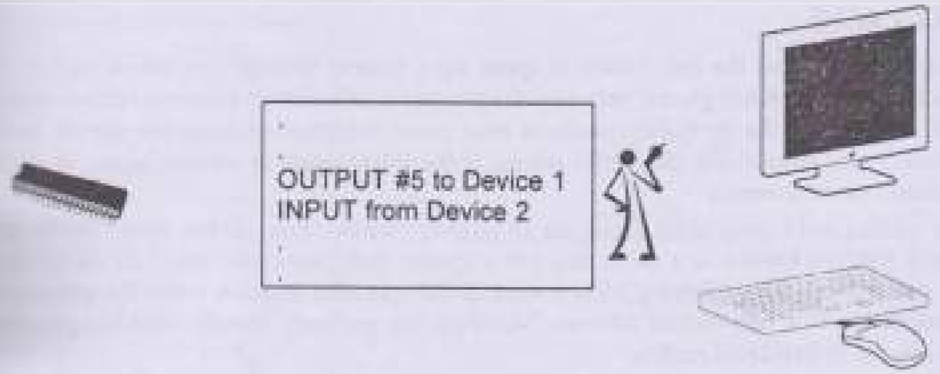


Figure 5.13 I/O Instructions

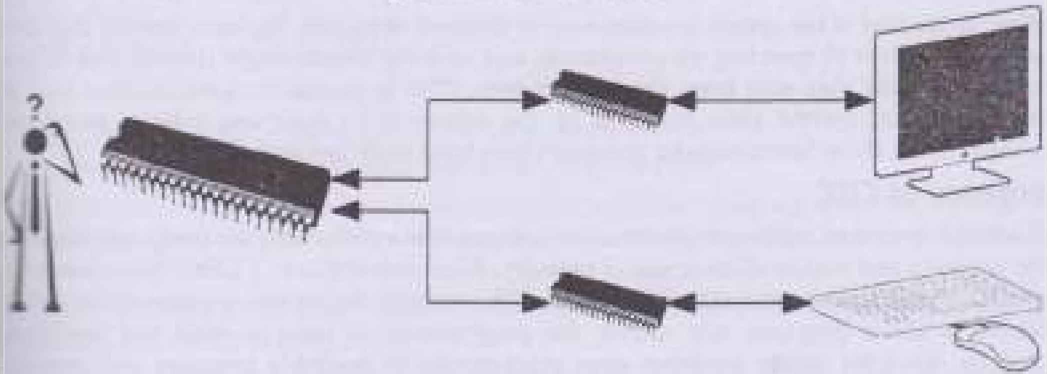


Figure 5.14 I/O Processors

SPEEDING UP THE SYSTEM

One of the few constants in the computer industry is the desire for ever-faster computer systems. There are several places where you can speed up a system, including the memory, processor, connection to the peripheral devices, or the actual peripherals.

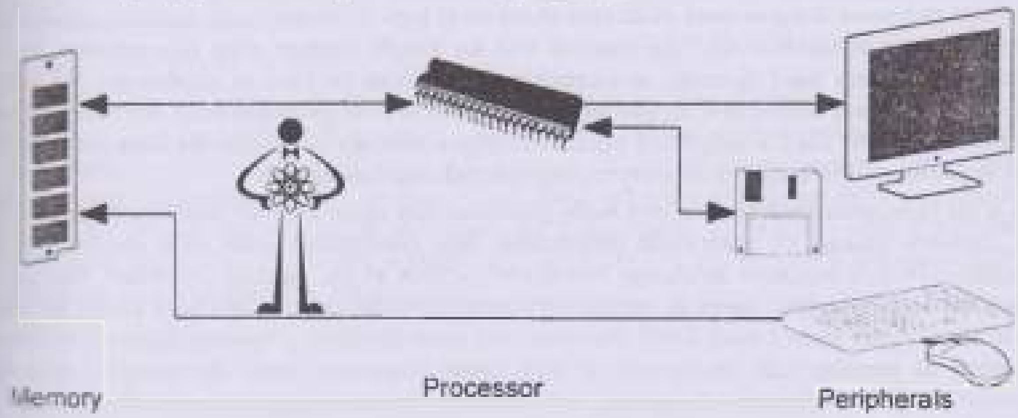


Figure 5.15 I/O Memory, Processors and Peripherals

MEMORY CACHE

Memory provides one of the best places to speed up a system through the use of caches. A memory cache is a block of fast RAM placed between the processor and slower memory such as main memory or a hard disk. When the processor needs to read some information from the slower memory, that information is also copied into the cache where, if the information is needed again, it can be re-read from the faster cache memory.

Some caches hold individual locations separately, while other caches store blocks of locations (where each block is known as a cache line.) In a system that uses cache lines, the cache circuitry will read in a run of locations beginning with or around the specified location when the processor executes a read instruction to a non-cached address. Many caches are built directly onto the processor chip—these are known as first-level caches.

CISC AND RISC

Speeding up the rest of the system involves several different strategies. We have already discussed the use of I/O processors in speeding up peripherals, and each peripheral might contain a small memory buffer, which holds data sent from the main system. (This is similar in some fashion to a cache.) However, the most fruitful place to speed up the system is by designing a faster processor. The following sections show how computer designers have tried to do just that.

Emergence of CISC

CISC, which stands for Complex Instruction Set Computer, is a philosophy for designing chips that are easy to program and makes efficient use of memory. Each instruction in a CISC instruction set might perform a series of operations inside the processor. This reduces the number of instructions required to implement a given program, and allows the programmer to learn a small but flexible set of instructions. Since the earlier machines were programmed in assembly language and memory was slow and expensive, the CISC strategy made sense, and was commonly implemented in such large computers as the PDP-11 and the DEC system 10 and 20 machines. Most common microprocessor designs—including the Intel(R) 80x86 and Motorola 68K series—also follow the CISC strategy. As we shall see, recent changes in software and hardware technology have forced a re-examination of CISC. But first, let us take a closer look at the decisions, which led to CISC.

Use of Microcode

The earliest processor designs used dedicated (hardwire) logic to decode and execute each instruction in the processor's instruction set. This worked well for simple designs with few registers, but made complex architectures hard to build, as control path logic can be hard to implement. So, designers switched tactics—they built some simple logic to control the data paths between the various elements of the processor, and used a simplified microcode instruction set to control the data path logic. This type of implementation is known as a microprogrammed implementation.

In a microprogrammed system, the main processor has some built-in memory (typically ROM) which contains groups of microcode instructions that correspond with each machine language instruction. When a machine language instruction arrives at the central processor, the processor executes the corresponding series of microcode instructions. Because instructions could be retrieved up to 10 times faster from a local ROM than from the main memory, designers began to put as many instructions as possible into microcode. In fact, some processors could be ordered with custom microcode, which would replace frequently used but slow routines in certain application.

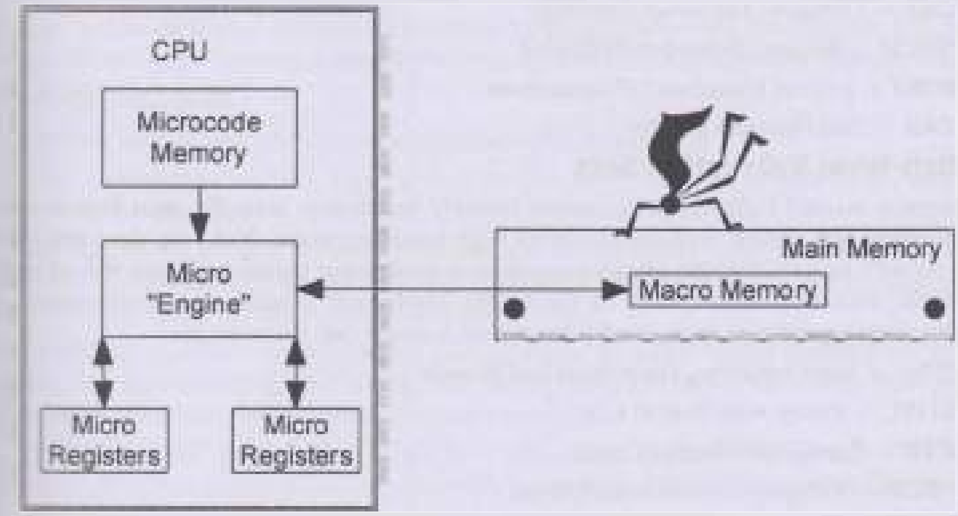


Figure 5.16 Microprogram Representation

There are some real advantages to a microcoded implementation:

- Since the microcode memory can be much faster than the main memory, an instruction set can be implemented in microcode without losing much speed over a purely hard-wired implementation.
- New chips are easier to implement and require fewer transistors than implementing the same instruction set with dedicated logic.
- A microprogrammed design can be modified to handle entirely new instruction sets quickly.

Using microcoded instruction sets, the IBM 360 series was able to offer the same programming model across a range of different hardware configurations. Some machines were optimized for scientific computing, while others were optimized for business computing. However, since they all shared the same instruction set, programs could be moved from machine to machine without re-compilation (but with a possible increase or decrease in performance depending on the underlying hardware). This kind of flexibility and power made microcoding the preferred way to build new computers for quite some time.

Build "Rich" Instruction Sets

One of the benefits of using a microprogrammed design is that designers could build more functionality into each instruction. This not only reduced the total number of instructions required to implement a program, but also made mor· efficient use of a slow main memory, and made the assembly-language programmer's life simpler. Soon, designers were enhancing their instruction sets with instructions aimed specifically at the assembly language programmer. Such enhancements included string manipulation operations, special looping constructs, and special addressing modes for stepping through tables in memory. For example:

- ABCD – Add Decimal with Extend
- ADDA – Add Address
- ADDX – Add with Extend
- ASL – Arithmetic Shift Left

- **CAS** – Compare and Swap Operands
- **NBCD** – Negate Decimal with Extend
- **EORI** – Logical Exclusive OR Immediate
- **TAS** – Test Operand and Set

Build High-level Instruction Sets

Once designers started building programmer-friendly instruction sets, the next logical step wa[s to] build instruction sets, which map directly from high-level languages. Not only does this simplify [the] compiler writer's task, but it also allows compilers to emit fewer instructions per line of source co[de]. Modern CISC microprocessors, such as the 68000, implement several such instructions, inclu[ding] routines for creating and removing stack frames with a single call. For example:

- **DBcc** – Test Condition, Decrement and Branch
- **ROXL** – Rotate with Extend Left
- **RTR** – Return and Restore Codes
- **SBCD** – Subtract Decimal with Extend
- **SWAP** – Swap register Words
- **CMP2** – Compare Register against Upper and Lower Bounds

Rise of CISC

CISC Design Decisions namely, use of microcode, rich instruction sets, and high-level instruction [sets] led to the CISC philosophy that drove all computer designs until the late 1980s, and is still in [use] today. (Note that "CISC" did not enter the computer designer's vocabulary until the advent of RISC; it was simply the way that everybody designed computers).

Characteristics of a CISC Design

While the chips that emerged from the 1970s and 1980s followed their own unique design paths, [they] were bound by what we are calling the "CISC Design Decisions". These chips all have si[milar] instruction sets, and similar hardware architectures. In general terms, the instruction sets are desi[gned] for the convenience of the assembly-language programmer and the hardware designs are [fairly] complex.

Instruction Sets

The design constraints that led to the development of CISC (small amounts of slow memory, and [the] fact that most early machines were programmed in assembly language) give CISC instruction [sets] some common characteristics:

- A two-operand format, where instructions have a source and a destination. For exampl[e, the] add instruction "add #5, D0" would add the number 5 to the contents of register D0 and [place] the result in register D0.
- Register to register, register to memory, and memory to register commands.
- Multiple addressing modes for memory, including specialized modes for indexing th[rough] arrays.
- Variable length instructions where the length often varies according to the addressing mo[de].
- Instructions which require multiple clock cycles to execute. If an instruction re[quires] additional information before it can run (for example, if the processor needs to read [...]

memory locations before operating on them), collecting the extra information will require extra clock cycles. As a result, some CISC instructions will take longer than others to execute.

...ware Architectures

...CISC hardware architectures have several characteristics in common:

- Complex instruction-decoding logic, driven by the need for a single instruction to support multiple addressing modes.
- A small number of general purpose registers. This is the direct result of having instructions which can operate directly on memory and the limited amount of chip space not dedicated to instruction decoding, execution, and microcode storage.
- Several special purpose registers. Many CISC designs set aside special registers for the stack pointer, interrupt handling, and so on. This can simplify the hardware design somewhat, at the expense of making the instruction set more complex.
- A "Condition code" register that is set as a side-effect of most instructions. This register reflects whether the result of the last operation is less than, equal to, or greater than zero, and records if certain error conditions occur.

...Ideal CISC Machine

...processors were designed to execute each instruction completely before beginning the next ... Even so, most processors break the execution of an instruction into several definite stages; ... one stage is finished, the processor passes the result to the next stage:

- An instruction is fetched from the main memory.
- The instruction is decoded—the controlling code from the microprogram identifies the type of operation to be performed, where to find the data on which to perform the operation, and where to put the result. If necessary, the processor reads in additional information from memory.
- The instruction is executed. The controlling code from the microprogram determines the circuitry/hardware that will perform the operation.
- The results are written to memory.

In an ideal CISC machine, each complete instruction would require only one clock cycle (which ... that each stage would complete in a fraction of a cycle). In fact, this is the maximum possible ... for a machine that executes one instruction at a time. In reality, some instructions may require ... than one clock per stage. However, a CISC design can tolerate this slowdown since the idea ... CISC is to keep the total number of cycles small by having complicated things happen within ... cycle.

...SC and the Classic Performance Equation

The usual equation for determining performance is the sum for all instructions of (the number of ... per instruction * instruction cycle time) = execution time. This allows you to speed up a ... in three different ways—use fewer instructions for a given task, reduce the number of cycles ... instructions, or speed up the clock (decrease the cycle time). CISC tries to reduce the number ... instructions for a program, and (as we will see) RISC tries to reduce the cycles per instruction.

...antages of CISC

At the time of their initial development, CISC machines used the available technologies to optimize ... performance.

- Microprogramming is as easy as assembly language to implement, and much less expen than hardwiring a control unit.
- The ease of microcoding new instructions allowed the designers to make CISC mach upwardly compatible—a new computer could run the same programs as earlier compu because the new computer would contain a superset of instructions of the earlier compute
- As each instruction became more capable, fewer instructions could be used to impleme given task. This made more efficient use of the relatively slow main memory.
- Because microprogram instruction sets can be written to match the constructs of high- languages, the compiler does not have to be as complicated.

Disadvantages of CISC

Designers soon realized that the CISC philosophy had its own problems, including:

- Earlier generations of a processor family were generally contained as a subset in every version—so instruction set and chip hardware become more complex with each genera computers.
- So that as many instructions as possible could be stored in memory with the least wasted space, individual instructions could be of almost any length—this means that diff instructions will take different amounts of clock time to execute, slowing down the ov performance of the machine.
- Many specialized instructions are not used frequently enough to justify their exist approximately only 20% of the available instructions are used in a typical program.
- CISC instructions typically set the condition codes as a side effect of the instruction. Not does setting the condition codes take time, but programmers have to remember to ex the condition code bits before a subsequent instruction changes them.

What is RISC?

In the mid-1970s advances in semiconductor technology began to reduce the difference in between main memory and processor chips. As memory speed increased, and high-level lang replaced assembly language, the major reasons for CISC began to disappear, and computer de began to look at ways computer performance could be optimized beyond just making faster har One of their key realizations was that a sequence of simple instructions produces the same resu sequence of complex instructions, but can be implemented with a simpler (and faster) har design assuming that memory can keep up. Reduced Instruction Set Computers—RISC mac was the result.

RISC Characteristics

The following are some of the characteristics of RISC machines:

- **Simple instruction set** — In a RISC machine, the instruction set contains simple, instructions, from which more complex instructions can be composed.
- **Same length instructions** — Each instruction is the same length, so that it may be fetch single operation.
- **One machine-cycle instructions** — Most instructions complete in one machine cycle, allows the processor to handle several instructions at the same time. This pipelining technique used to speed up RISC machines.

- Complex instructions, which require multiple clocks for execution (many floating-point operations, for example).
- Instructions which need to read and write the same register. For example "ADD 5 to register 3" had to read register 3, add 5 to that value, then write 5 back to the same register (which may still be "busy" from the earlier read operation, causing the processor to stall until the register becomes available).
- Dependence on single-point resources such as a condition code register. If one instruction sets the conditions in the condition code register and the following instruction tries to read those bits, the second instruction may have to stall until the first instruction's write completes.

▲ **Dependencies** – One problem that RISC programmers face is that the processor can be slowed down by a poor choice of instructions. Since each instruction takes some amount of time to store its result, and several instructions are being handled at the same time, later instructions may have to wait for the results of the earlier instructions to be stored. However, a simple rearrangement of the instructions in a program (called Instruction Scheduling) can remove these performance limitations from RISC programs. Sophisticated compilers can apply other optimization techniques to an application. Another optimization involves "loop unrolling." Instead of executing a sequence of instruction inside a loop, the compiler may replicate the instructions multiple times. This eliminates the overhead of calculating and testing the loop control variable. Compilers also perform function inlining, where a call to a small subroutine is replaced by the code of the subroutine itself. This gets rid of the overhead of a call/return sequence.

Speeding up Pipelined Machines

As we have seen, the ultimate speed of a pipelined machine is one instruction per clock—Is it true? Researchers have developed two techniques—Super-pipelining and Superscalar—for executing multiple instructions per clock cycle.

Super-pipelining (Speeding up Pipelining)

A super-pipelined system divides each stage of the pipeline into two sub-stages, and then doubles the clock speed internally. Each sub-stage still executes one instruction per clock, but since the internal clock is twice as fast, the pipeline can load two instructions for every tick of the (external) clock. This technique is used commercially (in the MIPS R4000 RISC processor), but is hard to implement and is not being used by any other commercial chip. In practical terms, super-pipelining will never give you more than a 2x improvement in performance.

Superscalar (Doing Multiple Things at Once)

Superscalar (also known as multiple-issue) machines contain multiple execution units which are capable of doing the same thing. This allows the processor to execute several similar instructions concurrently by routing each instruction to the first available execution unit. For example, a superscalar machine with two arithmetic units could add two pairs of numbers at the same time as long as the results did not have to go to the same place. This machine would be known as a "2-issue" machine.

The typical simplified RISC instruction set makes superscalar machines possible since each instruction can be executed in a simple execution unit which takes up less space on the chip and therefore can be replicated one or more times, and because the dependencies between instructions have been minimized. (If two instructions require the same resource such as a register or the condition cases, they cannot be executed at the same time.) Note that a multiple-issue machine usually has only one fetch stage and one decode stage, but that these stages operate in a fraction of a clock cycle each so they do not limit the overall speed of the machine.

Advantages of RISC

Implementing a processor with a simplified instruction set design provides several advantages over implementing a comparable CISC design:

- **Speed** – Since a simplified instruction set allows for a pipelined, superscalar design RISC processors often achieve 2–4 times the performance of CISC processors using comparable semiconductor technology and the same clock rates.
- **Simpler hardware** – Because the instruction set of a RISC processor is so simple, it uses up much less chip space; extra functions, such as memory management units or floating point arithmetic units, can also be placed on the same chip. Smaller chips allow a semiconductor manufacturer to place more parts on a single silicon wafer, which can lower the per-chip cost dramatically.
- **Shorter design cycle** – Since RISC processors are simpler than corresponding CISC processors, they can be designed more quickly, and can take advantage of other technological developments sooner than corresponding CISC designs, leading to greater leaps in performance between generations.

Disadvantages of RISC

The transition from a CISC design strategy to a RISC design strategy is not without its problem. Software engineers should be aware of the key issues, which arise when moving code from a CISC processor to a RISC processor.

- **Code Quality** – The performance of a RISC processor depends greatly on the code that it is executing. If the programmer (or compiler) does a poor job of instruction scheduling, the processor can spend quite a bit of time stalling—waiting for the result of one instruction before it can proceed with a subsequent instruction. Since the scheduling rules can be complicated, most programmers use a high-level language (such as C or C++) and leave the instruction scheduling to the compiler. This makes the performance of a RISC application depend critically on the quality of the code generated by the compiler. Therefore, developers (and development tool suppliers such as Apple) have to choose their compiler carefully based on the quality of the generated code.
- **Debugging** – Unfortunately, instruction scheduling can make debugging difficult. If scheduling (and other optimizations) is turned off, the machine-language instructions show a clear connection with their corresponding lines of source. However, once instruction scheduling is turned on, the machine language instructions for one line of source may appear in the middle of the instructions for another line of source code. Such an intermingling of machine language instructions not only makes the code hard to read, it can also defeat the purpose of using a source-level compiler, since single lines of code can no longer be executed by themselves. Therefore, many RISC programmers debug their code in an un-optimized, unscheduled form and then turn on the scheduler (and other optimizations) and hope that the program continues to work in the same way.
- **Code expansion** – Since CISC machines perform complex actions with a single instruction, where RISC machines may require multiple instructions for the same action, code expansion can be a problem. Code expansion refers to the increase in size that you get when you take a

program that had been compiled for a CISC machine and re-compile it for a RISC machine. The exact expansion depends primarily on the quality of the compiler and the nature of the machine's instruction set. Fortunately for us, the code expansion between a 68K processor used in the non-PowerPC Macintoshes and the PowerPC seems to be only 30-50% on the average, although size-optimized PowerPC code can be the same size (or smaller) than corresponding 68K code.

- **System Design** – Another problem that faces RISC machines is that they require very fast memory systems to feed instructions. RISC-based systems typically contain large memory caches, usually on the chip itself. This is known as a first-level cache. Apple's first PowerPC based machines can contain an optional second-level cache external to the PowerPC chip. This card supplements the cache built into the processor, which increases the overall system performance.

REVIEW QUESTIONS

Short Answer Questions

01. Name the early inventors whose ideas and designs influenced the creation of today's computers?
02. What was the significance of Pascal's machine?
03. What was the contribution of Charles Babbage?
04. Who developed the first mechanical calculator?
05. Which was the first electronic computer?
06. What is contribution of John Von Neumann?
07. What is the importance of EDSAC?
08. What are low-level languages?
09. Give a few examples high-level languages
10. Name the first commercial computer.
11. Give the names of a few commercial computers.
12. What is the difference between RAM and ROM?
13. What is the function of ALU?
14. Give the names of few peripheral devices.
15. Give the names of few CISC machines.
16. Give a few examples for Rich instructions.
17. Give a few examples for high-level instructions.
18. What do you mean by pipelining?

Descriptive Type Questions

01. What were the features and capabilities of Mark I?
02. What do you mean by Harvard architecture?
03. What is the importance of ENIAC?
04. What were the developments that made computers faster and smaller?
05. Explain the Von Neumann architecture. What are its advantages and disadvantages?
06. What is machine language? What are its advantages and limitations?
07. What is assembly language? What are its advantages and limitations?
08. What is high-level language? What are its advantages and limitations?
09. What are the advantages of high-level languages over assembly language?
10. Explain the importance of computer memory in detail with examples.

11. Explain how memory is organized with the help of a diagram.
12. What are the main components of a processor and what are their functions?
13. What are peripheral devices and what are their functions?
14. What is memory mapped I/O?Explain with the help of a diagram.
15. What are I/O instructions? Explain with the help of a diagram.
16. Explain what do you mean by I/O processors with a diagram?
17. How will you speed up a system?
18. What do you mean by memory cache?
19. What do you mean by microccode?
20. How is CISC implemented using microcode? Explain with a diagram.
21. What are the advantages of microcoded implementations?
22. What do you mean by rich instruction sets? How are they used in implementing CISC?
23. How is CISC developed using high-level instructions?
24. What are the characteristics of CISC instruction sets?
25. What are the characteristics of CISC hardware architectures?
26. Explain the components of an ideal CISC machine.
27. What are the advantages and disadvantages of CISC machines?
28. What are the characteristics of RISC machines?
29. What do you mean by pipelining? Explain in detail.
30. What are the performance issues in pipelined systems?
31. What do you mean by instruction latency?
32. What are dependencies and how do they affect the performance of RISC machines?
33. Explain super-pipelining in detail.
34. What do mean by the term superscalar and what is its purpose?
35. What are the advantages and disadvantages of RISC machines?

Essay Questions

01. Trace the evolution of electronic computers.
02. Explain low-level and high-level languages with examples.
03. Trace the evolution of commercial computers.
04. Explain the emergence, development, advantages and disadvantages of CISC.
05. What are the characteristics of a CISC design?
06. Explain the emergence, development, advantages and disadvantages of RISC.

Fill in the Blanks

01. A machine for adding numbers mechanically was developed by ___________.
02. ___________ was the machine that was supposed to be an automatic mechanical calculator but that never werked.
03. The first mechanical calculator was developed by ___________.
04. The first electronic computer was ___________.
05. The technique of storing data and instructions separately has become known as ___________.
06. ENIAC stands for ___________.
07. The first all-electronic computer was ___________.
08. ___________ was the first computer to have this Von Neumann architecture.
09. EDSAC stands for ___________.

10. __________ uses mnemonic codes that are easier to learn and remember than machine language's numeric codes.
11. __________ are programs that translate assembly language into machine language.
12. Machine language and assembly language are called __________.
13. The first high-level language was __________.
14. FORTRAN stands for __________.
15. COBOL stands for __________.
16. __________ are programs that translate the high-level source code into the machine language.
17. __________ was the first commercial computer.
18. UNIVAC stands for __________.
19. Every modern computer system consists of three basic sections: ________, ________ and ________.
20. ALU stands for __________.
21. __________ makes the peripheral look like a block of RAM to the main processor.
22. __________ is a block of fast RAM placed between the processor and slower memory such as main memory or a hard disk.
23. CISC stands for __________.
24. RISC stands for __________.
25. __________ is a design technique where the computer's hardware processes more than one instruction at a time, and does not wait for one instruction to complete before starting the next.
26. A simple rearrangement of the instructions in a program to remove the performance limitations from RISC programs is called __________.
27. __________ divides each stage of the pipeline into 2 sub-stages, and then doubles the clock speed internally.
28. _______ means add decimal with extend.
29. _______ means subtract decimal with extend.
30. _________ machines contain multiple execution units which are capable of doing the same thing which allows the processor to execute several similar instructions concurrently by routing each instruction to the first available execution unit.

[**Answers:** (1) Blaise Pascal (2) Babbage's Folly (3) William Seward Burroughs (4) Mark I (5) Harvard Architecture (6) Electronic Numerical Integrator and Calculator (7) ENIAC (8) EDSAC (9) Electronic Discrete Variable Automatic Computer (10) Assembly language (11) Assemblers (12) Low-level languages (13) FORTRAN (14) Formula Translation (15) Common Business Oriented Language (16) Compilers (17) UNIVAC (18) Universal Automatic Computer (19) Processor, memory, and peripheral devices (20) Arithmetic Logic Unit (21) Memory-Mapped I/O (22) Memory cache (23) Complex Instruction Set Computer (24) Reduced Instruction Set Computer (25) Pipelining (26) Instruction Scheduling (27) Super-pipelined system (28) ABCD (29) SBCD (30) Superscalar]

True or False

01. Blaise Pascal was a 17th century mathematician and philosopher.
02. Mark I was developed at Stanford University.
03. Mark I had 3000 decimal storage wheels, 1400 rotary dial switches, and 500 miles of wire and weighed 5 tons.
04. ENIAC was the first all-electronic computer.
05. ENIAC could do 5000 additions per second or 357 multiplications per second.
06. In the late 1950s transistors, which were 1/200th the size of a vacuum tube, came into use.
07. In a typical Von Neumann system, instructions and data are mixed together in the same memory

8. Assembly languages can be automatically converted into machine language.
9. ALGOL was the first high-level language.
10. Modern high-level languages include Pascal, C, C++, Smalltalk, etc.
11. Programmers who learn a particular high-level language on one system typically can use that language on another system.
12. UNIVAC was the first computer to handle both numerical and alphabetic information with equal ease.
13. The processor can read from and write to ROM but can never change what is in RAM.
14. The Program Counter contains the address of the instruction being executed.
15. Many caches, known as first-level caches, are built directly onto the processor chip.
16. A cache is a section of fast memory placed between the processor and the slower memory.
17. Most common microprocessor designs – including the Intel(R) 80x86 and Motorola 68K series – do not follow the CISC philosophy.
18. Function inlining is a programming technique where a call to a small subroutine is replaced by the code of the subroutine itself.
19. A super-pipelined system divides each stage of the pipeline into 2 sub-stages, and then doubles the clock speed internally.
20. TAS means test operand and set.

[Answers: (1) True (2) False (3) True (4) True (5) True (6) True (7) True (8) False (9) False (10) True (11) True (12) True (13) False (14) True (15) True (16) False (17) True (15) True (19) True (20) True]

CHAPTER 06

The Number System

TOPICS COVERED

- Introduction
- Decimal number system
- Binary number system
- Complements
- Signed and unsigned number representations
- Fixed-point representation of numbers
- Floating-point representation of numbers
- Binary Coded Decimal (BCD)
- Gray code
- Excess-3 Code
- ASCII Code
- EBCDIC Code
- Bits, bytes, and words
- Octal number system
- Hexadecimal number system

Key Points

- We use the decimal numbers or the decimal number syst[...] for our day-to-day activities. But computers understand only [...] and 1s and hence use the binary number system.
- The base or radix of a number system is defined as th[...] number of digits it uses to represent the numbers in the system.
- Decimal number system uses 10 digits—0 through 9—[...] base or radix is 10.
- The radix of the binary number system is 2. It uses only tw[...] digits—0 and 1.
- Octal number system refers to the base-8 number syst[...] which uses just eight unique symbols (0, 1, 2, 3, 4, 5, 6, and 7).
- Hexadecimal number system uses 16 as the base [...] consists of 16 unique symbols: the numbers 0 to 9 and the lett[...] A to F.
- The binary coded decimal (BCD) is the simplest binary co[...] that is used to represent a decimal number. In the BCD code, [...] bits represent a decimal number.
- ASCII code is used extensively in small comput[...] peripherals, instruments and communications devices.
- EBCDIC stands for Extended BCD Interchange Code. [...] the standard character code for large computers.

INTRODUCTION

We use the decimal numbers or the decimal number system for our day-to-day activities. As we know, in the decimal number system there are ten digits—0 through 9. [...] computers understand only 0s and 1s—the machine language.

Using 0s and 1s to program a computer is a thing in the past. Now we can use the deci[...] numbers, the alphabets and special characters like +,-,*,?,/, etc. for programming the computer.

Inside the computer, these decimal numbers, alphabets and the special characters are conve[...] into 0s and 1s, so that the computer can understand what we are instructing it to do. To underst[...] the working of a computer, the knowledge of binary, octal and hexadecimal number system[...] essential.

DECIMAL NUMBER SYSTEM

The base or radix of a number system is defined as the number of digits it uses to represent [...] numbers in the system. Since decimal number system uses 10 digits — 0 through 9 — its base or rad[...] is 10. The decimal number system is also called base-10 number system. The weight of each digit [...]

decimal number system depends on its relative position within the number. For example, consider the number 3256

3256 = 3000 + 200 + 50 + 6

or, in other words,

$3256 = 3 \times 10^3 + 2 \times 10^2 + 5 \times 10^1 + 6 \times 10^0$

From the above example, we can see that the weight of the nth digit of the number from the right hand side is equal to nth digit x 10^{n-1} which is again equal to nth digit x $(base)^{n-1}$. The number system, in which the weight of each digit depends on its relative position within the numbers, is called the positional number system.

BINARY NUMBER SYSTEM

The base or radix of the binary number system is 2. It uses only two digits—0 and 1. Data is represented in a computer system by either the presence or absence of electronic or magnetic signals in its circuitry or the media it uses. This is called a binary or two-state representation of data since the computer is indicating only two possible states or conditions.

For example, transistors and other semiconductor circuits are either in a conducting or non-conducting state. Media such as magnetic disks and tapes indicate these two states by having magnetized spots whose magnetic fields can have two different directions or polarities. These binary characteristics of computer circuitry and media are the primary reasons why the binary number system is the basis for data representation in computers. Thus, for electronic circuits, the conduction state (ON) represents a ONE and the non-conducting state (OFF) represents a ZERO.

Therefore, as mentioned earlier, the binary number system has only two symbols, 0 and 1. The binary symbol 0 or 1 is commonly called a bit, which is a contraction of the term binary digit. In the binary system, all numbers are expressed as groups of binary digits (bits), that is, as groups of 0s and 1s. Just as in any other number system, the value of a binary number depends on the position or place of each digit in a grouping of binary digits. The values are based on the right to left position of digits in a binary number, using the power of 2 as position values. For example, consider the binary number 10100.

$10100 = 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$

$= 16 + 0 + 4 + 0 + 0 = 20$

Table 6.1 gives the binary equivalents of the decimal numbers from 0 to 20.

Table 6.1 Binary equivalents of the decimal numbers from 0 to 20

Decimal	Binary	Decimal	Binary
0	0	11	1011
1	1	12	1100
2	10	13	1101
3	11	14	1110
4	100	15	1111
5	101	16	10000
6	110	17	10001
7	111	18	10010
8	1000	19	10011
9	1001	20	10100
10	1010		

Binary-decimal Conversion

To convert a binary number to its decimal equivalent we use the following expression: The weight of the nth bit of a number from the right hand side = nth bit x 2^{n-1}. After calculating the weight of each bit they are added to get the decimal value as shown in the following examples:

$101 = 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 4 + 0 + 1 = 5$

$1010 = 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 8 + 0 + 2 + 0 = 10$

$1111 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 8 + 4 + 2 + 1 = 15$

$1.001 = 1 \times 2^0 + 0 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} = 1 + 0 + 0 + 0.125 = 1.125$

Decimal-binary Conversion

Decimal numbers are converted into binary by a method called *Double Dabble Method*. In this method the mantissa part of the number is repeatedly divided by two and noting the reminders, which will be either 0 or 1. This division is continued till the mantissa becomes zero. The reminders, which are noted down during the division is read in the reverse order to get the binary equivalent. This can be better illustrated using the following example.

2	14	
2	7	0
2	3	1
2	1	1
2	0	1

The number is written from below, that is 1110. So the binary equivalent of 14 is 1110.

If the decimal number has a fractional part, then the fractional part is converted into binary by multiplying it with 2. Only the integer of the result is noted and the fraction is repeatedly multiplied by 2 until the fractional part becomes 0. This can be explained using the following example.

0.125	
x 2	
0.25	0
x 2	
0.5	0
x 2	
1.00	1

Here the number is written from top i.e. 0.001. So the binary equivalent of 0.125 is .001.

Therefore, from the above two examples, we can conclude that the binary equivalent of the decimal number 14.125 is 1110.001.

Binary Addition

The addition of numbers in the binary system is shown in the table 6.2 and is illustrated by the examples.

Table 6.2 Binary Addition

x	y	x+y
0	0	0
0	1	1
1	0	1
1	1	Carry →1 0

The addition of 101101 and 1111(which are 45 and 15 in the decimal system) is done as follows:

Binary	Decimal
101101	45
+ 001111	+ 15
111100	**60**

Similarly, the addition of 1111011 and 11011 (which are 123 and 27 in the decimal system) is:

Binary	Decimal
1111011	123
+ 0011011	+ 27
10010110	**150**

Binary Subtraction

The subtraction of 1111 from 101101 (which are 15 and 45 in the decimal system) is done as follows:

Binary	Decimal
101101	45
- 001111	- 15
11110	**30**

Similarly the subtraction of 11011 from 1111011 (which are 27 and 123 in the decimal system) is:

Binary	Decimal
1111011	123
- 0011011	- 27
1100000	**96**

When you are **subtracting** a larger number from a smaller number, the result obtained will be the 2's complement. That is, instead of getting a negative number, we are getting the 2's complement of the negative number. For example, if we subtract 45 (101101) from 15 (1111), we should get -30. But when we do the **binary** subtraction, instead of getting - 11110 (-30) we will get the 2's complement of 11110, which is 10.

	Binary	Decimal
	001111	15
	- 101101	- 45
Ignore Carry	→1 **00010**	-30
	10	

COMPLEMENTS

Computers use complemented numbers or complements to perform subtraction. In the binary number system there are two types of complements – 1's complement and 2's complement. Similarly, in the decimal number system also there are two types of complements – the 9's complement and the 10's complement.

9's Complement

The 9's complement of a decimal number is obtained by subtracting each digit of the number from 9. For example, the 9's complement of 2 is 7; that of 123 is 876 and so on.

10's Complement

The 10's complement of decimal number is obtained by adding one to the 9's complement of th number. For example, the 10's complement of 2 is 8; that of 123 is 877, etc. When a decimal numbe added to its 10's complement we get zero.

To illustrate this, consider the following example. In the example, the given decimal number is digits and if the sum of the number and its 10's complement are considered only up to 3 digits, sum is equal to zero. Or, in other words, the 10's complement of a number represents its nega value.

123
+ 877
Ignore Carry →1 000

Thus adding a number to the 10's complement of another number is equivalent to subtracting second number from the first. For example, if you want to subtract 101 from 123, you add the complement of 101 to 123 as shown below:

10's complement method	Normal method
123	123
+ 899	- 101
Ignore Carry →1 022	22
22	

In the case of subtracting a larger number from a smaller one, the method is the same, but result obtained will be the 10's complement. To get the correct result, take the 9's complement of result, add 1 and put a minus (–) sign before it, as shown in the following example:

10's complement method	Normal method
123	123
+ 875	- 125
Result's 10's complement → 998	-2
-((999-998)+1) = -2	

If we are adding two negative numbers, the method is slightly different. You add the complement of both the numbers, ignore the carry, take the 10's compliment of the result and p minus (–) sign before it, as shown in the following example:

10's complement method	Normal method
877	- 123
+ 899	+(- 101)
Ignore Carry →1 776	-224
-((999-776)+1) = -224	

1's Complement

The 1's complement in the binary system is similar to the 9's complement in the decimal system. To the 1's complement of a number, each bit is subtracted from 1. For example, the 1's compleme 1010 is 0101, that of 1111 is 0000, etc.

2's Complement

The 2's complement in the binary system is similar to the 10's complement in the decimal system. To get the 2's complement of a number, add 1 to the 1's complement of the number. For example, the 2's complement of 1010 is 0110, that of 1111 is 0001, etc. Adding a number to the 10's complement of another number is equivalent to subtracting the second number from the first in the decimal system. Similarly, adding a number to the 2's complement of another number is equivalent to subtracting the second number from the first in the binary system. For example, if you want to subtract 101 from 1111, you add the 2's complement of 101 to 1111 as shown below:

10's complement method	Normal method
1111	1111
+ 1011	– 0101
Ignore Carry →1 **1010**	**1010**
1010	

SIGNED AND UNSIGNED NUMBER REPRESENTATIONS

We put a plus (+) or minus (–) sign before the number to represent its sign. In computers such symbols cannot be employed and therefore, a different method is used. To represent a positive number a 0 is placed before the binary number. Similarly, to represent a negative number, a 1 is placed before the binary number. For example +15 and –15 are represented by **01111** and **11111** respectively. There is only one way to represent a positive number, but there are different ways to represent a negative number. These are:

- Signed-magnitude representation
- Signed-1's complement representation
- Signed-2's complement representation

The number –15 can be represented in the above three ways as **11111**, **10000** and **10001** respectively. Since 15 is represented by 4 bits and a separate bit is used to represent sign, in a computer, the most significant bit (MSB) can be used to represent the sign of the number. For example, an 8-bit computer will represent –15 as 10001111, 10000000 and 10000001 for signed-magnitude, signed-1's complement and signed-2's complement respectively. 7 bits are used to represent the number and the MSB is used to represent the sign of the number. When all the bits of the computer word (in an 8-bit computer, the length of a word is 8 bits) are used to represent the number and no bit is used for sign representation, it is called unsigned representation of numbers.

FIXED-POINT REPRESENTATION OF NUMBERS

In the fixed-point number representation system, all numbers are represented as integers or fractions. Signed integer or BCD numbers are referred to as fixed-point numbers because they contain no information regarding the location of the decimal point or the binary point. The binary or decimal point is assumed to be at the extreme right or left of the number. If the binary or decimal point is at the extreme right of the computer word, then all numbers are positive or negative integers. If the radix point is assumed to be at the extreme left, then all numbers are positive or negative fractions.

Consider that you have to multiply 23.15 and 33.45. This will be represented as 2315 x 3345. The result will be 7743675. The decimal point has to be placed by the user to get the correct result, which is 774.3675. So in the fixed-point representation system, the user has to keep track of the radix point, which can be a tedious job.

FLOATING-POINT REPRESENTATION OF NUMBERS

In most computing applications, fractions are used very frequently. So a system of num[...] representation which automatically keeps track of the position of the binary or decimal point is be[...] than the fixed-point representation. Such a system is the floating-point representation of numbers[...] number, which has both an integer part and a fractional part, is called a real number or a floating-po[...] number. These numbers can be either positive or negative.

Examples of real numbers (decimal) are 123.23, -56.899, 0.008, etc. The real number 123.23 ca[...] written as 1.2323×10^2 or 0.12323×10^3. Similarly the numbers 0.008 and 1345.66 can be represente[...] 0.8×10^{-2} and 1.34566×10^3 respectively. This kind of representation is called the *scientific representa[...]* Using this scientific form, any number can be expressed as a combination of a mantissa and [...] exponent, or in other words, the number 'n' can be expressed as '$n=mr^e$' where 'm' is the **mantissa** [...] is the **radix** of the number system and 'e' is the **exponent**.

In a computer also the real or floating-point number is represented by two parts—mantissa a[...] exponent. Mantissa is a signed fixed point number and the exponent indicates the position of [...] binary or decimal point. For example, the number 123.23 is represented in the floating-point system [...]

Sign		Sign	
0	.12323	0	03
Mantissa		Exponent	

The zero in the leftmost position of the mantissa and exponent indicates the plus sign. [...] mantissa can be either a fraction or an integer, which is dependent on the computer manufact[...] Most computers use the fractional system of representation for mantissa. The decimal point sh[...] above is an assumed decimal point and is not stored in the register. The exponent of the ab[...] example, +3, indicates that the actual decimal point is 3 digits to the right of the assumed one. In [...] above example, the mantissa is shown as a fraction. As mentioned, we can use an integer as [...] mantissa. The following example shows how it is done.

Sign		Sign	
0	12323	1	02
Mantissa		Exponent	

In the above representation, the sign of the exponent is negative and it indicates that the ac[...] decimal point lies 2 decimal positions to the left of the assumed point (in this case, the assu[...] decimal point is placed at the extreme right of the integer or 12323.). A negative number say -12[...] can be expressed as follows.

Sign		Sign	
1	.12323	0	03
Mantissa		Exponent	

A negative fraction, say -0.0012323 can be represented as follows.

Sign		Sign	
1	.12323	1	02
Mantissa		Exponent	

BINARY CODED DECIMAL (BCD)

The BCD is the simplest binary code that is used to represent a decimal number. In the BCD code, 4 bits represent a decimal number. For example, 2 is represented as 0010. If a decimal number consists of more than 1 digit, each decimal digit is represented individually by its 4-bit binary equivalent. For example, 123 is represented as 0001 0010 0011. There is a difference between the binary equivalent of a decimal number and its BCD code. For example, the binary equivalent of 45 is 101101 and its BCD code is 0100 0101. Computers perform subtraction using complements and there is difficulty in forming complements when numbers are represented in BCD. For example, 1's complement of 2 (0010) is 1101 which is 13 in the decimal system and is not an acceptable BCD code. To overcome this difficulty, other BCD codes such as Excess-3 are used.

GRAY CODE

The Gray code is binary code. It is used in shaft encoder, which indicates the angular position of a shaft in digital form. The bits are arranged in such a way that only one bit changes at a time when we make a change from one number to the next. Its use reduces the error in reading shaft position. The largest possible error will be one least significant digit. The gray code is often used in computer controlled machines such as lathes, etc. Photoelectric coders or shaft position encoders are used as sensors.

Table 6.3 Gray Codes

Decimal	Gray Code
0	0000
1	0001
2	0011
3	0010
4	0110
5	0111
6	0101
7	0100
8	1100
9	1101
10	1111
11	1110
12	1010
13	1011
14	1001
15	1000

The Table 6.3 shows the Gray codes for the decimal numbers 0 through 15.

EXCESS-3 CODE

As mentioned above, to overcome the disadvantage of BCD in forming complements, other systems like Excess-3 are used. This code is formed by adding 3 to the decimal number and then forming the binary coded number. For instance, to form the Excess-3 representation of 5, first 3 is added to 5 yielding 8, and normal BCD is used which is 1000. Similarly, the decimal number 123 coded in Excess-3 would be 0011 0100 0101. The Table 5.4 shows the BCD and Excess-3 codes for decimal numbers 0 through 9.

Table 6.4 BCD and Excess-3 codes

Decimal	BCD	Excess-3
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010
8	1000	1011
9	1001	1100

ASCII CODE

ASCII stands for American Standard Code for Information Interchange. ASCII code is used extens in small computers, peripherals, instruments and communications devices. It has replaced many of special codes that were previously used. It is a seven-bit code. Microcomputers using 8-bit word le use 7 bits to represent the basic code. The 8th bit is used for parity or it may be permanently 1 With 7 bits, up to 128 characters can be coded. A letter, digit or special symbol is called a characte includes upper and lower case alphabets, numbers, punctuation mark and special and co characters.

ASCII-8 Code

A newer version of ASCII is the ASCII-8 code, which is an 8-bit code. With 8 bits, the code capac extended to 256 characters.

EBCDIC CODE

EBCDIC stands for Extended BCD Interchange Code. It is the standard character code for computers. It is an 8-bit code without parity. A 9th bit can be used for parity. With 8 bits up to characters can be coded. In ASCII-8 and EBCDIC, the first 4 bits are known as zone bits and remaining 4 bits represent digit values. In ASCII, the first 3 bits are zone bits and the remaining 4 represent digit values. Some examples of ASCII and EBCDIC values are shown in Table 6.5.

Table 6.5 ASCII and EBCDIC Codes

Character	ASCII	EBCDIC
0	00110000	11110000
1	00110001	11110001
2	00110010	11110010
3	00110011	11110011
4	00110100	11110100
5	00110101	11110101
6	00110110	11110110
7	00110111	11110111
8	00111000	11111000
9	00111001	11111001
A	01000001	11000001
B	01000010	11000010

C	01000011	11000011
D	01000100	11000100
E	01000101	11000101
F	01000110	11000110
G	01000111	11000111
H	01001000	11001000
I	01001001	11001001
J	01001010	11010001
K	01001011	11010010
L	01001100	11010011
M	01001101	11010100
N	01001110	11010101
O	01001111	11010110
P	01010000	11010111
Q	01010001	11011000
R	01010010	11011001
S	01010011	11100010
T	01010100	11100011
U	01010101	11100100
V	01010110	11100101
W	01010111	11100110
X	01011000	11100111
Y	01011001	11101000
Z	01011010	11101001

BITS, BYTES, AND WORDS

A byte is a basic grouping of **bits** (binary digits) that the computer operates on as a single unit. It consists of 8 bits and is used to represent a character by the ASCII and EBCDIC coding systems. For example, each storage location of computers using EBCDIC or ASCII-8 codes consist of electronic circuit elements or magnetic or optical media positions that can represent at least 8 bits. Thus each storage location can hold one character. The capacity of a computer's primary storage and its secondary storage devices is usually expressed in terms of bytes.

A word is a grouping of bits (usually larger than a byte) that is transferred as a unit between primary storage and the registers of the ALU and control unit. Thus, a computer with a 32-bit word length might have registers with a capacity of 32 bits, and transfer data and instructions within the CPU in groups of 32 bits. It should process data faster than computers with a 16-bit or 8-bit word length. However, processing speed also depends on the size of the CPU's data path or data bus, which are the circuits that interconnect the various CPU components. For example, a microprocessor like the Intel 80386 SX has 32-bit registers but only a 16-bit data bus. Thus, it only moves data and instructions 16 bits at a time. Hence, it is slower than Intel 80386 DX microprocessor, which has 32-bit registers and data paths.

OCTAL NUMBER SYSTEM

Octal number system refers to the base-8 number system, which uses just eight unique symbols (0, 1, 2, 3, 4, 5, 6, and 7). Programs often display data in octal format because it is relatively easy for humans to read and can easily be translated into binary format, which is the most important format for computers. By contrast, decimal format is the easiest format for humans to read because it is the o… we use in everyday life, but translating between decimal and binary formats is relatively difficult. … octal format, each digit represents three binary digits, as shown in the Table 6.6.

Table 6.6 Octal numbers with Binary equivalents

Octal	Binary
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

With this table, it is easy to translate between octal and binary. For example, the octal number 3… is 011 100 101 110 in binary. To convert an octal number to decimal, the same method used for bin… decimal conversion is used, the only difference is that, instead of 2 the base is 8. For example, the oc… number 24.25 is 20.328125 in decimal as shown below.

$$
\begin{aligned}
24.25 &= 2 \times 8^1 + 4 \times 8^0 + 2 \times 8^{-1} + 5 \times 8^{-2} \\
&= 16 + 4 + 0.25 + 0.078125 \\
&= 20.328125
\end{aligned}
$$

To convert a decimal number to octal system, it is repeatedly divided by 8 as illustrated in … following example, where the number 888 is converted to octal system.

8	888	
8	111	0
8	13	7
8	1	5
	0	1

The number is written from below, that is 1570. So the octal equivalent of 888 is 1570.

0.0625	
x 8	
0.50	
x 8	0
0	4

Here the number is written from top i.e., 0 .04. So the octal equivalent of 0.0625 is .04.

If the decimal number has a fractional part, then the fractional part is converted into octal … multiplying it with 8. Only the integer of the result is noted and the fraction is repeatedly multip… by 8 until the fractional part has become 0. This can be explained using the above example. Therefo… from the above two examples, we can conclude that the octal equivalent of the decimal num… 888.0625 is 1570.04.

HEXADECIMAL NUMBER SYSTEM

Hexadecimal number system uses 16 as the base or radix. This base-16 number system consists of 16 unique symbols: the numbers 0 to 9 and the letters A to F. For example, the decimal number 15 is represented as F in the hexadecimal numbering system as shown in the Table 6.7. The hexadecimal system is useful because it can represent every byte (8 bits) as two consecutive hexadecimal digits. Compared to binary numbers, hexadecimal numbers are easier for humans to read.

Table 6.7 Hexadecimal number system

Hexadecimal	Decimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

To convert a value from hexadecimal to binary, you merely translate each hexadecimal digit into its 4-bit binary equivalent. For example, the hexadecimal number 3F7A translates to the following binary number: 0011 1111 0111 1010. To convert a hexadecimal number to decimal, the same method used for binary-decimal conversion is used; the only difference is that instead of 2 the base is 16. For example, the hexadecimal number 24.25 is 36.14453125 in decimal as shown below.

$$24.25 = 2 \times 16^1 + 4 \times 16^0 + 2 \times 16^{-1} + 5 \times 16^{-2}$$
$$= 32 + 4 + 0.125 + 0.01953125$$
$$= 36.14453125$$

To convert a decimal number to hexadecimal system, it is repeatedly divided by 16 as illustrated in the following example. To convert 888 to hexadecimal system, we will do as follows:

16	888	
16	55	8
16	3	7
	0	3

The number is written from below, that is 378. So the hexadecimal equivalent of 888 is 378.

If the decimal number has a fractional part, then the fractional part is converted into hexadecimal by multiplying it with 16. Only the integer of the result is noted and the fraction is repeatedly multiplied by 16 until the fractional part has become 0. This can be explained using the following example.

0.62		
x 16		
0.72		
x 16	9	
0.52		
x 16	E	
0.32		
x 16	B	

This process will further continue. Therefore, the result has been taken up to 3 decimal places. So the hexadecimal equivalent of 0.62 is .9EB (approximately).

Therefore, from the above two examples, we can conclude that the hexadecimal equivalent of the decimal number 888.62 is 378.9EB approximately.

REVIEW QUESTIONS

Short Answer Questions

01. Which number system is used for our day-today activities?
02. Which number system is used in computers?
03. Which numbers are used in machine language?
04. What is the radix of the binary number system?
05. What is the radix of the decimal number system?
06. What is the radix of the octal number system?
07. What is the radix of the hexadecimal number system?
08. What are the complements used in the binary system?
09. What are the complements used in the decimal system?
10. What do you mean by ASCII?
11. What is the expansion of EBCDIC?
12. What is the expansion of BCD?
13. What do you mean by a bit?
14. What is a byte?
15. What is a word?

Descriptive Type Questions

01. Name the different number systems.
02. What do you mean by the base or radix of a number system?
03. How do you convert binary numbers to decimal numbers? Explain with examples.
04. How do you convert decimal numbers to binary numbers? Explain with examples.
05. What are complements and what are their uses?
06. What is 9's complement? Explain with examples.
07. What is 10's complement? Explain with examples.
08. What is 1's complement? Explain with examples.
09. What is 2's complement? Explain with examples.
10. What do you mean by binary coded decimal? Explain with examples.
11. What is the limitation of binary coded decimals and how is it overcome?
12. What do you mean by Gray code? Explain with examples.
13. What do you mean by Excess-3 code? Explain with examples.

[illegible] Explain bit, bytes and words and their uses.
[illegible] What is the advantage of Excess-3 code over BCD?
[illegible] What do you mean by ASCII code? Explain with examples.
[illegible] What do you mean by ASCII-8 code? Explain with examples.
[illegible] What do you mean by EBCDIC code? Explain with examples.
[illegible] How do you convert decimal numbers to octal numbers? Explain with examples.
[illegible] How do you convert hexadecimal numbers to binary numbers? Explain with examples.
[illegible] How do you convert hexadecimal numbers to decimal numbers? Explain with examples.

[illegible] Questions

[illegible] Explain the importance and uses of the binary number system with examples.
[illegible] Explain binary addition and subtraction with examples.
[illegible] What are signed and unsigned numbers? How are they represented? Explain with examples.
[illegible] What do you mean by fixed-point representation of numbers? Explain with examples.
[illegible] What do you mean by floating-point representation of numbers? Explain with examples.

Fill in the Blanks

1. We use the __________ number system for our day-to-day activities.
2. The number of digits a number system uses to represent the numbers in the system is called the __________ or __________.
3. The base of the octal number system is __________.
4. ASCII stands for __________.
5. Binary number system uses only two digits: __________ and __________.
6. A binary digit is called a __________.
7. The decimal equivalent of the binary number 10100 is __________.
8. The 9's complement of a decimal number is obtained by subtracting each digit form __________.
9. EBCDIC stands for __________.
10. BCD stands for __________.

[Answers: (1) Decimal (2) Base, Radix (3) 8 (4) American Standard Code for Information Interchange (5) [illegible] (7) 20 (8) 9 (9) Extended BCD Interchange Code (10) Binary Coded Decimal]

True or False

1. In the decimal number system there are ten digits – 0 through 9.
2. The radix of the hexadecimal number system is 8.
3. When you add 1 to the 9's complement you will get the 10's complement.
4. The binary equivalent of 15 is 1111.
5. The hexadecimal equivalent of 15 is E.
6. Adding a number to the 2's complement of another number is equivalent to subtracting the second number from the first.
7. To represent positive number a 1 is placed before the binary number.
8. In the fixed-point number representation system, all numbers are represented as integers or fractions.
9. The binary equivalent of 45 is 101101 and its BCD code is 0100 0101.
10. Excess-3 code is formed by adding 3 to the decimal number and then forming the binary coded number.

[Answers: (1) True (2) False (3) True (4) True (5) False (6) True (7) False (8) True (9) True (10) True]

Multiple Choice

01. Which of the following is the radix of the binary number system?
    (1) 0 (2) 2 (3) 8 (4) 10
02. Which of the following is the radix of the octal number system?
    (1) 2 (2) 16 (3) 8 (4) 10
03. The number of digits a number system uses to represent the numbers in the system called______.
    (1) Base (2) Basis (3) Radix (4) Base or Radix
04. The binary equivalent of 20 is ______.
    (1) 11111 (2) 10100 (3) 10101 (4) 10011
05. The decimal equivalent of the binary number 111111 is________.
    (1) 25 (2) 40 (3) 65 (4) None of the above
06. The BCD of 123 is
    (1) 0001 0010 0011 (2) 0001 0011 0010 (3) 0011 0010 0001 (4) None of the above
07. The Excess-3 equivalent of BCD code 0101 is
    (1) 0000 (2) 0101 (3) 1000 (4) 0001
08. How many characters can be coded in ASCII?
    (1) 7 (2) 128 (3) 256 (4) None of the above
09. How many characters can be coded in ASCII-8 and EBCDIC?
    (1) 7 (2) 128 (3) 256 (4) None of the above
10. The EBCDIC code of 4 is ________.
    (1) 11110100 (2) 11110010 (3) 11110000 (4) None of the above

[**Answers:** (1) 2 (2) 8 (3) Base or Radix (4) 10100 (5) None of the above (6) 0001 0010 0011 (7) 1000 (8) (9) 256 (10) 11110100]

CHAPTER 07

Central Processing Unit (CPU) and Memory

TOPICS COVERED

- Introduction
- Central Processing Unit (CPU)
- Memory
- Memory organization
- Random Access Memory (RAM)
- Read Only Memory (ROM)
- Registers
- Factors affecting processor speed
- Instruction set
- Machine cycle
- Working of CPU and memory

> **Key Points**
>
> ▲ A computer does the following four functions: receive input, process information, produce output and store information.
>
> ▲ The part of the computer that executes program instructions is known as the processor or central processing unit (CPU).The CPU has two parts—the control unit and the arithmetic logic unit (ALU).
>
> ▲ Memory is a part of the microcomputer that holds data for processing, instructions for processing the data (the program) and information (processed data). There are mainly two types of memory: RAM (random access memory) and ROM (read only memory).
>
> ▲ The main factor that determines the speed of the processor is its architecture, design, registers, memory, cache memory, clock speed, data bus, etc.
>
> ▲ The instructions that the processor can execute are called its instruction set.
>
> ▲ CISC (complex instruction set computing) processors use a large number of complicated instructions, to try to do more work with each one.
>
> ▲ RISC (reduced instruction set computing) processors use a small number of simple instructions, to try to do less work with each instruction but execute them much faster.

INTRODUCTION

To function properly, the computer needs both hardware and software. Hardware consists of the mechanical and electronic devices, which we can see and touch. The software consists of programs, the operating systems and the data that reside in the memory and storage devices. A computer does mainly the following four functions:

- **Receive input** — Accept information from outside through various input devices like the keyboard, mouse, etc.
- **Process information** — Perform arithmetic or logical operations on the information.
- **Produce output** — Communicate information to the outside world through output devices like monitor, printer, etc.
- **Store information** — Store the information in storage devices like hard disk, floppy disks, etc.

These four basic functions are responsible for everything that computers do. The hardware components of the computer specialize in any one of these functions. Computer hardware falls into two categories—**processing hardware**, which consists of the central processing unit (CPU), and the peripheral devices. The CPU is where the data processing is done. Peripheral devices allow people to interact with the CPU. Together, they make it possible to use the computer for a variety of tasks main parts of a computer are shown in Figure 7.1.

CENTRAL PROCESSING UNIT (CPU)

The part of the computer that executes program instructions is known as the processor or processing unit (CPU). In a microcomputer, the CPU is on a single electronic component microprocessor chip, within the system unit or system cabinet. The system unit also includes boards, memory chips, ports and other components. A microcomputer's system cabinet will also disk drives, hard disks, etc., but these are considered separate from the CPU.

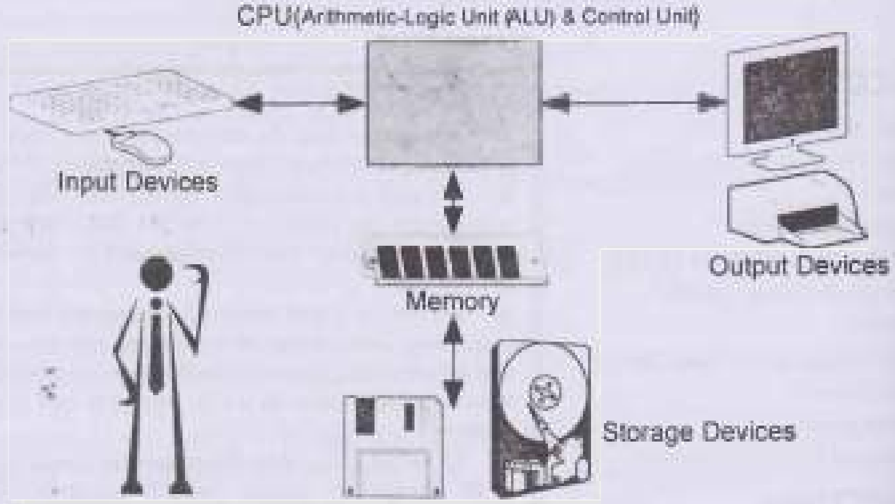


Figure 7.1 Parts of a Computer

CPUs tend to form evolutionary families. Since 1981, all IBM personal computers and compatibles have been created around Intel's chips. Although 8088 was the first chip to be used in an IBM PC used an earlier chip – 8086 – in a subsequent model called IBM PC XT. The chips that came 80286, 80386, 80486, Pentium, Pentium Pro, Pentium II, Pentium III, Celeron, Pentium IV, Itanium line, Pentium Dual Core, Intel Core 2 Duo, Intel Core 2 Quad – correspond to certain standards established by 8086. This line of chips is often referred to as the **80x86** line. The structural design of each chip, known as architecture, has grown steadily in sophistication complexity. The architecture of 8086 contained only a few thousand transistors, but a Pentium processor contains 9.5 million. This increasingly complex architecture is primarily responsible continually increasing power and speed of the Intel processor line. Motorola Corporation is major manufacturer of microprocessors. Apple's Macintosh computers use Motorola processors. Motorola offers two families of processor chips – the **680x0** family and the **Power PC** family. The family consists of chips like 68000, 68020, 68030, 68040, 68060, etc. The first Power PC chip was which was followed by 603, 604, 604e, 620, 750, etc. The Power PC 750 chip was for desktop mobile computers that needed significant power in a low voltage processor. The G3 chip released 1998 provides even more power and Apple's iMAc and PowerMac personal computers are around the G3 chip. The G4 chip was introduced in 1999 and the latest in that series is G5.

As you might expect from its name, the central processing unit is the heart of the computer this is where all the computing is done. All the other devices are concerned with moving data from the CPU. The central processing unit consists of three main components, the control unit, the arithmetic logic unit (ALU), and the registers. The CPU has two parts—the **control unit** and the **arithmetic logic unit (ALU)**. In a microcomputer, both are on the microprocessor chip.

Control Unit

The control unit tells the rest of the computer system how to carry out a program's instructions. It directs the movement of electronic signals between memory, which temporarily holds data, instructions and processed information—and the ALU. It also directs these control signals between the CPU and input/output devices

All the computer's resources are managed from the control unit. The control unit is the logical hub of the computer. The CPU's instructions for carrying out commands are built into the control unit. The instructions, or the **instruction set, list all** the operations that the CPU can perform.

Each instruction in the instruction set is expressed in **microcode**—a series of basic directions that tells the CPU how to execute more complex operations. Microcode is the lowest-level instructions that directly control a microprocessor. As we have seen, a single machine-language instruction typically translates into several microcode instructions.

Arithmetic Logic Unit (ALU)

Arithmetic Logic Unit, usually called the ALU, performs two types of operations—arithmetic and logical. Arithmetic operations are the fundamental mathematical operations consisting of addition, subtraction, multiplication and division. Logical operations consist of comparisons. That is, two pieces of data are compared to see whether one is equal to, less than, or greater than the other. Table 7.1 shows the operations performed by the ALU.

Because all computer data is stored as numbers, much of the processing that takes place inside the computer involves carrying out mathematical or logical operations on the numbers. In addition to establishing ordered sequences and changing those sequences, the computer can perform the arithmetic and logical operations specified seen in Table 7.1. Some of the logical operations can be performed on text data. For example, when you want to search for a word in a document, the CPU carries out a rapid succession of equals operations to find a match for the sequence of ASCII codes that make up the word that you are searching.

Table 7.1 Operations Performed by the ALU

Arithmetic Operations	Logical Operations
Addition	Equal to
Subtraction	Not equal to
Multiplication	Greater than; not greater than
Division	Less than; not less than
Exponentiation	Greater than or equal to; not greater than or equal to
	Less than or equal to; not less than or equal to

Many instructions carried out in the control unit involve moving data from one place to another—from memory to storage, from memory to the printer or monitor and so on. When the control unit encounters an arithmetic or logic operation, it passes that instruction to the ALU. The ALU performs the operations. The ALU includes a group of high speed memory locations built directly into the CPU. These memory locations are called registers and are used to hold data that is currently being processed.

MEMORY

Memory—also known as the primary storage or main memory—is a part of the microcomputer th holds data for processing, instructions for processing the data (the program) and informat (processed data). Part of the contents of the memory is held only temporarily, that is, it is stored o as long as the microcomputer is turned on. When you turn the machine off, the contents are lost. T capacity of the memory to hold data and program instructions varies in different computers. T original IBM PC could hold approximately 640000 characters of data or instructions only. But mode microcomputers can hold millions, even billions of characters in their memory. To locate the charac of data or instructions in the main memory, the computer stores them in locations known as addre A unique number designates each address. Addresses can be compared to post office mailboxes. T numbers stay the same, but contents continuously change.

Memory units are the internal storage areas in a computer. The term "memory" identifies d storage that comes in the form of chips, and the word "storage" is used for memory that exists tapes or disks. Moreover, the term memory is usually used as a short form for physical memory, w refers to the actual chips capable of holding data. Some computers also use virtual memory, wh nds physical memory onto a hard disk.

ry computer comes with a certain amount of physical memory, usually referred to as the ory or the RAM. You can think of the main memory as an array of boxes, each of which can h a single byte of information. A computer that has 1 MB of memory, therefore, can hold about 1 m bytes (or characters) of information. Memory is like an electronic scratch pad inside the compute we have seen before, when you load a program, it is loaded into and run from memory. There mainly two types of memory:

- **RAM (random access memory)** — This is the same as the main memory.
- **ROM (read only memory)** — Computers almost always contain a small amount of read- memory that holds instructions for starting up the computer. Unlike RAM, ROM canno written to.

MEMORY ORGANIZATION

Memories are characterized by their function, capacity, and response times. Operations on mem are called reads and writes, defined from the perspective of a processor or other device that u memory: read transfers information from the memory to the other device, and a write tra information into the memory. A memory that performs both reads and writes is often just ca RAM, for random access memory. Other type of memory commonly used in systems is read- memory or ROM.

The performance of a memory system is defined by two different measures—the access time the cycle time. **Access time**, also known as **response time or latency**, refers to how quickly memory can respond to a read or write request. Several factors contribute to the access time memory system. The main factor is the physical organization of the memory chips used in the sy This time varies from about 80 nanoseconds (1 **nanosecond or ns** is equal to one billionth (10^{-9}) second) in the chips used in personal computers to 10 ns or less for chips used in caches and bu **Memory cycle time** refers to the minimum period between two successive requests.

Since the access time and cycle time and other factors of the different types of memory different the memory of a computer system is organized as a **hierarchy**. In other words, inste building the entire memory out of the same material, we construct a hierarchy of memories, each different capacities and access times. At the top of the hierarchy there will be a small memory, pe with a few KB, built from the fastest chips. The bottom of the hierarchy will be the largest but slowest memory. The processor will be connected to the top of the hierarchy, i.e. when it fetches an instruction it will send its request to the small, fast memory. If this memory contains the requested item, it will respond, and the request is satisfied. If a memory does not have an item, it forwards the request to the next lower level in the hierarchy. The following terminology is used when discussing the memory hierarchy:

- The memory closest to the processor is known as a **cache**. Some systems have separate caches for instructions and data, in which case it has a **split cache**. An **instruction buffer** is a special cache for instructions that also performs other functions that make fetching instructions more efficient.
- The main memory is known as the **primary memory**.
- The low end of the hierarchy is the **secondary memory**. It is often implemented by a disk, which may or may not be dedicated to this purpose.
- The unit of information transferred between items in the hierarchy is a **block**. Blocks transferred to and from cache are also known as cache lines, and units transferred between primary and secondary memory are also known as **pages**.
- Eventually the top of the hierarchy will fill up with blocks transferred from the lower levels. A **replacement strategy** determines which block currently in a higher level will be removed to make room for the new block. Common replacement strategies are random replacement (throw out any current block at random), first-in-first-out (FIFO; replace the block that has been in memory the longest), and least recently used (LRU; replace the block that was last referenced the furthest in the past).
- A request that is satisfied is known as a **hit**, and a request that must be passed to a lower level of the hierarchy is a **miss**. The percentage of requests that result in hits determines the **hit rate**. The hit rate depends on the size and organization of the memory and to some extent on the replacement policy. It is not uncommon to have a hit rate near 99% for caches on workstations and mainframes.

The performance of a hierarchical memory is defined by the **effective access time** (EAT), which is a function of the hit ratio and the relative access times between successive levels of the hierarchy. For example, suppose the cache access time is 10ns, main memory access time is 100 ns, and the cache hit rate is 98%. Then the average time for the processor to access an item in memory is calculated as follows:

EAT = Hit rate * cache access time + (1 – Hit rate) * main memory access time

= 0.98 * 10 + 0.02 * 100 = 9.8 + 2 = **11.8 ns**

Over a long period of time the system performs as if it had a single large memory with an 11.8ns cycle time, thus the term "effective access time." With a 98% hit rate the system performs nearly as well as if the entire memory was constructed from the fast chips used to implement the cache, i.e. the average access time is 11.8 ns, even though most of the memory is built using less expensive technology that has an access time of 100 ns.

RANDOM ACCESS MEMORY (RAM)

Pronounced "ram," RAM is the acronym for **random access memory**, a type of computer memory that can be accessed randomly; i.e. any byte of memory can be accessed without touching the preceding bytes. RAM is the most common type of memory found in computers and other devices, such as printers. When used by itself, the term RAM refers to **read and write memory**; that is, you can both

write data into RAM and read data from RAM. This is in contrast to ROM, which permits you onl
read data. RAM is **volatile**, which means that it requires a steady flow of electricity to maintai
contents. As soon as the power is turned off, whatever data was in RAM is lost. There are two b
types of RAM:

▲ **Dynamic RAM (DRAM)** — DRAM is a type of physical memory used in most pers computers. The term dynamic indicates that the memory must be constantly refre (reenergized) or it will lose its contents.

▲ **Static RAM (SRAM)** — SRAM (pronounced as ess-ram) is the abbreviation of **static ran access memory**. SRAM is a type of memory that is faster and more reliable than the m common DRAM. The term static is derived from the fact that it does not need to be refre like dynamic RAM.

The two types differ in the technology they use to hold data, dynamic RAM being the m common type. Dynamic RAM needs to be refreshed thousands of times per second. Static RAM n to be refreshed less often, which makes it faster; but it is also more expensive than dynamic RAM. B types of RAM are volatile, meaning that they lose their contents when the power is turned off. W DRAM supports access times of about 60 nanoseconds, SRAM can give access times as low a nanoseconds. In addition, its cycle time is much shorter than that of DRAM because it does not ne pause between accesses. Unfortunately, it is also much more expensive to produce than DRAM. D its high cost, SRAM is often used only as a **memory cache**.

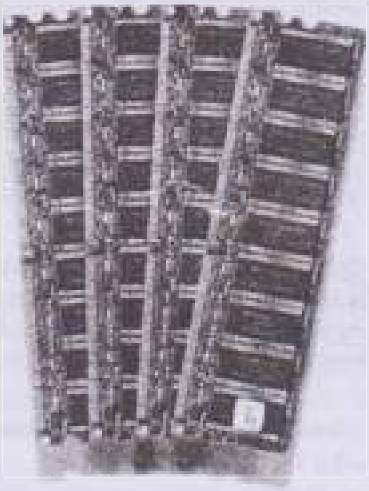


Figure 7.2 Dual In-line Memory Modules (DIMMs)

In common usage, the term RAM is synonymous with main memory, the memory avail programs. For example, a computer with 8 MB RAM has approximately 8 million bytes of m that programs can use. In contrast, ROM refers to special memory used to store programs that b computer and perform diagnostics. Most personal computers have a small amount of ROM thousand bytes). In fact, both types of memory (ROM and RAM) allow random access. To be p therefore, RAM should be referred to as read/write RAM and ROM as read-only RAM. In m computers, chips are usually grouped together on small circuit boards called single inline m modules (SIMMs) or dual in-line memory modules (DIMMs). The bus from a SIMM to the a memory chips is 32 bits wide. A newer technology, called dual inline memory module (D provides a 64-bit bus. Today, single DIMMs that can hold up to 4 GB of RAM are available although the common configurations are one that holds 128 MB, 256 MB, 512 MB, 1 GB, etc.

Dynamic RAM (DRAM)

DRAM is available in several different technology types. At their core, all of these different memory types are similar. They differ mostly in the way that they are organized and how they are accessed. As processors get faster, memory needs to run increasingly faster and more efficiently. Memory companies have invented progressively faster memory architectures to allow memory speeds to increase.

The differences between the various acronyms of DRAM—FPM DRAM, EDO DRAM, BEDO DRAM, SDRAM, DDR SDRAM, etc. technologies are primarily a result of how the DRAM inside the module is connected, configured and addressed, in addition to any special enhancement circuits added to the device. For example, some fancy modules include SRAM (cache) directly in the DRAM module to improve performance. We will see the different types of DRAM:

- **Conventional DRAM** — This is the oldest and slowest DRAM technology. It uses the standard memory addressing method, where first the row address is sent to the memory, and then the column address. This type of DRAM is now quite obsolete and is not used on any new systems, having been replaced by fast page mode memory and newer technologies.
- **Fast Page Mode (FPM) DRAM** — Fast page mode or FPM memory is slightly faster than conventional DRAM. While standard DRAM requires that a row and column be sent for each access, FPM works by sending the row address just once for many accesses to memory in locations near each other, improving access time. Despite its name, FPM is actually the slowest memory technology used in modern PCs. It is also not suitable for high speed memory buses over 66 MHz, because excessive numbers of wait states would have to be added.
- **Extended Data Out (EDO) DRAM** — The most common type of asynchronous DRAM used is called extended data out or EDO memory; sometimes it is also called **hyper page mode** DRAM. It is slightly faster than FPM memory due to another evolutionary tweak in how the memory access works. In simplified terms, EDO memory has had its timing circuits modified so one access to the memory can begin before the last one has finished. It is therefore slightly faster than FPM memory, giving a performance boost of around 3-5% over FPM in most systems.
- **Burst Extended Data Out (BEDO) DRAM** — Burst EDO or BEDO memory is another evolutionary improvement in conventional asynchronous RAM. In this case, EDO memory is combined with pipelining technology and special latches to allow for much faster access time than regular EDO. BEDO memory allows the use of much higher memory bus speeds than EDO.
- **Synchronous DRAM (SDRAM)** — SDRAM differs from earlier types in that it does not run asynchronously to the system clock the way older, conventional types of memory do. SDRAM is tied to the system clock and is designed to be able to read or write from memory in burst mode at 1 clock cycle per access at memory bus speeds up to 100 MHz or even higher. SDRAM accomplishes its faster access using a number of internal performance improvements, including internal interleaving, which allows half the module to begin an access while the other half is finishing one.
- **Double Data Rate SDRAM (DDR SDRAM)** — DDR SDRAM is similar in function to regular SDRAM, but doubles the bandwidth of the memory by transferring data twice per cycle—on

the system memory. SRAMs are used instead for level 1 cache and level 2 cache memory, for which it is perfectly suited; cache memory needs to be very fast, and not very large.

READ ONLY MEMORY (ROM)

ROM is the acronym for read-only memory, a computer memory on which data has been prerecorded. Once data has been written onto a ROM chip, it cannot be removed and can only be read. Unlike the main memory (RAM), ROM retains its contents even when the computer is turned off. ROM is referred to as being non-volatile, whereas RAM is volatile. There are two main reasons that ROM is used for certain functions within the PC:

- **Permanence** — The values stored in ROM are always there, whether the power is on or not. A ROM can be removed from the PC, stored for an indefinite period of time, and then replaced, and the data it contains will still be there. For this reason, it is called non-volatile storage. A hard disk is also non-volatile, for the same reason, but regular RAM is not.
- **Security** — The fact that ROM cannot easily be modified provides a measure of security against accidental (or malicious) changes to its contents. You are not going to find viruses infecting true ROMs, for example; it is just not possible. (It is technically possible with erasable EPROMs, though in practice never seen.)

Read-only memory is most commonly used to store system-level programs that we want to have available to the PC at all times. The most common example is the system BIOS program, which is stored in a ROM called the system BIOS ROM. Having this in a permanent ROM means it is available when the power is turned on so that the PC can use it to boot up the system. Remember that when you first turn on the PC the system memory is empty, so there has to be something for the PC to use when it starts up.

While the whole point of a ROM is supposed to be that the contents cannot be changed, there are times when being able to change the contents of a ROM can be very useful. There are several ROM variants that can be changed under certain circumstances. The following are the different types of ROMs with a description of their relative modifiability:

- **PROM** — PROM (pronounced prom) is an acronym for **programmable read-only memory.** A PROM is a memory chip on which data can be written only once. Once a program has been written onto a PROM, it remains there forever. Unlike the main memory, PROMs retain their contents when the computer is turned off. The difference between a PROM and a ROM is that a PROM is manufactured as blank memory, whereas a ROM is programmed during the manufacturing process. To write data onto a PROM chip, you need a special device called a PROM programmer or a PROM burner. The process of programming a PROM is sometimes called burning the PROM.
- **EPROM** — EPROM is the abbreviation for **erasable programmable read-only memory**, and pronounced "ee-prom." EPROM is a special type of memory that retains its contents until it is exposed to ultraviolet light. The ultraviolet light clears its contents, making it possible to reprogram the memory. An EPROM differs from a PROM in that a PROM can be written to only once and cannot be erased. EPROMs are used widely in personal computers because they enable the manufacturer to change the contents of the PROM before the computer is actually shipped. This means that bugs can be removed and new versions installed shortly before delivery.
- **EEPROM** — EEPROM stands for **electrically erasable programmable read-only memory**. Pronounced "double-ee-prom," an EEPROM is a special type of PROM that can be erased by

exposing it to an electrical charge. Like other types of PROM, EEPROM retains its conten even when the power is turned off. Also like all other types of ROM, EEPROM is not as fast a RAM. EEPROM is similar to flash memory (sometimes called flash EEPROM). The princip difference is that EEPROM requires data to be written or erased one byte at a time where flash memory allows data to be written or erased in blocks. This makes flash memory faster

- **Flash Memory** – Flash memory is a special type of EEPROM that can be erased an reprogrammed in blocks instead of one byte at a time. Many modern PCs have their BIO (Basic Input Output System) stored on a flash memory chip so that it can easily be updated necessary. Such a BIOS is sometimes called a flash BIOS. Flash memory is also popular modems because it enables the modem manufacturer to support new protocols as th become standardized.

Most personal computers contain a small amount of ROM that stores critical programs such as th program that boots the computer. In addition, ROMs are used extensively in calculators an peripheral devices such as laser printers, whose fonts are often stored in ROMs. Finally, one oth characteristic of ROM, compared to RAM, is that it is much slower, typically having double the acc time of RAM or more.

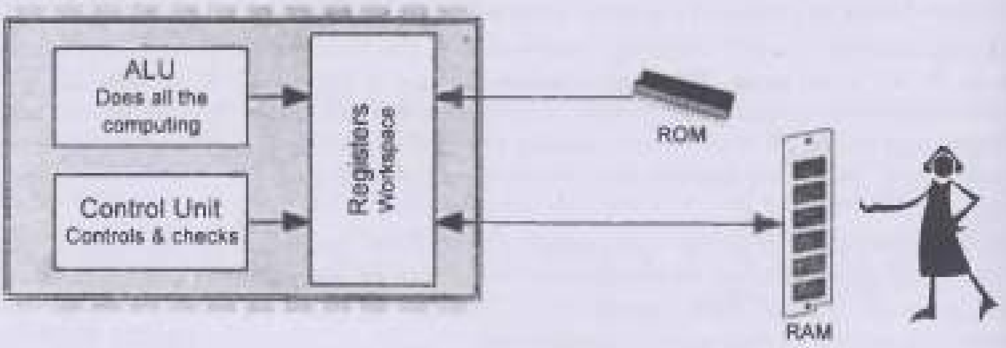


Figure 7.3 CPU and Memory

REGISTERS

Computers also have several additional storage locations called registers. These appear in the con unit and ALU and make processing more efficient. Registers are a sort of special hi-speed staging ar that hold data and instructions temporarily during processing. They are parts of the control unit an ALU rather than the memory. Their contents can therefore be handled much faster than the content the memory.

Registers are a number of small, high-speed memory units. They hold various types information such as data, instructions, addresses and the intermediate results of calculat Essentially, they hold the material that the CPU is currently working with and they can be thoug as being the CPU's workspace. As soon as a particular instruction or piece of data is finished with, immediately replaced by the next ones and information that results from the processing is return main memory. Data and instructions do not go into either the ALU or the control unit. The ALU w on the data held in the registers acting on the instructions which are also held there. The relation between the component parts of the CPU and memory is shown in Figure 7.3. The arrows indicat movement of data.

FACTORS AFFECTING PROCESSOR SPEED

The main factor that determines the speed of the processor is its architecture and design, but there are several additional components that improve the performance of the processor. Some of these components are registers, memory, cache memory, clock speed, data bus, etc. We will see how each of these items affects the processor speed.

Registers

As we have seen above a register is a special, high-speed storage area within the CPU. All data must be represented in a register before it can be processed. For example, if two numbers are to be multiplied, both numbers must be in registers, and the result is also placed in a register. (The register can contain the address of a memory location where data is stored rather than the actual data itself.)

The number of registers that a CPU has and the size of each (number of bits) help determine the power and speed of a CPU. The registers in the first PCs could hold two bytes – 16 bits – each. Most CPUs sold today (for both PCs and Macs) have 32-bit registers. Many newer PCs, minicomputers and high-end workstations have 64-bit registers.

The size of the registers is called the **word length** of the computer and indicates the amount of data with which the computer can work on at any given time. The bigger the word size, the more quickly the computer can process a set of data. For example a 32-bit CPU is one in which each register is 32 bits wide. Therefore, each CPU instruction can manipulate 32 bits of data. If all other factors are kept equal, a CPU with 32-bit registers can process data twice as fast as one with a 16-bit register. The processors are sometime referred by the size of their registers – 32-bit processor, 64-bit processor, etc.

Memory

The amount of RAM available on the computer is a factor that has great impact on the speed and performance of the processor. The computer can manipulate only data that is in main memory. Therefore, every program you execute and every file you access must be copied from a storage device into main memory. The amount of main memory on a computer is crucial because it determines how many programs can be executed at one time and how much data can be readily available to a program. More RAM can make the computer run faster.

The computer does not have to load an entire program into the memory to run it. However, the more the amount of the program that is stored in the memory, the faster it will run. Because computers often have too little main memory to hold all the data they need, computer engineers invented a technique called **swapping**, in which portions of data are copied into main memory as they are needed. Swapping occurs when there is no room in memory for needed data. When one portion of program code or data is copied into memory (**swap-in**), an equal-sized portion is copied out (**swap-out**) to make room. While swapping is an effective method for managing when memory is limited, it can result in slow system performance because the CPU, memory and the hard disk are continuously occupied by the swapping process. If you purchase a new computer, it will probably come with 128 or 256 MB of RAM. Many new computers can hold as much as 4 GB of RAM.

Clock Speed

Every computer has a system clock. The computer uses the system clock to time its processing operations. The system clocks have become much faster over the years. The first PC operated at 4.77 MHz (Mega Hertz) or 4.77 millions of cycles per second. Today computers with clock speed in the range of 2 GHz are commonplace.

The computer's operating speed is related to its clock speed. For example, a computer with clock speed 300 MHz, ticks 300 million times per second. A **clock cycle** is a single tick or vibration of the clock and it is the time taken to turn a transistor off and back on again. A processor can execute an instruction in a specified number of clock cycles. So, the faster the clock ticks (or in other words higher the clock speed) the higher the number of instructions it can carry out each second. So as the clock speed increases the processor speed and performance will also increase.

Bus

Bus is a collection of wires through which data is transmitted from one part of a computer to another. You can think of a bus as a highway on which data travels within a computer. There are two main buses in a computer—the **internal** or **system bus** and the **external** or **expansion bus**. When used in reference to personal computers, the term bus usually refers to internal bus. This is a bus that connects all the internal computer components to the CPU and main memory. The expansion bus connects external devices like keyboard, mouse, modem, printer, etc. to the CPU.

On PCs, the old **ISA (Industry Standard Architecture)** bus is being replaced by faster buses such as **PCI (Peripheral Component Interconnect)**. Nearly all PCs made today include a **local bus** for data that requires especially fast transfer speeds, such as video data. Another type of bus is AGP **(Accelerated Graphics Port)**. AGP is an interface specification developed by Intel Corporation. AGP is based on PCI, but is designed especially for the throughput demands of 3-D graphics. The local bus is a high-speed pathway that connects directly to the processor. Two new bus technologies are replacing most existing buses. These are **USB (Universal Serial Bus)** and **IEEE 1394 (FireWire)**. These buses not only provide fast data transfer speeds but also eliminate the need for expansion slots and boards.

All buses consist of two parts—an **address bus** and a **data bus.** The data bus transfers actual data whereas the address bus transfers information about where the data should go. The size of a bus, known as its width, is important because it determines how much data can be transmitted at one time. For example, a 16-bit bus can transmit 16 bits of data, whereas a 32-bit bus can transmit 32 bits of data. Every bus has a clock speed measured in MHz. A fast bus allows data to be transferred faster, which makes applications run faster.

Cache Memory

Cash memory is a special high-speed storage mechanism. It can be either a reserved section of main memory or an independent high-speed storage device. A memory cache, sometimes called a cache store or RAM cache, is a portion of memory made of high-speed static RAM (SRAM) instead of the slower and cheaper dynamic RAM (DRAM) used for main memory. Memory caching 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.

Some memory caches are built into the architecture of microprocessors. The Intel 80486 microprocessor, for example, contains an 8 KB memory cache, and the Pentium has a 16 KB cache. Today many CPUs have as much as 256 KB memory cache. Such internal caches are often called Level 1 (L1) caches. Most modern PCs also come with external cache memory, called Level 2 (L2) caches. These caches sit between the CPU and the DRAM. Like L1 caches, L2 caches are composed of SRAM but they are much larger. Many PCs sold today have 512 or 1024 KB of L2 cache while high-end systems can have as much as 2 MB of L2 cache. The more the cache you have on your computer (both L1 and L2) the more will be the processing speed.

- To execute this instruction, the control unit informs the ALU that two numbers are coming and the ALU is to multiply them. The control unit next sends to the ALU a copy of the contents of address 7(10) and address 8 (4).
- The ALU performs the multiplication: 10 x 4 =40.
- The control unit sends a copy of the multiplied result (40) back to memory, to address 9.
- The next program instruction is executed: "Print the Result".
- To execute this instruction, the control unit sends the contents of the address 9 (40) to the monitor.
- The monitor displays the value 40.

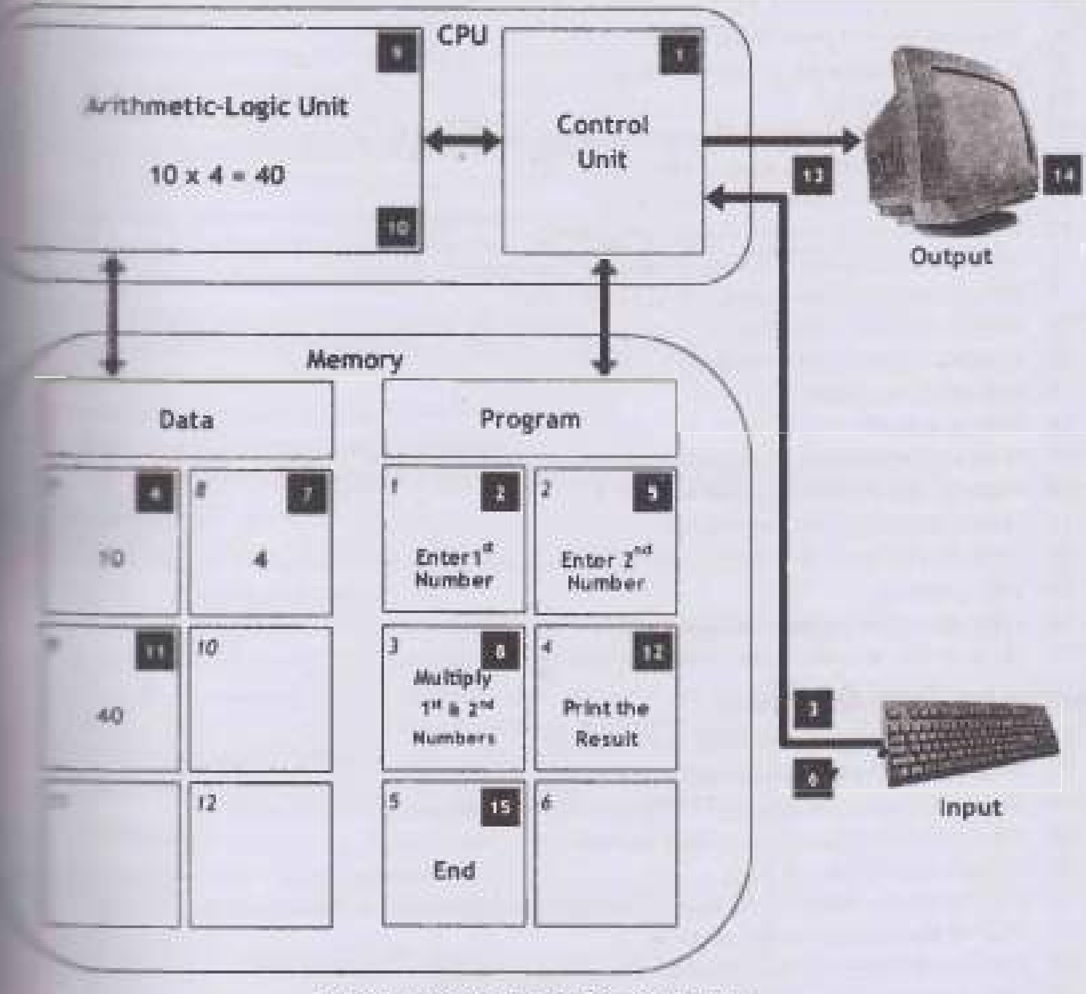


Figure 7.4 Working of the CPU and Memory

- The final instruction is executed: "End." The program is complete.

The Figure 7.4 is a simplified version of the actual processing activity. The actual working of the CPU and memory is much more complicated. For example, there are actually many more memory

- What is cache memory and what are its uses?
- What is the difference between primary memory and secondary memory?
- What do you mean by the terms hit, miss and hit rate?
- What is effective access time?
- What are the different types of DRAM?
- What are the advantages and disadvantages of SRAM?
- What are the reasons for using ROM?
- What are the two basic types of RAM?
- How is PROM different from EPROM?
- How is EEPROM different from EPROM and PROM?
- What is flash memory?
- What are registers and how are they important?
- What is an instruction set and what are they used for?
- What is microcode and where is it used?
- What are the factors affecting the processor speed?
- How do registers affect the processor speed?
- How does memory or RAM affect processor speed?
- What is clock speed of a computer and how is it related to processor speed?
- What is a bus? What are the different types of buses?
- How does the bus affect the processor speed?
- What is cache memory and how is it related to processor speed?
- What is a machine cycle?
- What are the different phases of the machine cycle?
- What are instruction and execution cycles?
- How does the choice of the instruction set affect the performance of the computer?

[illegible] Questions

- Explain the functions and parts of a computer using a diagram.
- Explain the working of the CPU.
- Explain the functions, working and different types of computer memory.
- Explain memory organization and its importance.
- What do you mean by ROM, what are its uses and what are the different types?
- What are registers? Explain its working using a suitable diagram.
- Explain the factors affecting the processor speed.
- Explain how the CPU and memory work using an example.

Fill in the Blanks

- To function properly the computer needs _________ and _________.
- Computer hardware falls into two categories: _________ and _________.
- CPU stands for _________.
- The two major components of the CPU are _________ and _________.
- _________ are the internal storage areas in a computer.
- Every computer has a certain amount of physical memory, called _________.
- RAM stands for _________.
- The memory unit that holds instructions for starting up the computer is _________.

09. _________ is a special type of EEPROM that can be erased and reprogrammed in blocks instead one byte at a time.
10. Each instruction in the instruction set is expressed in _________.
11. _________ is the lowest-level instructions that directly control a microprocessor.
12. ALU stands for _________.
13. _________ are a number of small, high-speed memory units, which are used to hold various typ of information such as data, instructions, addresses and the intermediate results of calculations.
14. CISC stands for _________.
15. The machine cycle consists of two sub-cycles: _________ and _________.
16. The machine cycle consists of four steps: _________, _________, _________ and _________.
17. MIPS stands for _________.

[Answers: (1) Hardware and software (2) Processing hardware and peripherals (3) Central Process Unit (4) Control unit and Arithmetic-Logic unit (5) Memory (6) RAM (7) Random Access Memory BIOS ROM (9) Flash memory (10) Microcode (11) Microcode (12) Arithmetic-Logic Unit (13) Regis (14) Complex Instruction Set Computing (15) Instruction cycle and Execution cycle (16) Fetch Decoding, Executing and Storing (17) Millions of instructions per second]

True or False

01. Hardware is the mechanical and electronic devices, which we can see and touch.
02. Peripheral devices allow people to interact with the CPU.
03. The part of the computer that executes program instructions is known as the memory.
04. You can write data into ROM and read data from ROM.
05. Static RAM is faster than Dynamic RAM.
06. ROM is read-once memory.
07. The contents of an EPROM can be erased by exposing it to ultraviolet light.
08. An EEPROM can be erased by exposing it to an electrical charge.
09. A single machine-language instruction typically translates into several microcode instructions.
10. In a microcomputer the control unit and ALU are on the microprocessor chip.
11. The control unit tells the rest of the computer system how to carry out a program's instructions.
12. Addition, subtraction, multiplication, division, etc. are the logical operations performed by ALU.
13. RISC stands for Redundant Instruction Set Computing.
14. IBM RS/6000 is a machine based on the RISC architecture.
15. Both Intel 80x86 and Motorola 680x0 families are RISC processors.

[Answers: (1) True (2) False (3) False (4) False (5) True (6) False (7) True (8) True (9) True (10) True True (12) False (13) False (14) True (15) False]

CHAPTER 08

Secondary (Auxiliary) Storage Devices

TOPICS COVERED

- Secondary storage devices
- Magnetic tape
- Magnetic disks
- Optical disk
- Zip disk
- Jaz disk
- SuperDisk
- Magneto-Optical (MO) disk

Key Points

▲ Secondary storage is the memory that supplements the main storage. Secondary storage devices are also useful in transferring data or programs from one computer to another. They also function as back-up devices, which allow you to back-up the valuable information that you are working on.

▲ There are two types of secondary storage devices: sequential and random. In the case of sequential-access media, the data stored in the media can only be read in sequence and to get to a particular point on the media you have to go through all the preceding points. Random access is also called direct access media because a disk drive can access any point at random without passing through intervening points.

▲ Sequential access storage is off-line. The data in this kind of storage is not accessible to the CPU until it has been loaded onto an input device. Examples of storage are magnetic tapes—Half-inch tapes, Quarter-inch cartridge (QIC) tapes, 8 mm helical scan tapes and DAT cartridge.

▲ Direct access storage requires an input/output device that is directly connected to the CPU. In other words, direct access is said to be on-line, making the stored data available to the CPU at all times. Examples of direct-access media are magnetic disks (hard disks and floppy disks), optical disks (CDs and DVDs), Zip disks, Jaz disks, SuperDisks, and Magneto-optical disks.

SECONDARY STORAGE DEVICES

The computer's ability to store and retrieve data is at the core of almost every business application—whether in inventory management, word-processing or management decision-making. The efficiency of computer systems in information processing greatly depends on how it stores data and how fast it can retrieve the data. For example, if data are stored sequentially on a magnetic tape, they are ideal for using in batch-processing applications, but they cannot be used in an on-line application or in a spreadsheet application for decision-making. Because data storage and retrieval are closely related to what can be done with data, it is important to know how data are stored and retrieved. This chapter will give you an introduction to the different storage devices.

The main components of a computer include Central Processing Unit (CPU), input, output, and storage devices. The CPU temporarily stores data and programs in its main memory while the data are being processed. Because of the high cost and volatile nature of the main memory, permanent storage of data is done in the auxiliary storage devices.

Secondary storage also known as **secondary memory** or **auxiliary storage** is the memory that supplements the main storage. This is a long-term, non-volatile memory. The term non-volatile means it stores and retains the programs and data even after the computer is switched off. Unlike RAM which looses the contents when the computer is turned off, and ROM, to which it is not possible to ad anything new, auxiliary storage devices allows the computer to record information semi-permanent so it can be read later by the same computer or by another computer.

Secondary storage devices are also useful in transferring data or programs from one computer another. They also function as back-up devices which allow you to back-up the valuable informa that you are working on. So even if by some accident your computer crashes and the data in it unrecoverable, you can restore it from your back-ups. The most common types of auxiliary stor devices are magnetic tapes, magnetic disks, floppy disks, hard disks, etc. the backbone of a organization. In a world that focuses on achievement and advantage, information can be the criti factor that enables managers and organizations to gain a competitive edge. It is the most criti resource of the organization.

Classification of Secondary Storage Devices

As we have seen primary storage (also known as internal storage) is storage within the C Secondary storage (also known as auxiliary storage or external storage) is storage outside the CPU even outside the computer. There are two types of secondary storage devices. This classificatio based on the type of data access: **sequential** and **random**. Based on the type of access they are cal sequential-access media and random-media. In the case of sequential-access media, the data stored the media can only be read in sequence and to get to a particular point on the media you have t through all the preceding points as shown in Figure 8.1. In contrast, disks are random-access called direct-access media because a disk drive can access any point at random without pas through intervening points.

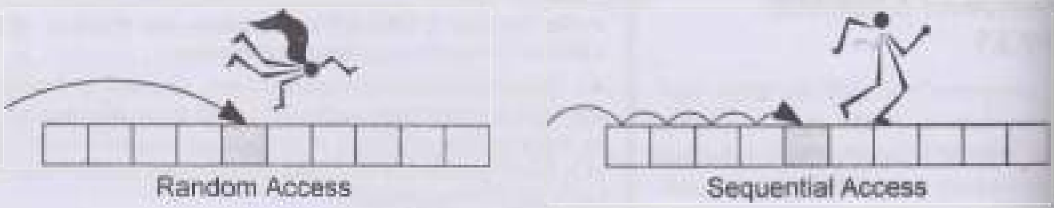


Figure 8.1 Comparison between Random and Sequential Access

Sequential access storage is off-line. The data in this kind of storage is not accessible to the C until it has been loaded onto an input device. An example of sequential access storage is the magn tape. **Direct access storage** requires an input/output device that is directly connected to the CP other words, direct access is said to be on-line, making the stored data available to the CPU at all ti Such storage devices are called Direct Access Storage Devices (DASD). An example of direct ac media is the hard disk of the computer. Other examples of direct access media are magnetic optical disks, zip disks, etc.

Advantages of Secondary Storage

Although primary storage (main memory) can process data faster, secondary storage has a numb advantages:

- Economy — It is more economical to store data on secondary storage devices than in pr storage.
- Capacity — There is much more capacity in secondary storage than in primary stor fact, the secondary storage capacity is practically unlimited.

* Security – Data is usually stored in secondary storage devices so that it is safe from tampering by unauthorized people or from natural hazards and degradation.

MAGNETIC TAPE

Magnetic tape is a magnetically coated strip of plastic on which data can be encoded. Tapes for computers are similar to the tapes used to store music. Some personal computers, in fact, enable you to use normal cassette tapes. Storing data on tapes is considerably cheaper than storing data on disks. Tapes also have large storage capacities, ranging from a few hundred kilobytes to several gigabytes.

Figure 8.2 Magnetic Tape

Accessing data on tapes, however, is much slower than accessing data on disks. Tapes are sequential-access media, which means that to get to a particular point on the tape, the tape must go through all the preceding points. In contrast, disks are random-access media because a disk drive can access any point at random without passing through intervening points. Because tapes are so slow, they are generally used only for long-term storage and backup. Data to be used regularly is almost always kept on disks. Tapes are also used for transporting large amounts of data.

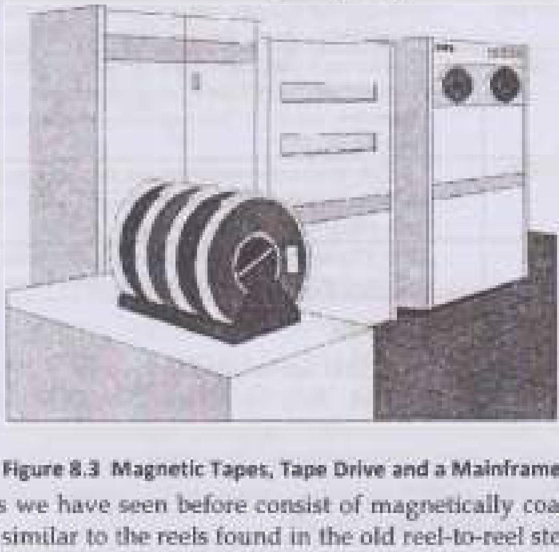


Figure 8.3 Magnetic Tapes, Tape Drive and a Mainframe

The magnetic tapes as we have seen before consist of magnetically coated plastic tape wound on reels. These reels are very similar to the reels found in the old reel-to-reel stereo tape recorders. But the reels used in minicomputers and mainframes are much larger (than the reels of the stereo reels) and can take magnetic tapes that are half an inch wide and 2400 feet long and are capable of storing 6.25 characters per inch. The devices on which such tapes are run are called **magnetic tape drives** or **magnetic tape units** (see Figure 8.3).

These devices are similar to a refrigerator in size and shape and consist of two reels – a **supply reel** and a **take-up reel**. They also have a **read/write head** and an **erase head**. The read/write head is an electromagnet that reads magnetized areas, which represent data on the tape, converts them into electrical signals and sends them to the CPU.

It writes (or records) data onto the tape from the CPU. If there is previous data on the tape, it also erases that data using the erase head, as it writes the new data. Data is represented on the tape by invisible magnetized spots – the presence or absence corresponding to a 1 bit or a 0 bit. The most common way of organizing data is a 9-track code. The tape is divided into 9 tracks or channels that run through the entire length of the tape. Each row across the nine tracks represents a single EBCDIC or ASCII character plus a parity bit (see Figure 8.4).

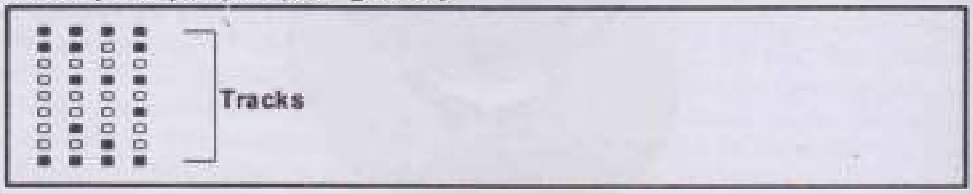


Figure 8.4 9-Track Magnetic Tape

In the past, the simplicity and lower cost of magnetic tapes made it a better alternative to magnetic disks. This is no longer true and today magnetic tapes are used to make backup copies of files. Because there is no need to start and stop the tapes during the process of making the backup, a kind of magnetic tape drives called **Streamer tape drives** are used. Streamer tape drives use a much larger percentage of the tape for data storage. Tapes come in a variety of sizes and formats (see Table 8.1).

Table 8.1 Types of Tapes

Type	Capacity	Description
Half-inch	60 MB – 400 MB	Half-inch tapes come both as 9 track reels and as cartridges. These tapes are relatively cheap, but require expensive tape drives.
Quarter-inch	40 MB – 5 GB	Quarter-inch cartridges (QIC tapes) are relatively inexpensive and support fast data transfer rates. Quarter-inch mini cartridges are even less expensive, but their data capacities are smaller and their transfer rates are slower.
8-mm Helical-scan	2.5 GB – 15 GB	8-mm helical-scan cartridges use the same technology as VCR tapes and have the greatest capacity. But they require expensive tape drives and have relatively slow data transfer rates.
4-mm DAT	2 GB – 24 GB	DAT (Digital Audio Tape) cartridges have the greatest capacity but they require expensive tape drives and have relatively slow data transfer rates.

Quarter-inch Cartridge (QIC) Tapes

The quarter-inch-tape cartridge (QIC) was first introduced in 1972 by the 3M Company as a means to store data from telecommunications and data acquisition applications. As time passed, the comparatively inexpensive QIC drive became an accepted data storage system. QIC cartridges are much like audiotape cassettes, with two reels inside, one with tape and the other for take-up. A belt built into the cartridge drives the reels. A metal rod, known as a capstan, projects from the drive motor and pinches the tape against a rubber drive wheel.

The QIC format employs a linear (or longitudinal) recording technique in which data is written to parallel tracks, which run along the length of the tape. It is the number of tracks that is the principle determinant of capacity. The cartridges come in two varieties, DC600 cartridge and DC2000 mini-cartridge, the latter being more popular. The encoding method used is either MFM (Modified Frequency Modulation) or RLL (Run Length Limited)—similar to the way in which data is encoded on a hard drive. When a backup is commenced, directory information from the file allocation table is loaded into a memory buffer in the system's RAM, along with the appropriate files. Both sets of data are sent to the tape drive controller, each file being prefaced by a header containing the directory information.

QIC tape uses a linear read/write head similar to those found in domestic cassette recorders. Typically this comprises a single write head flanked on either side by a read head. This allows the tape drive to verify data just written when the tape is running in either direction. In recording mode the tape moves past the stationary read/write heads at 100-125 inches per second. With a standard drive and format, the head reads or writes data in straight lines, one track at a time. Extra read/write heads can be added to improve performance. The 800 Kbps achieved by two heads could be doubled to 1600 Kbps by four heads. In some environments where high performance and capacity are required, as many as 36 read/write heads can be stacked up at one time. When the tape reaches one of its ends, the direction reverses and the head goes to the next outside track. Each track is made up of blocks of 512 or 1024 bytes, of which there are 32 in a segment. Eight of the 32 blocks contain error correction code, and each block contains a Cyclic Redundancy Check (CRC) at the end for further error correction. Generally, a special directory track, or the beginning of track 0, contains a complete directory of the files.

8mm Helical-Scan Tapes

The term helical scan usually refers to 8 mm tapes, although 4 mm tapes (called DAT tapes) also use the same technology. 8 mm helical-scan tape technology was originally designed for the video industry.

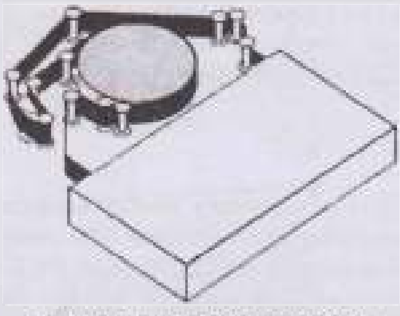


Figure 8.5 8mm Helical-Scan Tape

The original purpose of 8mm Helical-Scan tape was to transfer high-quality color images to tape for storage and retrieval. Now 8 mm technology has been adopted by the computer industry as a reliable way to store large amounts of computer data. It is similar to DAT but has generally greater storage capacity. 8 mm tapes employ helical scan technology. The tape in a helical scan system is pulled from a two-reel cartridge and wrapped halfway around a cylindrical drum containing two read heads and two write heads, arranged alternately. The read heads verify the data written by the write heads. The cylinder head is tilted slightly in relation to the tape, and spins at 2,000 rpm. The tape moves in the opposite direction to the cylindrical spin, at less than one inch per second but because it is recording more than one line at a time, it has an effective speed of 150 inch per second. Short diagonal tracks are written across the width of the tape, about eight times longer than the width. The contain about 128 KB of data and an Error Correction Code (ECC) each. A drawback to the helical sc system is the complicated tape path. Because the tape must be pulled from a cartridge and wrapp tightly round the spinning read/write cylinder, a great deal of stress is placed on the tape. The 8m helical-scan tapes have data capacities from 2.5 GB to 15 GB.

DAT Cartridge

DAT stands for Digital Audio Tape and, as its name implies, was originally conceived as a CD-qual audio format. In 1998, Sony and HP defined the Digital Data Storage (DDS) standard, transforming format into one that could be used for computer data storage. DAT technology is a 4 mm tape, wh employs a technique called helical scan recording. This is the same type of recording as that use videotape and 8 mm tape recorders and is inherently slower than the linear type. For this reason, generally only used in environments where high capacity is the primary requirement.

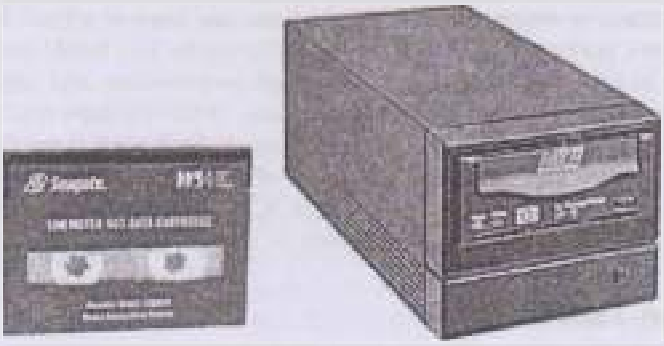


Figure 8.6 DAT Drive and Cartridge

A DAT cartridge is slightly larger than a credit card and contains a magnetic tape that can from 2 to 24 gigabytes of data. It can support data transfer rates of about 2 Mbps (Million byte second). Like other types of tapes, DATs are sequential-access media. The latest format, D specifies tapes that can hold 40 GB (the equivalent of over 70 CD-ROMs) and support data tra rates of 5 Mbps.

MAGNETIC DISKS

One of the most popular and important secondary storage medium today is the magnetic disk. technology permits direct and immediate access to data. The computer can directly access a sp record or piece of data on the disk instead of reading through the records one by one (as in the c sequential access devices). It is because of this reason that the disks are often called Direct A Storage Devices (DASDs).

Magnetic disks offer several advantages over magnetic tapes. Individual records can be acc much faster because they have a precise disk address. The main drawback of the disk technology need for backup. In disk technology there is only one copy of the information because th information is written over when it is changed. So the information in the magnetic disk sho backed up onto magnetic tapes or floppy disks. There are two kinds of magnetic disks – **solid** o **disks** (includes disk packs, Winchester disks, etc.) and **flexible disks** (includes floppy disks, Zip Jaz disks, SuperDisks, etc.).

Hard Disks

Magnetic hard disks are thin steel platters with an iron oxide coating. Several **disks** may be mounted together on a vertical shaft on which they rotate at high speeds. Electromagnetic **read/write heads** are mounted on **access arms**. The heads fly over the rotating disks and read or write data on concentric circles called **tracks**. Data are recorded on tracks as tiny magnetized spots forming binary digits. Each track can store thousands of bytes. In most disk systems, each track contains the same number of bytes with the data packed together more closely on the inner tracks. The read/write head never actually touches the disk but hovers a few thousandths or millionths of an inch above it. A dust particle or a human hair on the disk surface could cause the head to crash into the disk—an event known as **head crash**.

Access time to locate data on **hard disks** is 10 to 100 milliseconds, compared to 100 to 600 milliseconds on floppy disks. **Access time is the duration taken to complete a data transfer—from the time when** the computer requests data from a secondary storage device, to the time when the transfer operation is complete. Access time consists of four factors:

* **Seek time** — The time it takes an access arm to get into position over a particular track.
* **Head switching** — The activation of a particular read/write head over a particular track and surface.
* **Rotational delay time** — The time it takes for the particular record to be positioned under the read/write head.
* **Data transfer** — The time it takes to transfer the data to the primary storage.

The average access time for most disk drives is less than 25 milliseconds, but the actual processing speeds of computer are measured in microseconds or nanoseconds. Disk storage capacity depends on the type, quantity and arrangement of disks in a unit. Individual disk packs or fixed disk drives have storage capacities in the range of several gigabytes. Microcomputer hard disks that have capacities in the range of 20 to 30 GB are currently available in the market. Two popular kinds of hard disk systems are **removable-pack disk systems** (used with mainframes and minicomputers) and **Winchester disk systems** (used with all types of computers).

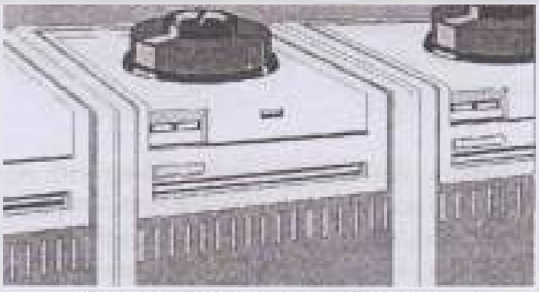


Figure 8.7 Removable-Pack Disk System

Removable-Pack Disk Systems

Removable-pack disk systems consist of hard disks stacked into a pack or an indivisible unit that can be mounted or removed as a unit. They are typically found on mainframe and minicomputer systems. A typical disk pack has 11 disks, each with two surfaces. Only 20 surfaces on the disk can be used for recording data—the top and the bottom surfaces are not used. Each surface area is divided into tracks, where the data is recorded. A cylinder consists of 20 tracks located at one position of the read/write arms. The read/write heads are directed to a specific record using a disk address consisting of the cylinder number, the recording surface number and the data record number. Figure 8.7 shows a disk drive that is used to read data from the disk pack and write data to it.

Winchester Disk Systems

The term Winchester comes from an early type of disk drive developed by IBM that stored 30 MB and had a 30 millisecond access time; so its inventors named it 'Winchester' in honor of the 30-caliber rifle of the same name. Although modern disk drives are faster and hold more data, the basic technology is the same. So Winchester has become synonymous with **fixed hard disk systems** (see Figure 8.8). The primary difference between the Winchester disks and the removable-pack disk systems is that the Winchester disks are hermetically sealed units that cannot be removed from the disk drive. They are typically used in microcomputers and have capacities in the range of 40–80 GB. Because they are hermitically sealed from dust in the environment, Winchester disks can achieve very high rotation speeds and smaller distances between the disks and the read/write heads. Winchester disk cannot be replaced with an empty disk once they are full (as in the case of the removable-pack disk systems). Instead the data must be transferred into some other storage device like a backup tape or the floppy disk or zip disk or written over the existing information.

Figure 8.8 Winchester Disk (Hard Disk)

Hard disks hold more data and are faster than floppy disks. A hard disk can store anywhere from 10 MB to several GBs, whereas most floppies have a maximum storage capacity of 1.44 MB. A single hard disk usually consists of several platters. Each platter requires two read/write heads, one for each side. All the read/write heads are attached to a single access arm so that they cannot move independently. Each platter has the same number of tracks, and a track location that cuts across all platters is called a cylinder. For example, a typical 84 MB hard disk for a PC might have two platters (four sides) and 1,053 cylinders.

Flexible Disks

You must already be familiar with the flexible disks from working with personal computers. Made of thin film of plastic with metal oxide and encased within a sleeve or non-removable paper or plastic, these disks are flexible and hence the name flexible disks. These flexible disks are used mainly with microcomputers. The different kinds of flexible disks are 5¼-inch disks (mini floppies), 3½-inch disks (microfloppies), Zip disks, Jaz disks, SuperDisks, etc.

Floppy Disks

Floppy disk is a soft magnetic disk. It is called 'floppy' because it flops if you wave it (at least, the 5¼-inch variety does). Unlike most hard disks, floppy disks (often called floppies or diskettes) are portable, because you can remove them from a disk drive. Disk drives for floppy disks are called floppy drives. Floppy disks are slower to access than hard disks and have less storage capacity, but they are less expensive and are portable.

Figure 8.9 3½ and 5¼-inch Floppies

Floppies come in two basic sizes:

- 5¼-inch – The common size for PCs made before 1987. This type of floppy is generally capable of storing between 100K and 1.2 MB of data. The most common sizes are 360 K and 1.2 MB.
- 3½-inch – Floppy is something of a misnomer for these disks, as they are encased in a rigid envelope. Despite their small size, microfloppies have a larger storage capacity than their cousins – from 400 K to 1.44 MB of data. The most common sizes for PCs are 720 K (double-density) and 1.44 MB (high-density). Macintoshes support disks of 400 K, 800 K, and 1.2 MB.

OPTICAL DISK

Optical disks are a storage medium from which data is read and to which it is written by lasers. Optical disks can store much more data – up to 6 GB (6 billion bytes) – than magnetic media, such as floppies and hard disks.

Figure 8.10 Optical Disks

There are three basic types of optical disks:

- CD-ROM – Like audio CDs, CD-ROMs come with data already encoded onto them. The data is permanent and can be read any number of times, but CD-ROMs cannot be modified.
- WORM – This term stands for write-once, read-many. With a WORM disk drive, you can write data onto a WORM disk, but only once. After that, the WORM disk behaves just like a CD-ROM.
- Erasable – Optical disks that can be erased and loaded with new data, just like magnetic disks. These are often referred to as EO (erasable optical) disks.

These three technologies are not compatible with one another; each requires a different type of drive and disk. Even within one category, there are many competing formats, although CD-ROMs are relatively standardized.

CD-ROM

CD-ROM, pronounced 'see-dee-rom', is the abbreviation of **Compact Disc-Read-Only Memory**. C[illegible] ROM is a type of optical disk capable of storing large amounts of data—up to 1 GB, although the m[illegible] common size is 630 MB (megabytes). A single CD-ROM has the storage capacity of 700 floppy d[illegible] enough memory to store about 300,000 text pages. CD-ROMs are recorded by the vendor, and o[illegible] recorded; they cannot be erased and filled with new data. To read a CD, you need a CD-ROM pl[illegible] Also called a CD-ROM drive, a CD-ROM player is a device that can read information from CD-R[illegible] CD-ROM players can be either internal, in which case they fit in a bay, or external, in which case t[illegible] generally connect to the computer's parallel port.

Figure 8.11 CD-ROM Drive

Parallel CD-ROM players are easier to install, but they have several disadvantages: The[illegible] somewhat more expensive than internal players; they use up the parallel port which means th[illegible] cannot use that port for another device such as a printer; and the parallel port itself may not b[illegible] enough to handle all the data pouring through it. There are a number of features that distinguis[illegible] ROM players, the most important of which is probably their speed. CD-ROM players are gen[illegible] classified as single-speed or some multiple of single-speed. For example, a 4x player accesses d[illegible] four times the speed of a single-speed player. Within these groups, however, there is some vari[illegible] Also, you need to be aware of whether the CD-ROM uses the CLV (Constant Linear Velocity) or C[illegible] (Constant Angular Velocity) technology. The reported speeds of players that use CAV are gen[illegible] not accurate because they refer only to the access speed for outer tracks. Inner tracks are accessed m[illegible] slowly.

Two more precise measurements are the drive's **seek time** and data **transfer rate**. The seek t[illegible] also called the access time, measures how long, on an average, it takes the drive to access a part[illegible] piece of information. The data transfer rate measures how much data can be read and sent t[illegible] computer in a second. Apart from its speed, another important feature of a CD-ROM player [illegible] compatibility with existing standards. If you plan to run a CD-ROM in a Windows environment, [illegible] need a player that conforms to the **MPC III** standard. If you want to view photographs stored o[illegible] ROM, make sure your player conforms to **Kodak's PhotoCD** format.

Finally, you should consider how the player connects to your computer. Most CD-ROMs co[illegible] via a **SCSI** bus. If your computer does not already contain such an interface, you will need to [illegible] one. Other CD-ROMs connect to an IDE or Enhanced IDE interface, which is the one used by the [illegible] disk drive; still others use a proprietary interface. Almost all CD-ROMs conform to a standard s[illegible] format, so it is usually possible to load any type of CD into any ROM player. In addition, m[illegible] ROM players are capable of playing audio CDs, which share the same technology. CD-RO[illegible] particularly well suited to information that requires large storage capacity. This includes [illegible] graphics, sound, and especially video. In recent years, as the prices of CD-ROM player[illegible] decreased, and the tools for creating new CD-ROM titles have improved, the CD-ROM indus[illegible] been expanding rapidly. To date, the most popular CD-ROM titles have been computer games and multimedia reference works.

CD-R

CD-R drive, which is short for Compact Disk-Recordable drive, is a type of disk drive that can create CD-ROMs and audio CDs. This allows the users to "master" a CD-ROM or audio CD for publishing. Until recently, CD-R drives were quite expensive, but prices have dropped dramatically. A feature of many CD-R drives, called multi-session recording, enables you to keep adding data to a CD-ROM over time. This is extremely important if you want to use the CD-R drive to create backup CD-ROMs. To create CD-ROMs and audio CDs, you will need not only a CD-R drive, but also a CD-R software package. Often, it is the software package, not the drive itself that determines how easy or difficult it is to create CD-ROMs. CD-R drives can also read CD-ROMs and play audio CDs.

CD-RW

CD-RW disk is short for CD-ReWritable disk and this is a type of CD disk that enables you to write onto it in multiple sessions. One of the problems with CD-R disks is that you can only write to them once. With CD-RW drives and disks, you can treat the optical disk just like a floppy or hard disk, writing data onto it multiple times. The first CD-RW drives became available in mid-1997. They can read CD-ROMs and can write onto today's CD-R disks, but they cannot write on CD-ROMs.

DVD

DVD is the short for **Digital Versatile Disc** or **Digital Video Disc** and is a type of optical disk technology similar to the CD-ROM. A DVD holds a minimum of 4.7 GB of data—enough for a full-length movie. DVDs are commonly used as a medium for digital representation of movies and other multimedia presentations that combine sound with graphics. The DVD specification supports disks with capacities of from 4.7 GB to 17 GB and access rates of 600 KBps to 1.3 Mbps. To read a DVD you will need a DVD drive. One of the best features of DVD drives is that they are backward-compatible with CD-ROMs, meaning they can play not only the DVD disks but also CD-ROMs, CD-R disks, CD-RW disks and video CDs.

DVD-R and DVD-RW

DVD-R stands for **DVD-Recordable** and is a recordable DVD format similar to CD-R. A DVD-R can only record data once and then the data becomes permanent on the disc. The disc cannot be recorded onto a second time. There also are two standards for DVD-R disks: **DVD-RG** for general use, and DVD-RA for authoring, which is used for mastering DVD video or data and is not typically available to the general public. DVD-RW stands for **DVD-ReWritable**, a re-recordable DVD format similar to CD-RW. The data on a DVD-RW disc can be erased and recorded over numerous times without damaging the medium. DVD-R and DVD-RW are supported by Panasonic, Toshiba, Apple Computer, Hitachi, NEC, Pioneer, Samsung and Sharp. These formats are also supported by the DVD Forum.

DVD+R and DVD+RW

DVD+R—pronounced as "DVD plus R"—is the abbreviation of **DVD+Recordable.** DVD+R is a recordable DVD format similar to CD-R. A DVD+R can only record data once and then the data becomes permanent on the disc. The disc cannot be recorded onto a second time. DVD+RW (pronounced as DVD plus RW) stands for **DVD+ReWritable.** It is a re-recordable DVD format similar to CD-RW. The data on a DVD+RW disc can be erased and recorded over numerous times without damaging the medium. DVD+RW and DVD+R formats are supported by Philips, Sony, Hewlett-Packard, Dell, Ricoh, Yamaha and others.

Combo Drives

We have seen that to read a CD, CD-R and CD-RW we need a CD-ROM drive. Similarly to read a DVD, DVD-R, DVD+R, DVD-RW and DVD+RW we need a DVD-ROM drive. To write data into a CD-R we need a CD-R drive. To write data into a CD-RW drive we need a CD-RW drive. Similarly for DVD-R, DVD-RW, DVD+R, DVD+RW, etc. we need different drives for writing data into them. Now **combo drives**, drives that combine the DVD technology, CD technology, DRV-R, CD-R, DVD-RW and CD-RW technologies are available in the market. These drives can read both CDs and DVDs, write CD-R, DVD-R, DVD-RW, CD-RW, DVD-RW and DVD+RW disks. But the cost of the combo drives is very much higher compared to CD-ROM or DVD-ROM drives.

Figure 8.12 Zip Disk and Drive

ZIP DISK

These are high-capacity floppy disk drives developed by the Iomega Corporation. Zip disks are slightly larger than the conventional floppy disks, and are about twice as thick. They can hold 100 MB of data. Because they are relatively inexpensive and durable, they have become a popular media for backing up hard disks and for transporting large files.

Figure 8.13 Jaz Disk and Drive

JAZ DISK

These are removable disk drives developed by the Iomega Corporation. The Jaz drive has a 12-ms average seek time and a transfer rate of 5.5 Mbps. The removable cartridges hold 1 GB of data. The fast data rates and large storage capacity make it a viable alternative for backup storage as well as for everyday use.

SUPERDISK

This is a disk storage technology developed by the Imation Corporation that supports very high density diskettes. SuperDisk diskettes are etched with a servo pattern at the factory. This pattern is used by the SuperDisk drive to precisely align the read/write head. The result is that a SuperDisk diskette can have 2,490 tracks, as opposed to the 135 tracks that conventional 3.5-inch 1.44 MB diskettes use. This higher density translates into 120 MB capacity per diskette

Figure 8.14 Superdrive and Disk

Unlike the other removable disk storage solutions, such as the Zip drive, SuperDisk is backward compatible with older diskettes. This means that you can use the same SuperDisk drive to read and write older 1.44 MB diskettes as well as the new 120 MB SuperDisk diskettes.

MAGNETO-OPTICAL (MO) DISK

It is a type of disk drive that combines magnetic disk technologies with CD-ROM technologies. Like magnetic disks, MO disks can be read and written to. Like floppy disks, they are also removable.

Figure 8.15 Magneto-Optical (MO) Disk and Drive

The storage capacity of a magneto-optical disk can be more than 200 MB, much greater than magnetic floppies. In terms of data access speed, they are faster than floppies and CD-ROMs, but not as fast as hard disk drives.

REVIEW QUESTIONS

Short Answer Questions

01. What is an auxiliary storage device?
02. What are the major auxiliary storage devices for a computer?
03. How are secondary storage devices classified?
04. Give examples of sequential access devices.
05. What are the different types of magnetic tapes?
06. Give examples of random access devices.
07. What are streamer tape drives?
08. What do you mean by the term head crash?
09. What do you mean by the terms seek time, head switching, rotational delay and data transfer?

10. What do you mean by the terms IRG and IBG?

Descriptive Type Questions

01. What are the uses of secondary storage devices?
02. What are the advantages of secondary storage?
03. What is the difference between a random access device and a sequential access device?
04. What are magnetic tapes?
05. What is blocking and blocking factor in the case of magnetic tapes?
06. What are the different types of magnetic tapes and what are their properties?
07. What are the advantages and disadvantages of magnetic tapes?
08. What are QIC tapes?
09. What are helical scan tapes?
10. What are DAT cartridges?
11. What is a hard disk?
12. What are the factors that affect the access time of hard disks?
13. What is a floppy disk, how is it different from a hard disk and what are the different types?
14. What are removable disk pack systems and how do they work?
15. What are Winchester disk systems and how do they work?
16. What are optical disks and what are the different types of optical disks?
17. What is the difference between CD, CD-R and CD-RW?
18. What is the difference between DVD, DVD-R and DVD-RW?
19. What are combo drives?
20. What are Zip disks?
21. What are Jaz disks?
22. What are SuperDisks?
23. What are magneto-optical drives?

Essay Questions

01. What is a magnetic tape and how does it work?
02. What are the main components of a magnetic tape drive?
03. Explain the working of a magnetic tape with an illustration.
04. How is data stored in a magnetic tape?
05. Explain the working of QIC tapes.
06. How does a helical scan tape work?
07. Explain the working of a DAT cartridge.
08. How does a hard disk work?

Fill in the Blanks

01. The two types of auxiliary storage devices are _________ and _________.
02. Magnetic tape is an example of _________ media.
03. The two main kinds of magnetic disks are _________ and _________.
04. _________ is an example of a hard disk.
05. _________ is an example of a flexible disk.
06. The factors that determine the access time of a hard disk are _________.
07. Two popular kinds of hard disk systems are _________ and _________.
08. _________ are a storage medium from which data is read and to which it is written by lasers

9. WORM stands for __________.
10. The different types of optical disks are________________.
11. CD-ROM stands for __________.
12. DVD stands for __________.
13. The devices on which magnetic tapes are run are called _________ or ___________.
14. The ____________ in a magnetic tape drive is an electromagnet that reads magnetized areas, which represent data on the tape, converts them into electrical signals and sends them to the CPU.
15. The most common way of organizing data in a magnetic tape is a _____________.
16. Because there is no need to start and stop the tapes during the process of making the backup, a kind of magnetic tape drive called _____________ are used for backups.
17. The quarter-inch-tape cartridge (QIC) was first introduced in 1972 by the ___________.
18. In 1998, Sony and HP defined the _____________ standard, a format for computer data storage.
19. In a ____________, data are recorded on tracks as tiny magnetized spots forming binary digits and each track can store thousands of bytes.
20. The capacity of a SuperDisk is ______________.

[Answers: (1) Sequential access and random access devices (2) Sequential (3) Hard disks and flexible disks (4) Winchester disk (5) Floppy disk (6) Seek time, head switching time, rotational delay time and data transfer time (7) Removable-pack disk system and Winchester disk systems (8) Optical disks (9) Write-once, read-many (10) CD, DVD, CD-R, DVD-R, CD-RW, DVD-RW (11) Compact Disc-Read-Only Memory (12) Digital Versatile Disc or Digital Video Disc (13) Magnetic Tape Drives or Magnetic Tape Units (14) Read/write head (15) 9-track code (16) Streamer tape drives (17) 3M Company (18) DDS (Digital Data Storage) (19) Magnetic tape (20) 120 MB]

True or False

1. Auxiliary storage is long-term, non-volatile memory.
2. The most common types of auxiliary storage devices are magnetic tapes, magnetic disks, floppy disks, hard disks, etc.
3. Hard disks hold more data and are faster than floppy disks.
4. The read/write head of the hard disk actually touches the disk platters while reading and writing.
5. Winchester disks are hermetically sealed units that cannot be removed from the disk drive.
6. Floppy disk is a hard magnetic disk.
7. The two popular sizes in which floppy disks are available are 5" and 3.5".
8. The maximum amount of data that can be stored in a floppy disk is 1.44 GB.
9. A single CD-ROM has the storage capacity of 700 floppy disks—enough memory to store about 300,000 text pages.
10. CD-R drive is short for Compact Disk-Recordable drive.
11. A DVD holds a minimum of 4.7 GB of data—enough for a full-length movie
12. The two standards for DVD-R disks are DVD-RG and DVD-RA.
13. Tapes are direct-access media.
14. Because tapes are so slow, they are generally used only for long-term storage and backup.
15. Data is represented on the tape by invisible magnetized spots—the presence or absence corresponding to a 1 bit or a 0 bit.
16. 8mm helical-scan tape technology was originally designed for the video industry with the objective of transferring high-quality color images to tape for storage and retrieval.
17. The 8 mm helical-scan tapes have data capacities from 2.5 GB to 15 GB.
18. DDS specifies tapes that can hold 40 GB and support data transfer rates of 5 Mbps.

19. Zip and Jaz disks are high-capacity floppy disk drives developed by the Imation Corporation
20. Floppy disks are etched with a servo pattern at the factory.
21. SuperDisk drives can be used to read and write to older 1.44 MB diskettes as well as the 12
SuperDisk diskettes.
22. Magneto-optical disks are faster than floppies and CD-ROMs, but not as fast as hard disk dr

[**Answers:** (1) True (2) True (3) True (4) False (5) True (6) False (7) False (8) False (9) True (10) Tr True (12) True (13) False (14) True (15) True (16) True (17) True (18) False (19) True (20) False (2 (22) True]

CHAPTER 09

Input Devices

TOPICS COVERED

- Introduction
- Keyboard
- Mouse
- Trackball
- Game controllers
- Scanners
- Barcode reader
- Card reader
- Digitizer
- Voice recognition
- Webcams
- Digital cameras
- Video cameras
- OCR, OMR, ICR and MICR

Key Points

▲ An input device is any machine that feeds data into computer. The main input devices are keyboard, mouse, trackball, game controllers, scanners, barcode and card reader, digitizers, microphones, web, digital, and video cameras etc.

▲ Keyboard is an input device consisting of a set of typewriter-like keys that enable you to enter data into computer. Mouse is a device that controls the movement of cursor or pointer on a display screen. Trackball is another pointing device.

▲ A game controller is an input device that provides inputs for computer games. Game controllers fall into categories—joysticks and game pads.

▲ Scanner is an input device that can read text or illustrations printed on paper and translate the information into a form the computer can use. Bar-code readers are photoelectric scanners that read the bar codes, or vertical zebra striped marks printed on product containers.

▲ Digitizer is an input device that enables you to enter drawings and sketches into a computer.

▲ Microphones convert a person's speech into digital form. These input devices, when combined with appropriate software form voice recognition systems.

▲ A webcam in the simplest definition is a camera that is some way connected to the World Wide Web, or Internet. A digital camera is a camera that stores images digitally rather than recording them on film. A video camera is a portable electronic recording device that is capable of recording live-motion video and audio for later replay through VCRs, TVs or computers.

INTRODUCTION

An input device is any machine that feeds data into a computer. For example, a keyboard is an input device, whereas a display monitor is an output device. Input devices other than the keyboard are sometimes called alternate input devices. Mice, trackballs, and light pens are all alternate input devices.

KEYBOARD

Keyboard is an input device consisting of a set of typewriter-like keys that enable you to enter data into a computer. Computer keyboards are similar to electric-typewriter keyboards but contain additional keys. Keyboards for personal computers come in many styles.

The various models differ in the number of keys, size, shape, placement of keys and so on. Among the IBM-compatible computers, the most common keyboard layout is the IBM enhanced keyboard with 101 keys arranged into six groups as shown in Figure 9.1. The six groups are alphanumeric keys, modifier keys, numeric keypad, function keys, cursor movement keys and special-purpose keys.

Figure 9.1 IBM Enhanced Keyboard

Alphanumeric Keys

This part of the keyboard is similar to a typewriter. The letters are arranged as in a typewriter and arrangement is called QWERTY layout because the first six keys on the top row of letters are Q, W, E, R, T and Y. The QWERTY keyboard was designed in the 1800s for mechanical typewriters and actually designed to slow typists down to avoid jamming the keys. Another keyboard design, which has letters positioned for speed typing, is the DVORAK keyboard. The DVORAK keyboard was designed in the 1930s by August Dvorak. This keyboard places the most commonly used letters in the middle row of keys, making them easier to reach. Even though DVORAK keyboards are easier to use, they are not part of standard equipment and not commonly available and hence not very popular. Some keyboard manufacturers offer keyboards that can be switched from QWERTY to DVORAK configurations and vice-versa. The DVORAK keyboard layout is shown in Figure 9.2.

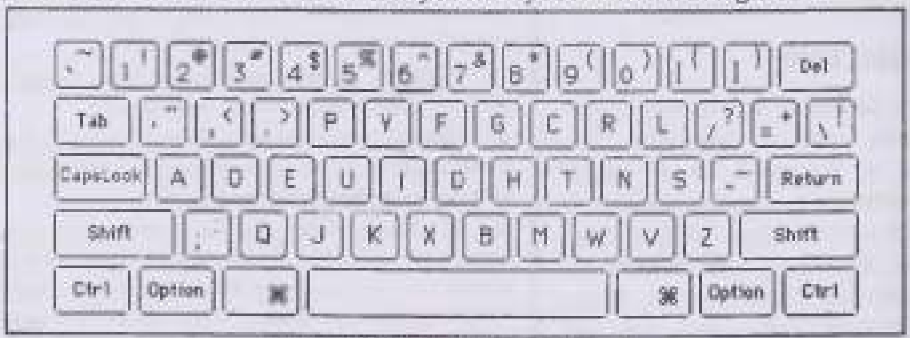


Figure 9.2 DVORAK Keyboard Layout

In addition to the letters the alphanumeric key group consists of numbers (0-9), punctuation and other characters (like ~, @, #, $, %, ^, &, *, etc.) and a few additional keys with special functions like **Tab, Caps Lock, Backspace, Enter and Spacebar**

Modifier Keys

The keyboard's modifier keys are used to modify the input of other keys. You press another key while you hold down the modifier key. The modifier keys are **Shift, Ctrl and Alt.** The Shift key when pressed in conjunction with an alpha numeric key forces the computer to output a capital letter or symbol. This function is the same as in typewriters. Shift key also acts as a modifier key on programs. In most word processors you can press shift along with the cursor movement keys to select one. In most other cases, after selecting an item, if you select another item holding down the shift key, the items in between are selected. Ctrl key (or Control key) produces different results depending on the program. Ctrl+C, **Ctrl+X** and **Ctrl+V** are the universally accepted keyboard shortcuts for Copy, Cut and Paste. The Alt key (Alternate key) combinations enable you to navigate menus and dialog boxes without using a mouse.

Numeric Keypad

The numeric keypad, usually located at the right side of the keyboard looks like a calculator. It contains 10 digits and the four mathematical operators. The numeric keypad also has a **Num Lock** key which turns the keys in the numeric keypad to output numbers. When the Num Lock is off, the key on the numeric keypad performs other functions like PgUp, PgDn, Home, End, Del, etc.

Function Keys

The function keys (F1 to F12) are usually arranged at the top of the keyboard in a single row. They allow you to input commands without typing the commands. The commands vary according to the application that you are using. For example, in most applications F1 is the Help key and if you press F1, then the Help menu of the program will appear.

Cursor Movement Keys

The cursor movement keys are used to navigate around the screen. The cursor is the blinking mark that you can see on the screen when you open the different programs. The cursor movement keys are the arrow keys (that allow you to move left, right, up and down one character at a time) **Home and End keys** (keys that enable you to move to the very beginning or end of the line) **Page Up (PgUp) and Page Down (PgDn) keys** (keys that enable you to move through a document screen by screen in upward and downward directions. The Home and End keys when used in conjunction with the Ctrl key will take you to the very beginning or the very end of a document or file. Similarly all the cursor movement keys will behave differently when used in conjunction with the Shift and Ctrl keys.

Special-Purpose Keys

The special-purpose keys are used to perform special functions. The special purpose keys in an IBM-compatible keyboard are **Insert (Ins), Delete (Del), Esc, Print Screen (Prt Scr), Scroll Lock** and **Pause**. The modern IBM-compatible keyboards include two additional keys designed to work with Windows operating systems – **Start key** (also called Windows logo key) and **Shortcut key**. The Start key opens the Start menu. Pressing this key is same as clicking the start button on the Windows taskbar. The Shortcut key opens an on-screen shortcut menu in Windows based application programs. Pressing this key is the same as right-clicking the mouse in an application which also will bring up the shortcut menu.

Ergonomic Keyboards

Ergonomic keyboards are designed with the objective of hand fatigue and repetitive stress injuries. Ergonomic keyboards are designed to help the user's hands stay positioned correctly reducing [illegible] and strain. Figure 9.3 shows some ergonomic keyboards. Most ergonomic keyboards may be curved in some way, or it may be broken into separate sections or it could have adjustable sections, etc.

Internet and Multimedia Keyboards

With the popularity of Internet, WWW and multimedia applications many keyboard manufact have developed keyboards with special keys for accessing and navigating the Internet (like one buttons to frequently visited sites, buttons for launching the Web browser, E-mail client, etc.) operate multimedia applications (like keys for common functions like Play, Pause, Mute, Vo Stop, Next, Previous, etc.). Some of the Internet and Multimedia keyboards are shown in Figure 9

Figure 9.3 Ergonomic Keyboards

There are several different types of keyboards for the Apple Macintosh. All of them are calle keyboards because they connect to the Apple Desktop bus (ADB). The two main varieties of Ma keyboards are the standard keyboard and the extended keyboard, which have 15 additional function keys.

Figure 9.4 Internet and Multimedia Keyboards

As technology advances the keyboard manufactures are bringing out new and more fe the keyboards. Now **wireless** or **cordless** keyboards are available in the market. These keyb not need a wire to connect them to the computer. They use radio frequency (RF) waves to c the computer. They will have a receiver which will be connected to the computer and the k sends the signals to the receiver which is then transmitted to the computer. These keyboards have 6–8 feet range.

MOUSE

A mouse is a device that controls the movement of the cursor or pointer on a display screen. is a small object you can roll along a hard, flat surface. Its name is derived from its shap resembles a mouse, its connecting wire like the mouse's tail, and the fact that one must mak along a surface. As you move the mouse, the pointer on the display screen moves in direction. Mice contain at least one button and sometimes as many as three, which have functions depending on what program is running.

Figure 9.5 The Mechanical Mouse

Invented by Douglas Engelbart of Stanford Research Center in 1963, and pioneered by Xerox in the 1970s, the mouse is one of the great breakthroughs in computer ergonomics because it frees the user to a large extent from using the keyboard. In particular, the mouse is important for graphical user interfaces because you can simply point to options and objects and click a mouse button. Such applications are often called point-and-click programs. The mouse is also useful for graphics programs that allow you to draw pictures by using the mouse like a pen, pencil, or paintbrush.

Types of Mice

There are three basic types of mice – mechanical, opto-mechanical, optical and laser. The **mechanical mouse** has a rubber or metal ball on its underside that can roll in all directions. Mechanical sensors within the mouse detect the direction the ball is rolling and move the screen pointer accordingly. The working of the **opto-mechanical mouse** is the same as a mechanical mouse, but uses optical sensors to detect motion of the ball.

The **Optical mouse** uses photodiodes and LED (light emitting diode) technology that is usually present under the mouse, to detect the movements, than moving any of its inner parts, as in a mechanical mouse. The latest technology optical mouse uses an optoelectronic sensor that takes continuous images as the mouse moves. With the cost of computing components decreasing with time, it has become possible to pack the mouse with more powerful image processing chips that have many special functions. This helped the mouse to detect the movement at any surface, unlike mechanical mouse that need a soft and an even ground to perform. This further led to translating the motion of the mouse to the motion of the pointer on the screen, thus ruling out the need of a mouse pad. This led to the increase in the use of such mouse as it became more user-friendly and easy to use. Optical computer mouse illumines the surface on which it works. This is done with the help of LED. The image processing area of the chip helps in the shifting from one frame to the other. This is then translated into motion with the help of an optical flow-estimation algorithm.

The **laser mouse** is another type of mouse that makes use of an infrared laser instead of LED to light the surface under it. This helps in increasing the image resolution and thus can point more accurately and at a much faster rate. This type of mouse also has a power usage that allows it to be more efficient than the other mouse types.

TRACKBALL

Trackball is another pointing device. Essentially, a trackball is a mouse lying on its back. To move the pointer, you rotate the ball with your thumb, your fingers, or the palm of your hand. There are usually one to three buttons next to the ball, which you use just like mouse buttons. The advantage of trackballs over mice is that the trackball is stationary so it does not require much space to use it. In addition, you can place a trackball on any type of surface, including your lap. For both these reasons, trackballs are popular pointing devices for portable computers. On some portable computers trackb[illegible] may be directly built into the keyboard or clamped to the side of the keyboard. Many trackballs [illegible] two buttons, although three-button models are more common.

Figure 9.8 Types of Trackballs

GAME CONTROLLERS

Game controllers are input devices used widely in computer games. A game controller is an [illegible] device that provides the inputs for computer games, which are also computer programs. The comp[illegible] games accepts input from the users via the game controllers, processes the data and produces ou[illegible] in the form of graphics and sound. As computer games become more complex and sophisticated [illegible] and more specialized game controllers are developed to take advantage of their features.

Figure 9.9 Types of Joysticks

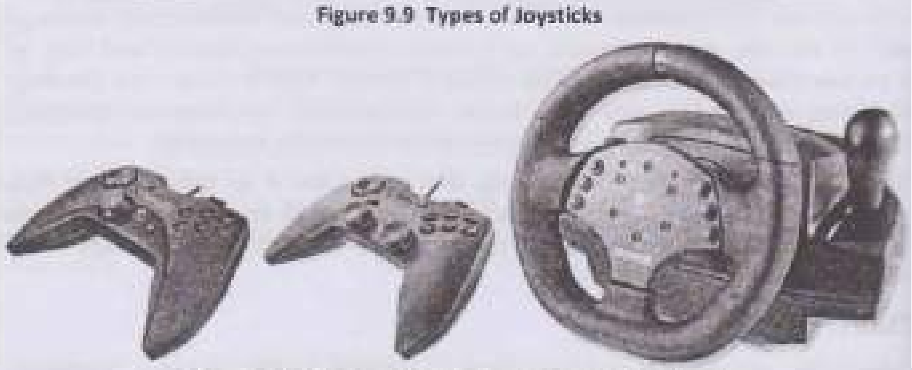


Figure 9.10 Game pad, Rumble pad and Racing Wheel

Game controllers fall into two categories—joysticks and game pads. Joystick is a lever tha[illegible] in all directions and controls the movement of a pointer or some other display symbols (see Fig[illegible] A joystick is similar to a mouse, except that with a mouse the cursor stops moving as soon as [illegible] moving the mouse. With a joystick, the pointer continues moving in the direction the joystick is pointing. To stop the pointer, you must return the joystick to its upright position. Most joysticks include two buttons called triggers. Joysticks are used mostly for computer games, but they are also used occasionally for CAD/CAM systems and other applications.

Game pads are also input devices used to play computer games. They have more features than the joystick. Today's sophisticated computer games requires more buttons and features that are provided by the game pads. Some game pads called **rumble pads** provide more realistic feedback by simulating the vibrations and movements of the game that is being played. Another device that is used for racing games is the racing game controller, which includes a steering wheel and pedals. The game pad, rumble pad, and racing wheels are shown in Figure 9.10.

SCANNERS

Scanner is an input device that can read text or illustrations printed on paper and translate the information into a form that the computer can use. A scanner works by digitizing an image—dividing it into a grid of boxes and representing each box with either a zero or a one, depending on whether the box is filled in. For color and gray scaling, the same principle applies, but each box is then represented by up to 24 bits. The resulting matrix of bits, called a bit map, can then be stored in a file, displayed on a screen, and manipulated by programs.

Optical scanners do not distinguish text from illustrations; they represent all images as bit maps. Therefore, you cannot directly edit text that has been scanned. To edit text read by an optical scanner, you need an Optical Character Recognition (OCR) system to translate the image into ASCII characters. Most optical scanners sold today come with OCR packages. Scanners differ from one another in the following respects:

* **Scanning technology** — Most scanners use Charge-Coupled Device (CCD) arrays, which consist of tightly packed rows of light receptors that can detect variations in light intensity and frequency. The quality of the CCD array is probably the single most important factor affecting the quality of the scanner. Industry-strength drum scanners use a different technology that relies on a photomultiplier tube (PMT), but this type of scanner is much more expensive than the more common CCD-based scanners.
* **Resolution** — The denser the bit map, the higher the resolution. Typically, scanners support resolutions from 72 to 600 dots per inch (dpi).
* **Bit depth** — The number of bits used to represent each pixel. The greater the bit depth, the more colors or grayscales can be represented. For example, a 24-bit color scanner can represent 2 to the 24th power (16.7 million) colors. Note, however, that a large color range is useless if the CCD arrays are capable of detecting only a small number of distinct colors.

Types of Scanners

Hand scanners are small hand-held devices that you move across the paper. Pen scanners (see Figure 9.11) are scanners that can scan one line at a time. These are handheld devices very similar to a pen. They can scan the text directly into the computer or store a few pages in the memory of the scanner and then transfer the contents to the computer. The pen scanners can be used to scan only one line at a time. Some advanced pen scanners can scan lines of text, store it in memory, OCR the text and then transfer the contents to the computer. With such devices, you can read, store and translate the text you want and place it where you want to. Modern pen scanners can perform other functions like send the scanned text as e-mail or SMS messages or transfer the text to handheld devices, laptops or computers. There are other handheld scanners which can scan more area than pen scanners.

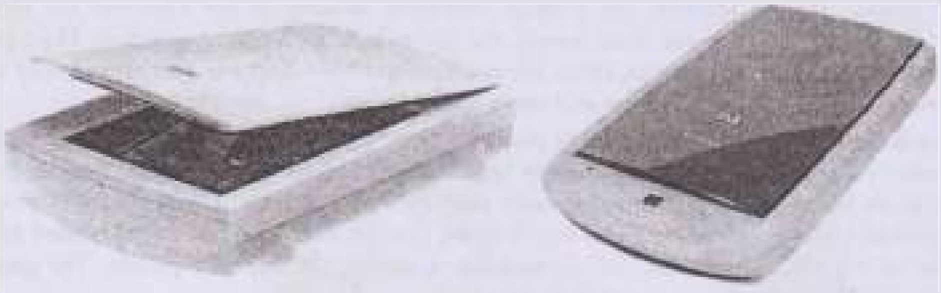


Figure 9.11 Flatbed Scanners

These handheld scanners are often called half-page scanners because they can scan 2-5 inches at a time. Hand-held scanners (see Figure 9.13) are adequate for small pictures and photos, but they are difficult to use if you need to scan an entire page of text or graphics.

Figure 9.12 Types of Pen Scanners

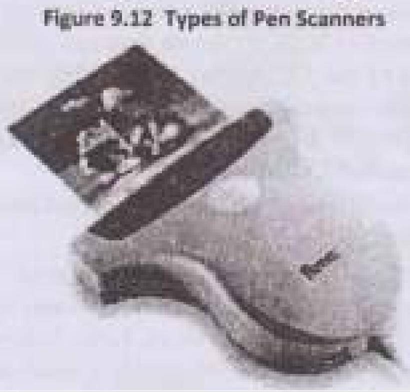


Figure 9.13 Handheld Scanner

A second type of large scanner, called a flatbed scanner, is like a photocopy machine (see Figure 9.11). It consists of a board on which you lay books, magazines, and other documents that you want to scan. Larger scanners include machines into which you can feed sheets of paper. These are called sheet-fed scanners. Sheet-fed scanners are excellent for loose sheets of paper, but they are unable to handle bound documents.

BARCODE READER

You are probably familiar with the barcode readers in supermarkets, bookshops, etc. Barcode readers are photoelectric scanners that read the barcodes, or vertical zebra striped marks, printed on [illegible] Supermarkets use a barcode system called the Universal Product Code (UPC). The barcode [illegible] the product to the supermarket's computer, which has a description and the latest price of [illegible]. The computer automatically tells the Point of Sales (POS) terminal what the price is. The [illegible] reader is a special type of scanner. Like any other scanner, the barcode reader converts the [illegible] image – the barcode – into electronic form by shining light onto the image and sensing the [illegible] of the light's reflection at every point. The barcode reader comes in different sizes and shapes.

Figure 9.14 Handheld Barcode Readers

Figure 9.15 Slot Reader

[illegible] barcode readers that you find in supermarkets can be fixed to a flat surface and the items can [illegible] above it so that the barcode is read by the scanner into the computer. There are barcode [illegible] similar to the handheld scanners where the equipment is moved against the barcode to read it. [illegible] also pen sized barcode readers which are very small in size. The last two types are portable [illegible] used by mobile users like courier company professionals. The different types of handheld [illegible] readers are shown in Figure 9.14. Another type of barcode readers is the **slot reader**. A slot [illegible] allows a user to manually "swipe" a card (or other item containing a barcode) through a slot to [illegible] decode the barcode symbol. Typical applications include employee badges, loyalty [illegible] cards, club passes, etc. A slot reader is shown in Figure 9.15. Slot readers are also used to [illegible] from the magnetic stripes like the ones on the back of the credit card.

[illegible] READER

[illegible] different types of card readers. Business card management systems consist of a business card [illegible] management system that automatically reads and organizes your business cards. Text [illegible] on the card is automatically extracted and stored into their proper fields – name, title, [illegible] address, city, state, zip, country, phone, fax, mobile, email, and web. You can easily sort and search data on any of the data fields. This is a real time saver in managing your business cards an contacts.

Figure 9.16 Business Card Readers

Figure 9.17 Smart Card Readers

A smart card reader is a card reader that reads smart cards. A smart card is a small ele device about the size of a credit card that contains electronic memory, and possibly an embe Integrated Circuit (IC). Smart cards containing an IC are sometimes called Integrated Circuit C (ICCs). Smart cards are used for a variety of purposes like storing a patient's medical records, st digital cash, identity cards, passes, etc. To use a smart card, either to pull information from it or w data to it, you need a smart card reader, a small device into which you insert the smart card.

Figure 9.18 Credit Card Readers

A credit card is a thin plastic card, usually 3-1/8 inches by 2-1/8 inches in size, that c identification information such as a signature or picture, and authorizes the person named w charge purchases or services to his account—charges for which he will be billed periodic stripe on the back of a credit card is a magnetic stripe, often called a magstripe.

The magstripe is made up of tiny iron-based magnetic particles in a plastic-like film. Each particle is really a tiny bar magnet about 20-millionth of an inch. The magstripe can be "written" because the tiny bar magnets can be magnetized in either a North or South Pole direction. The magstripe on the back of the card is very similar to a piece of cassette tape. A magstripe reader can understand the information on the three-track stripe. A magstripe reader is another kind of card reader and is also known as magnetic credit card reader.

DIGITIZER

Digitizer is an input device that enables you to enter drawings and sketches into a computer. A digitizing tablet consists of an electronic tablet and a cursor or pen. The pen (also called a **stylus**) looks like a simple ballpoint pen but uses an electronic head instead of ink. The tablet contains electronics that enable it to detect movement of the cursor or pen and translate the movements into digital signals that it sends to the computer. The **puck** is similar to a mouse, except that it has a window with cross hairs for pinpoint placement, and it can have as many as 16 buttons.

Figure 9.19 Digitizing Tablet, Stylus and Mouse

Figure 9.20 Digitizing Tablet and Puck

In digitizing tablets, each point on the tablet represents a point on the display screen in a fixed manner. This differs from mice, in which all movement is relative to the current cursor position. The absolute nature of digitizing tablets makes them particularly effective for tracing drawings. Most modern [illegible] also *support a mouse emulation mode, in which the pen or cursor acts like a mouse.* [illegible] called digitizing *tablets*, graphics tablets, touch tablets, or simply tablets.

Figure 9.21 Workstation with Tablet Digitizer, 4-Button Puck, Flatbed Scanner, and Keyboard

VOICE RECOGNITION

Speech or voice input devices convert a person's speech into digital form. These input devices, wh combined with appropriate software, form **voice recognition systems**. These systems enable use operate microcomputers using voice commands. Speech or voice recognition is the ability of a mach or program to recognize and carry out voice commands or take dictation. In general, spe recognition involves the ability to match a voice pattern against a provided or acquired vocabulary

Usually, a limited vocabulary is provided with a product and the user can record additi words. More sophisticated software has the ability to accept natural speech (meaning speech as usually speak it rather than carefully-spoken speech). Dragon Systems and IBM are two compa that have led in the research and development of products that support speech recognition. Som these systems must be "trained" to the particular user's voice. This is done by his/her spoken wor patterns previously stored in the computer. More advanced systems that can recognize the same w spoken by many different people have been developed. However, until recently the list of words been limited.

Figure 9.22 Microphones

A newly developed voice recognition system like Dragon NaturallySpeaking identifies mor 30,000 words and adapts to individual voices. There are even systems that will translate fro language to another, such as from English to Japanese. There are two types of voice reco systems—Continuous Speech and Discrete Speech. Both continuous speech and discrete sp recognition software lets you dictate text into your computer. The difference is in how you spe deliver your words. In **continuous speech** or **natural speech** the user can speak naturally eliminates the need to insert a pause between every word. Continuous speech lets you speak computer at a conversational pace. Two popular systems are Apple Computer's PlainTalk and Dragon NaturallySpeaking. **Discrete speech recognition systems** require you to insert a slight pause between every word. IBM Voice Type Simply Speaking and Dragon Dictate are examples.

WEBCAMS

A **webcam** in the simplest definition is a camera that is in some way connected to the World Wide Web or Internet. As you may imagine given this broad a definition, webcams can take many different forms and flavors. One of the most common types of webcams are personal cameras that are connected to a home PC, which with the help of some software allows the user to share a moving image of themselves with others.

Depending on the user, and the software, this image may be publicly available to the Internet at large via a directory of some sort, or only available to the user's friends who know the proper address to connect to. These cameras are on only when the user's computer is turned on, and they are connected to the Internet. With the rise of DSL and Cable modems users are leaving their computers on more, which is good overall for webcam watchers, however, it has other complications including speed and security. Figure 9.23 shows different types of webcams. Another common type of webcam is a camera that is pointing at a particular scene, monument, or other location of interest to potential viewers. Most of these cameras attempt to be available 24x7. The picture quality may not always be good.

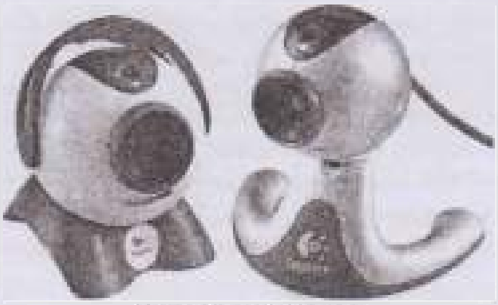


Figure 9.23 Webcams

DIGITAL CAMERAS

Images can be input into a computer using a digital camera. These images can then be manipulated in many ways using the various imaging tools available. A **digital camera** is a camera that stores images digitally rather than recording them on film. Once a picture has been taken, it can be downloaded to a computer system, and then manipulated with a graphics program and printed. Thus, the digital camera takes a still photograph, stores it, and then sends it as digital input into the computer. The images are then stored as digital files.

Suppose you want to take a picture and e-mail it to a friend. You need the image to be represented in the language that computers recognize—bits and bytes. Essentially, a digital image is just a long string of 1s and 0s that represent all the tiny colored dots—pixels—that collectively make up the image. If you want to get a picture into this form, you have two options:

1. You can take a photograph using a conventional film camera, process the film chemically, print it onto photographic paper and then use a digital scanner to sample the print (record the pattern of light as a series of pixel values).

2. You can directly sample the original light that bounces off your subject, immediately break that light pattern down into a series of pixel values—in other words, you can use a dig camera.

At its most basic level a digital camera is just like a conventional camera. It has a series of le that focus light to create an image of a scene. But instead of focusing this light onto a piece of fil focuses it onto a semiconductor device that records light electronically. A computer then breaks electronic information down into digital data.

The key difference between a digital camera and a film-based camera is that the digital camera no film. Instead, it has a sensor that converts light into electrical charges. The image sensor empl by most digital cameras is a **Charge Coupled Device (CCD)**. Some low-end cameras **Complementary Metal Oxide Semiconductor (CMOS)** technology. While CMOS sensors will al certainly improve and become more popular in the future, they probably will not replace CCD se in higher-end digital cameras. The CCD (or CMOS) is a collection of tiny light-sensitive diodes, w convert photons (light) into electrons (electrical charge). These diodes are called photosites. nutshell, each photosite is sensitive to light—the brighter the light that hits a single photosite greater the electrical charge that will accumulate at that site.

The amount of detail that the camera can capture is called the **resolution**, and it is measure pixels. The more pixels your camera has, the more detail it can capture. The more detail you hav more you can blow up a picture before it becomes "grainy" and starts to look out-of-focus. digital cameras on the market today have an LCD screen, which means that you can view your pi right away. This is one of the great advantages of a digital camera: You get immediate feedba what you capture. Most digital cameras can store dozens of high-resolution images at a time accept additional memory that increases the capacity of the camera even further. Transferrin images (downloading) from the camera to the computer is a simple process using standard cab even infrared networking capabilities. Using photo-manipulation software, graphic designers ca and enhance the digital images in a number of ways. The big advantage of digital cameras making photos is both inexpensive and fast because there is no film processing.

Figure 9.24 Types of Digital Cameras

Interestingly, one of the biggest boosters of digital photography is Kodak, the largest produ film. Kodak developed the Kodak PhotoCD format, which has become the de facto stand storing digital photographs. Leading digital camera manufacturers include Nikon, Canon, O Sony, Pentax, Minolta, etc.

make a computer to recognize an unlimited number of fonts and typefaces, OCR software is extr... complex. Advanced OCR systems can read text in a large variety of fonts, but they still have diffi... with handwritten text.

Even though the OCR software is quite complex and recognizing the characters, numbers ... symbols that come in a variety of sizes and shapes is a very complicated task, optical cha... recognition technology has made rapid advances. Today we have reached a state where we can ... and OCR with great accuracy. Today, there are OCR programs that can decipher a page of text ... received by a fax machine. Also many scanners come with OCR software bundled with them ... scanning and conversion to text a very easy task. OCR is already being used widely in the ... profession, where searches that once required hours or days can now be accomplished in ... seconds. OCR is also used by libraries in the creation of digital libraries from old magazines ... books. These digital libraries contain text that is scanned from books, magazines and a variety of ... printed sources. The potential of OCR systems is enormous because they enable users to harness ... power of computers to access printed documents.

OPTICAL MARK RECOGNITION (OMR)

Optical Mark Recognition (OMR) also called **mark sensing** is a technology where an OMR ... senses the presence or absence of a mark, such as a pencil mark. OMR is used in tests such as ... tests. Optical mark recognition is a flexible data collection technology ideally suited for colle... data without special equipment. While special OMR readers are required to read data on OMR ... individuals filling out the information do not need anything more technical than a black pencil.

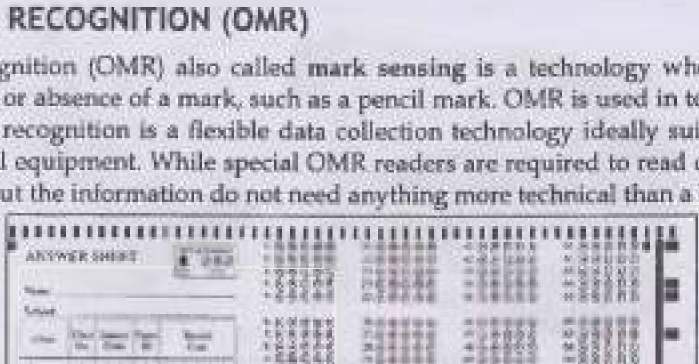


Figure 9.26 An OMR Form

Optical Mark Reading is a method of entering data into a computer system. Optical Mark ... "reads" pencil or pen marks, made in pre-defined positions on paper forms as responses to ... or tick list prompts. OMR uses specially-prepared forms, printed in light blue ink. OMR read... for dark marks (typically circles or rectangles) in specific locations on a form. Each positi... form can be assigned a different meaning, depending on the need. In many cases, the OMR te... may be used in conjunction with Optical Character Recognition (OCR) or bar-code reading. ... technology enables a high speed reading of large quantities of data and transferring the ... computer without using a keyboard: the OMR Reader scans the form, detects the presence ... makes control and passes this information to the computer for processing by application softw...

OMR is typically used for surveys, standardized tests, enrollment forms, and ballo... technology can be used when the documents mainly comprise the selection of categories or ... answers to multiple choice questions or when data is to be collected simultaneously from ...

number of sources and also when a large volume of data is to be collected and processed in a short period of time. The advantages of OMR are the following:

* It is relatively inexpensive to produce (in quantity).
* It requires no complex technology for recording data.
* It is accurate, and is disposable.

The limitations of OMR are that it requires complete marks and complete erasures; it may be tedious for entry of names and addresses and may be damaged by common contaminants. Also OMR requires precise printing of forms for accurate results and the cost of the OMR readers are high.

INTELLIGENT CHARACTER RECOGNITION (ICR)

Intelligent Character Recognition or ICR is the next generation of OMR. More sophisticated software can accept "checkmarks," "X marks," or "tics" provided that they are sufficiently bold. Spaces not filled properly can typically be differentiated from erasures. ICR uses paper based forms, which respondents can enter hand printed text such as names, dates, etc. as well as dash marks with no special equipment needed other than a pen/pencil. An ICR scanner then processes the forms, which are then verified and stored in the required database. ICR is the computer translation of manually entered text characters into machine-readable characters. In practice, characters are entered in a rough printed form from an I/O device, and the image of the captured data entry is then analyzed and translated into the machine-readable characters. ICR is similar to optical character recognition (OCR) and is sometime used in combination with OCR in form processing.

Figure 9.27 MICR Readers

Before ICR and OCR technology, form processing was performed by data entry operators who read and then manually keyed in data from paper forms into electronic forms on a computer, which were of the same format as the paper forms. Data taken from paper forms included typewritten or computer-generated fonts, handwritten characters, check boxes and bubbles, bar codes, and signatures. Today, form processing consists of scanners, OCR and ICR technology, and forms processing software that automates this process and takes a fraction of the time with approximately 98 percent accuracy, the same achieved by data entry operators.

MAGNETIC INK CHARACTER RECOGNITION (MICR)

Magnetic **Ink Character Recognition** (MICR) allows the computer to recognize characters printed using magnetic ink. MICR is a direct-entry method used in banks. This technology is used to automatically read those frustrating-looking numbers on the bottom of the cheque (see Figure 9.28). A special-purpose machine known as a reader/sorter reads characters made of ink contain magnetized particles. A related technology is the magnetic strip, used on the back of credit cards and bank debit cards, which allows readers such as Automated Teller Machines (ATMs) to read account information and facilitate monetary transactions. Another example of magnetic strip technology is in ID cards, which can be used for a variety of functions from attendance monitoring to restricting access to specific locations.

Originally designed to automate the cheque handling process, MICR technology, alone or in conjunction with a check authorization service, is now recognized as an effective deterrent to check fraud. The use of MICR check readers at the point of sale (POS) has grown dramatically in recent years. This document is designed to introduce this very effective technology to potential new users. Written in non-technical language, it covers the basics of MICR technology for both retail POS and banking applications.

MICR is a process in which magnetic ink and special fonts are used to create machine-readable information on documents. The most common application for MICR is automated cheque processing. MICR technology was developed in the 1950s to address the growing volume of cheques being used in the United States. The American Banking Association (ABA), in cooperation with Stanford University developed a set of 14 unique characters called the **E-13B MICR Font**, which was accepted as the standard by the ABA in 1959. The American National Standards Institute (ANSI) followed suit in 19[illegible] adopting E-13B as the American standard for MICR printing. Several other countries, including Canada, Japan, Australia, Columbia, Venezuela and the United Kingdom have adopted E-13B, as well. A second magnetic font, CMC-7 is used in Brazil, France, and a number of other European countries.

Figure 9.28 MICR Numeric Characters—E-13B and CMC-7

Both E-13B and CMC-7 characters are printed in magnetic ink or toner that when magnetized, emit a magnetic signal that identifies each unique character. The shape of the signal is developed from the character's horizontal/vertical attributes, and the amount/distribution of magnetic material in the ink or toner from which the character is formed. MICR cheque readers measure the strength of the magnetic signal emitted and reject the cheque if the shape and/or magnetics of the characters do not meet the specified standard.

As the quality of computers and color printers has improved, so has the ease with which fraudulent cheques can be created. A good quality color copy of a payroll cheque, for example, is almost impossible to detect with the human eye. A MICR reader, however, detects and rejects the fraudulent cheque because no magnetic signal is created. Similarly, changes to the MICR line using standard black ink will be ignored, and the original account number will be transmitted to the database or check service. Changes to the MICR line are generally used by forgers to prevent the detection of accounts.

REVIEW QUESTIONS

Short Answer Questions

01. What are the different types of keyboards?
02. How is the QWERTY keyboard different from the DVORAK keyboard?
03. What is so special about ergonomic keyboards?
04. What are multimedia and Internet keyboards?

25. How are they keys in a standard keyboard arranged?
26. What are the different pointing devices available?
27. What are the different types of mice?
28. What is the difference between a mouse and a trackball?
29. What are the advantages of a trackball?
30. What are game controllers?
31. What is a joystick and what is its most common use?
32. What are game pads and racing wheels and where are they used?
33. What is the function of a scanner and what are the different types of scanners?
34. What are pen scanners and where are they used?
35. What are the uses of handheld and flatbed scanners?
36. What are barcode readers and what are their applications?
37. What are the different types of card readers?
38. What are smart cards and what are they used for?
39. How does a digitizer work?
40. What do you mean by speech recognition?
41. What is continuous speech recognition?
42. What is discrete speech recognition?
43. What are webcams and what are their uses?
44. What are digital cameras?
45. What are the advantages of digital cameras?
46. What are camcorders and where are they used?
47. What do you mean by Optical Character Recognition?
48. What is Optical Mark Recognition?
49. What is Intelligent Character Recognition and what is its use?
50. What is MICR and what are the practical applications of MICR?

Descriptive Type Questions

1. What are the different kinds of input devices?
2. What are the different kinds of keyboards and pointing devices?
3. Explain the working of a digital camera.
4. What are the different types of voice recognition systems?
5. What are the practical applications of OCR technology?
6. Describe the OMR process of data entry.
7. What are the applications of ICR?
8. How does the MICR process work?

Fill in the Blanks

1. _________ is the input device consisting of a set of keys that enables you to enter data into a computer.
2. The modifier keys are _________, _________, and _________.
3. A device that controls the movement of the cursor or pointer on a display screen is called the _________.
4. Mouse was invented by _________ in 1963.
5. The four basic types of mice are _________, _________, _________ and _________.
6. Game controllers falls into two categories: _________ and _________.

07. The input device used mostly for computer games is the _________.
08. The input device that enables you to enter drawings and sketches into a computer is _______
09. _________ are used to scan only one line at a time.
10. Supermarkets use a bar code system called the _________.
11. _________ allows a user to manually "swipe" a card through a slot to automatically dec barcode symbol.
12. _________ is a small electronic device about the size of a credit card that contains ele memory, and possibly an embedded Integrated Circuit (IC).
13. OCR stands for ___________.
14. OMR stands for ___________.
15. ___________ is a flexible data collection technology ideally suited for collection of data w special equipment.
16. ICR stands for ___________.
17. ___________ is the next generation of OMR.
18. ___________ is the computer translation of manually entered text characters into m readable characters.
19. MICR is the abbreviation of ___________.
20. ___________ allows the computer to recognize characters printed using magnetic ink.
21. The American Banking Association (ABA), in cooperation with Stanford University, dev set of fourteen unique characters called ___________.
22. ___________ is an input device that enables you to enter drawings and sketches into a com
23. Apple Computer's PlainTalk and Dragon NaturallySpeaking are examples of ___________
24. The image sensor employed by most digital cameras is ___________.
25. The amount of detail that the camera can capture is called the ___________ and it is mea ___________.

[Answers: (1) Keyboard (2) Shift, Ctrl and Alt (3) Mouse (4) Douglas Engelbart (5) Mechan mechanical, Optical and Laser (6) Joysticks and game pads (7)Joystick (8) Scanner (9) Pen Sca Universal Product Code (UPC) (11) Slot reader (12) Smart card (13) Optical Character Recog Optical Mark Recognition (15) OMR (16) Intelligent Character Recognition (17) ICR (18) Magnetic Ink Character Recognition (20) MICR (21) E-13B MICR Font (22) Digitizer (23) C speech recognition systems (24) Charge coupled device (25) Resolution, Pixels]

True or False

01. The QWERTY keyboard was designed in the 1800s for mechanical typewriters and wa designed to slow typists down to avoid jamming the keys.
02. Ctrl+C, Ctrl+X and Ctrl+V are the universally accepted keyboard shortcuts for Copy Paste.
03. The special purpose keys in an IBM-compatible keyboard are Insert (Ins), Delete (Del), Screen (Prt Scr), Scroll Lock and Pause.
04. Optical mice have very few mechanical moving parts.
05. In the case of Macintosh computers most mice have only one button.
06. Mechanical mouse requires a special mouse pad that has grids drawn on them.
07. Trackball is a pointing device.
08. A joystick is similar to a mouse, except that with a mouse the cursor stops moving as s stop moving the mouse.
09. Most joysticks include two or more buttons called triggers.

10. Modern pen scanners can perform other functions like send the scanned text as e-mail or SMS messages or transfer the text to handheld devices, laptops or computers.
11. To edit text read by an optical scanner, you need an Optical Character Recognition (OCR) system.
12. A magstripe reader is a kind of card reader and is also known as magnetic credit card reader.
13. OMR is also known as mark sensing.
14. OMR is used in aptitude tests.
15. OMR uses specially-prepared forms, printed in red ink.
16. MICR is a direct-entry method used in banks.
17. CMC-7 is a magnetic font used in Brazil, France, and a number of other European countries.
18. Digitizers are also called graphics tablets.
19. IBM Voice Type Simply Speaking and Dragon Dictate are examples of Continuous speech recognition systems.
20. Low-end digital cameras use complementary metal oxide semiconductor (CMOS) technology for image sensing.

[Answers: (1) True (2) True (3) True (4) False (5) True (6) False (7) True (8) True (9) True (10) True (11) True (12) True (13) True (14) True (15) False (16) True (17) True (18) True (19) False (20) True]

CHAPTER 10

Output Devices

TOPICS COVERED

- Introduction
- Monitors
- Printers
- Plotters
- Multimedia projectors
- Speech synthesizers
- Soundcards and speakers
- Dumb, smart and intelligent terminals

Key Points

- An output device is any machine capable of repre[illegible] information from a computer.
- Monitor is the most commonly used output devic[illegible] are two types of monitors that are used with [illegible] computers—CRT monitors and flat-panel monitors.
- Printer is a device that prints text or illustrations [illegible] and in many cases on transparencies and other med[illegible] different types of printers are daisy-wheel, dot-matrix, [illegible] jet, LCD, LED and thermal. Plotter is a device that draws [illegible] on paper based on commands from a computer.
- Multimedia projectors are self-contained data [illegible] units. Speech synthesis refers to a computer's ability [illegible] sound that resembles human speech. A Text-To-Spe[illegible] synthesizer is a computer-based system that should [illegible] read any text aloud. Voice Response Systems are [illegible] speech synthesis in which sentences are formed by con[illegible] pre-recorded words from a database.
- Soundcard is an expansion board that enables a co[illegible] manipulate and output sounds. Sound cards [illegible] computer to output sound through speakers conne[illegible] board, to record sound input from a microphone c[illegible] the computer, and manipulate sound stored on a disk.

INTRODUCTION

Output is anything that comes out of a computer. Output can be meaningful information or gibberish, and it can appear in a variety of forms—as binary numbers, characters, pictures, sounds and printed pages. An output device is any machine capable of representing information from a computer. Output devices include display screens (monitors), printers, speakers, plotters, etc.

MONITOR

Monitor is another term for the display screen. The term monitor usually refers to the [illegible] whereas display screen can mean just the screen. In addition, the term monitor often impli[illegible] capabilities. Monitor is the most commonly used output device. There are two types of mo[illegible] are used with personal computers—**CRT monitors and flat-panel monitors**. The CRT mo[illegible] most common type of monitor and looks like a television and works the same way. Th[illegible] monitor uses a cathode ray tube (CRT). The flat-panel monitors were originally used [illegible] portable computers like laptops and notebooks but are becoming increasingly popular w[illegible] computers.

CRT Monitors

A CRT monitor works by moving an electron beam back and forth across the back of the sc[illegible] time the beam makes a pass across the screen, it lights up phosphor dots on the inside [illegible] lines, thereby illuminating the active portions of the screen. By drawing many such lines from the top to the bottom of the screen, it creates an entire screen of images.

Near the back of the CRT monitor is an electron gun. The gun sends out a beam of electrons through a magnetic coil, which aims at the front of the monitor. The back of the monitor's screen is coated with phosphors—chemicals that glow when they are struck by an electron beam. The screen's phosphor coating is arranged as grids of dots called picture elements or **pixels**. As we have seen, the electron beam aims at every pixel on the screen, starting from the top left corner and scanning to the right edge. Then it drops down a tiny distance and scans another line. This process is continued until the end of the screen is reached. Then the process starts all over again. As the electron gun scans the circuitry driving the monitor adjusts the intensity of the beam to determine whether a pixel is on or off.

In a monochrome and grayscale monitor there is only one electron gun. In a color monitor there are three electron guns—one for each primary color (red, green and blue). In the color monitor each pixel includes three phosphors—red, green and blue—arranged in a triangle. When the beams of the three guns are combined and focused on a pixel, the phosphors light up. The color monitor displays different colors by combining various intensities of the three beams.

Figure 10.1 CRT Monitors

CRT monitors have long been used with desktop computers and are still being used for most applications. They are very cheap and provide the brightest and clearest picture. But there are some disadvantages also. CRT monitors are big, take up a lot of desktop space and are difficult to move as they are very heavy. Another disadvantage is that the CRT monitors require a lot of power. Because of these disadvantages many people are now turning to flat-panel monitors.

Flat-Panel Monitors

Flat-panel monitors have long been used with portable computers. But in the last few years the flat-panel monitors are being increasingly used with desktop computers. There are several types of flat-panel monitors. The most common is the **Liquid Crystal Display (LCD)** monitor. The LCD technology is the same as that used in calculators and digital watches. The LCD monitor creates images with a special liquid crystal that is normally transparent but becomes opaque when charged with electricity.

black. These monitors are used for text-only displays where the user does not need to see any graphics.

- **Gray-scale** – A gray-scale monitor is a special type of monochrome monitor capable of displaying different shades of gray. Grayscale monitors display the different shades of gray—from very light gray to black—against a white or off-white background. They are used in low-end portable computers like handhelds, PDAs, etc. to keep the costs down.
- **Color** – Color monitors can display anywhere from 16 to over 1 million different colors. Color monitors are sometimes called RGB monitors because they accept three separate signals—red, green, and blue. This differs from color televisions, for example, which use composite video signals, in which all the colors are mixed together. All color computer monitors are RGB monitors. An RGB monitor consists of a vacuum tube with three electron guns—one each for red, green, and blue at one end and the screen at the other end. The three electron guns fire electrons at the screen, which contains a phosphorous coating. When the electron beams excite the phosphors, they glow. Depending on which beam excites them, they glow red, green, or blue. Ideally, the three beams should converge for each point on the screen so that each pixel is a combination of the three colors.

Color and gray-scaling monitors are often classified by the number of bits they use to represent each pixel. For example, an 8-bit monitor represents each pixel with 8 bits. The more bits per pixel, the more colors and shades of gray the monitor can display.

Classification of Monitors – Based on Signals

Another common way of classifying monitors is in terms of the type of signal they accept: analog or digital.

- **Digital Monitor** – A digital monitor accepts digital signals rather than analog signals. All monitors (except flat-panel displays) use CRT technology, which is essentially analog. The term digital, therefore, refers only to the type of input received from the video adapter. A digital monitor then translates the digital signals into analog signals that control the actual display. Although digital monitors are fast and produce clear images, they cannot display variable colors continuously. Consequently, only low-quality video standards, such as Monochrome Display Adapter (MDA), Color/Graphics Adapter (CGA), and Enhanced Graphics Adapter (EGA), specify digital signals. Video Graphics Array (VGA) and Super VGA (SVGA), on the other hand, require an analog monitor. Some monitors are capable of accepting either analog or digital signals.
- **Analog Monitor** – This is the traditional type of color display screen that has been used for years in televisions. In reality, all monitors based on CRT technology (that is, all monitors except flat-panel displays) are analog. Some monitors, however, are called digital monitors because they accept digital signals from the video adapter. EGA monitors, for example, must be digital because the EGA standard specifies digital signals. Digital monitors must nevertheless translate the signals into an analog form before displaying images. Some monitors can accept both digital and analog signals. Low-cost digital monitors are often called Transistor-Transistor Logic (TTL) monitors. Most monitors accept analog signals, which are required by the VGA, SVGA, 8514/A and other high-resolution color standards. Some monitors are capable of accepting either type of signal. Some monitors have fixed frequency, which means that they accept input at only one frequency. Another type of monitor, called a multi-scanning monitor, automatically adjusts to the frequency of the signals being sent to it.

This means that it can accept input from different types of video adapters. Like fixed frequency monitors, multi-scanning monitors accept TTL, analog, or both types of input.

Characteristics of a Monitor

The following section deals with some of the important characteristics of a monitor. You should be familiar with these when you choose a monitor for your use.

- **Size** – The most important aspect of a monitor is its screen size. Like televisions, screen sizes are measured in diagonal inches, the distance from one corner to the opposite corner diagonally. A typical size for small VGA monitors is 14 inches. Monitors that are 16 or more inches diagonally are often called full-page monitors. In addition to their size, monitors can be either portrait (height greater than width) or landscape (width greater than height). Larger landscape monitors can display two full pages, side by side. The screen size is sometimes misleading because there is always an area around the edge of the screen that cannot be used. Therefore, monitor manufacturers must now also state the viewable area, that is, the area of screen that is actually used. For the past few years 15-inch monitors was the standard with most desktop computer systems. Today many computer users are preferring 17-inch and 19-inch monitors. Many users are now switching to flat-panel monitors as they offer many advantages like smaller size, lower power consumption and larger viewing area. For example, a 15-inch flat-panel monitor provides almost the same viewing area as a 17-inch CRT monitor.
- **Resolution** – The resolution of a monitor indicates how densely the pixels are packed. Pixel is short for **Picture Element**. A pixel is a single point in a graphic image. Graphics monitors display pictures by dividing the display screen into thousands (or millions) of pixels, arranged in rows and columns. The pixels are so close together that they appear connected. The number of bits used to represent each pixel determines how many colors or shades of gray can be displayed. For example, an 8-bit color monitor uses 8 bits for each pixel, making it possible to display 2 to the 8th power (256) different colors or shades of gray. On color monitors, each pixel is actually composed of three dots—a red, a blue, and a green. The quality of a display monitor largely depends on its resolution, how many pixels it can display, and how many bits are used to represent each pixel. VGA monitors display 640 x 480, or about 300,000 pixels. In contrast, SVGA monitors display 1,024 x 768, or nearly 800,000 pixels. True color monitors use 24 bits per pixel, allowing them to display more than 16 million different colors. In general, the more number of pixels (often expressed in dots per inch), the sharper the image. Most modern monitors can display 1024 x 768 pixels, the SVGA standard. Some high-end models can display 1280 x 1024, or even 1600 x 1200.
- **Refresh Rate** – Display monitors must be refreshed many times per second. The refresh rate determines how many times per second the screen is to be refreshed (redrawn). The refresh rate for a monitor is measured in Hertz (Hz) and is also called the vertical frequency or vertical refresh rate. The old standard for monitor refresh rates was 60 Hz, but a new standard developed by VESA sets the refresh rate at 75 Hz for VGA and SVGA monitors. The faster the refresh rate, the less the monitor flickers.
- **Bandwidth** – Bandwidth is the amount of data that can be transmitted in a fixed amount of time. For digital devices, the bandwidth is usually expressed in bits or bytes per second (bps). For analog devices, the bandwidth is expressed in cycles per second, or Hertz (Hz).
- **Interlaced or Non-interlaced** – Interlacing is a display technique that enables a monitor to provide more resolution inexpensively. With interlacing monitors, the electron guns draw only half the horizontal lines with each pass (for example, all odd lines on one pass and

even lines on the next pass). Because an interlacing monitor refreshes only half the lines at one time, it can display twice as many lines per refresh cycle, giving it greater resolution. Another way of looking at it is that interlacing provides the same resolution as non-interlacing, but less expensively. A shortcoming of interlacing is that the reaction time is slower, so programs that depend on quick refresh rates (animation and video, for example), may experience flickering or streaking. Given two monitors that offer the same resolution, the non-interlacing one will generally be better.

▲ **Dot-pitch** – Dot pitch is a measurement that indicates the vertical distance between each pixel on a display screen. Measured in millimeters, the dot pitch is one of the principal characteristics that determine the quality of display monitors. The lower the number, the crisper the image. The dot pitch of color monitors for personal computers ranges from about 0.15 mm to 0.30 mm. Another term for dot pitch is phosphor pitch.

▲ **Convergence** – Convergence refers to how sharply an individual color pixel on a monitor appears. Each pixel is composed of three dots – red, blue, and green. Ideally, the three dots should all converge at the same point. If the dots are badly misconverged, the pixel will appear blurry. All monitors have some convergence errors, but they differ in degree.

Video Standards

There are a variety of video standards that define resolution and colors for displays. Support for a graphics standard is determined by both the monitor and the video adapter. The monitor must be able to show the resolution and colors defined by the standard, and the video adapter must be capable of transmitting the appropriate signals to the monitor. Listed here, in approximate order of increasing power and sophistication, are the more popular video standards for PCs. The popular video standards are given in Table 10.1.

Table 10.1 Popular Video Standards for PCs

Standard	Resolution	Simultaneous Colors
VGA	640 x 480	16
	320 x 200	256
SVGA	800 x 600	16
	1024 x 768	256
	1280 x 1024	256
	1600 x 1200	256
8514/A	1024 x 768	256
XGA	640 x 480	65536
	1024 x 768	256
TI 34010	1024 x 768	256

VGA

Abbreviation of video graphics array, a graphics display system for PCs developed by IBM. VGA has become one of the de facto standards for PCs. In text mode, VGA systems provide a resolution of 720 x 400 pixels. In graphics mode, the resolution is either 640 x 480 (with 16 colors) or 320 x 200 (with 256 colors). The total palette of colors is 262,144. Unlike earlier graphics standards for PCs – MDA, CGA, and EGA – VGA uses analog signals rather than digital signals. Consequently, a monitor designed for one of the older standards will not be able to use VGA. Since its introduction in 1987, several other standards have been developed that offer greater resolution and more colors, but VGA remains the lowest common denominator. All PCs made today support VGA, and possibly some other more advanced standard.

SVGA

Short for Super VGA, a set of graphics standards designed to offer greater resolution than VGA. Th are several varieties of SVGA, each providing a different resolution:

- 800 x 600 pixels
- 1024 x 768 pixels
- 1280 x 1024 pixels
- 1600 x 1200 pixels

All SVGA standards support a palette of 16 million colors, but the number of colors that ca displayed simultaneously is limited by the amount of video memory installed in a system. One S system might display only 16 simultaneous colors while another displays the entire palette million colors. The SVGA standards are developed by a consortium of monitor and gr manufacturers called Video Electronics Standards Association (VESA).

8514/A

8514/A is a high-resolution video standard for PCs developed by IBM in 1987 to exten capabilities of VGA. This standard provides a resolution of 1,024 x 768 pixels, which gives it ab times the pixels of VGA (640 x 480). Like VGA, 8514/Aprovides a palette of 262,000 colors, of wh can be displayed at one time. On monochrome displays, 8514/A provides 64 shades of gray original version, 8514/A relies on interlacing, a technique that makes it possible to provide resol low cost. Interlacing, however, carries a performance penalty, so many manufacturers produc interlaced 8514/A clones. In 1990, IBM released the Extended Graphics Array (XGA) standard, w supersedes 8514/A

XGA

Short for extended graphics array, a high-resolution graphics standard introduced by IBM XGA was designed to replace the older 8514/A video standard. It provides the same resolution 480 or 1024 x 768 pixels), but supports more simultaneous colors (65 thousand compared to 256 colors). In addition, XGA allows monitors to be non-interlaced.

TI 34010

TI 34010 is a video standard from Texas Instruments that supports a resolution of 1,024 x 768. conforms to TI's Graphics Architecture (TIGA). Unlike IBM's 8514/A, which supports th resolution, TI 34010 is non-interlaced.

PRINTER

Printer is a device that prints text or illustrations on paper and in many cases on transpare other media. Printers are classified according to the following characteristics:

- **Quality of type** — The output produced by printers is said to be either letter quality as a typewriter), near letter quality, or draft quality. Only daisy-wheel, ink-jet, printers produce letter-quality type. Some dot-matrix printers claim letter-quality p you look closely, you can see the difference.
- **Speed** — Measured in characters per second (cps) or pages per minute (ppm), th printers varies widely. Daisy-wheel printers tend to be the slowest, printing about printers are fastest (up to 3,000 lines per minute). Dot-matrix printers can print up and laser printers range from about 4 to 20 text pages per minute.

- **Impact or non-impact** – Impact printers include all printers that work by striking an ink ribbon. Daisy-wheel, dot-matrix, and line printers are impact printers. Non-impact printers include laser printers and ink-jet printers. The important difference between impact and non-impact printers is that impact printers are much noisier but are useful for making multiple copies like carbon copies.
- **Graphics** – Some printers (daisy-wheel and line printers) can print only text. Other printers can print both text and graphics.
- **Fonts** – Some printers, notably dot-matrix printers, are limited to one or a few fonts. In contrast, laser and ink-jet printers are capable of printing an almost unlimited variety of fonts. Daisy-wheel printers can also print different fonts, but you need to change the daisy wheel, making it difficult to mix fonts in the same document.

There are many different types of printers. In terms of the technology utilized, printers fall into the following categories.

Daisy-wheel Printer

A daisy-wheel printer is a type of printer that produces letter-quality type. A daisy-wheel printer works on the same principle as a ball-head typewriter. The daisy wheel is a disk made of plastic or metal on which characters stand out in relief along the outer edge. To print a character, the printer rotates the disk until the desired letter is facing the paper. Then a hammer strikes the disk, forcing the character to hit an ink ribbon, leaving an impression of the character on the paper. You can change the daisy wheel to print different fonts. Daisy-wheel printers cannot print graphics, and in general they are noisy and slow, printing from 10 to about 75 characters per second. As the price of laser and ink-jet printers has declined, and the quality of dot-matrix printers has improved, daisy-wheel printers have become almost obsolete.

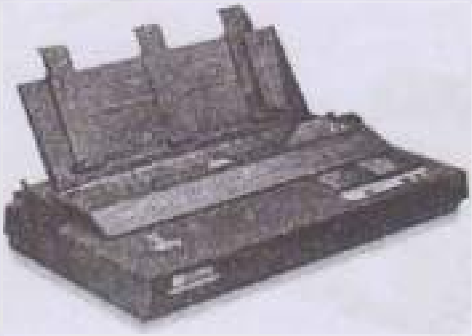


Figure 10.3 Dot-matrix Printer

Dot-matrix Printer

Dot-matrix printers create characters by striking pins against an ink ribbon. Each pin makes a dot, and combinations of dots form characters and illustrations. Dot-matrix printers are inexpensive and relatively fast, but they do not produce high-quality output. Dot-matrix printers vary in two important characteristics:

- Speed – Given in characters per second (cps), the speed can vary from about 50 to over 500 cps. Most dot-matrix printers offer different speeds depending on the quality of print desired.

- **Print quality** – Determined by the number of pins (the mechanisms that print the dots), can vary from 9 to 24. The best dot-matrix printers (24 pins) can produce near letter-quality type, although you can still see a difference if you look closely.

In addition to these characteristics, you should also consider the noise factor. Compared to laser and ink-jet printers, dot-matrix printers are notorious for making a racket. Although the prices of laser and ink-jet printers are dropping rapidly, dot-matrix printers are still cheaper to operate. In addition, since they are impact printers, the dot-matrix printers can print to multi-page forms (that is, carbon copies), something laser and ink-jet printers cannot do.

Ink-jet Printer

Ink-jet printers work by spraying ionized ink at a sheet of paper. Magnetized plates in the ink's path direct the ink onto the paper in the desired shapes. Ink-jet printers are capable of producing high quality print approaching that produced by laser printers. A typical ink-jet printer provides a resolution of 300 dots per inch, although some newer models offer higher resolutions. In general, the price of ink-jet printers is lower than that of laser printers. However, they are also considerably slower. Another drawback of ink-jet printers is that they require a special type of ink that is apt to smudge on inexpensive copier paper.

Figure 10.4 Ink-jet and Laser Printers

Because ink-jet printers require smaller mechanical parts than laser printers, they are especially popular as portable printers. In addition, color ink-jet printers provide an inexpensive way to print full-color documents.

Laser Printer

Laser printer utilizes a laser beam to produce an image on a drum. The light of the laser alters the electrical charge on the drum wherever it hits. The drum is then rolled through a reservoir of toner, which is picked up by the charged portions of the drum. Finally, the toner is transferred to the paper through a combination of heat and pressure. This is also the way copy machines work.

Because an entire page is transmitted to a drum before the toner is applied, laser printers are sometimes called page printers. There are two other types of page printers that fall under the category of laser printers even though they do not use lasers at all. One uses an array of LEDs to expose the drum, and the other uses LCDs. Once the drum is charged, however, they both operate like a real laser printer. One of the chief characteristics of laser printers is their resolution – how many dots per inch (dpi) they lay down. The available resolutions range from 300 dpi at the low end to 1,200 dpi at the high end. By comparison, offset printing usually prints at 1,200 or 2,400 dpi. Some laser printers achieve higher resolutions with special techniques known generally as resolution enhancement.

In addition to the standard monochrome laser printer, which uses a single toner, there also exist color laser printers that use four toners to print in full color. Color laser printers tend to be about five to ten times as expensive as their monochrome siblings. Laser printers produce very high-quality print and are capable of printing an almost unlimited variety of fonts.

Most laser printers come with a basic set of fonts, called internal or resident fonts, but you can add additional fonts in two ways:

* **Font cartridges** – Laser printers have slots in which you can insert font cartridges, ROM boards on which fonts have been recorded. The advantage of font cartridges is that they use none of the printer's memory.
* **Soft fonts** – All laser printers come with a certain amount of RAM memory, and you can usually increase the amount of memory by adding memory boards in the printer's expansion slots. You can then copy fonts from a disk to the printer's RAM. This is called downloading fonts. A font that has been downloaded is often referred to as a soft font, to distinguish it from the hard fonts available on font cartridges. The more RAM a printer has, more fonts that can be downloaded at one time.

In addition to text, laser printers are very adept at printing graphics. However, you need significant amounts of memory in the printer to print high-resolution graphics. To print a full-page graphic at 300 dpi, for example, you need at least 1 MB of printer RAM. For a 600-dpi graphic, you need at least 4 MB RAM.

Because laser printers are non-impact printers, they are much quieter than dot-matrix or daisy-wheel printers. They are also relatively fast, although not as fast as some dot-matrix printers. The speed of laser printers ranges from about 4 to 20 pages of text per minute (ppm). A typical rate of 6 ppm is equivalent to about 40 characters per second (cps). Laser printers are controlled through page description languages (PDLs). There are two de facto standards for PDLs:

* **PCL** – Hewlett-Packard (HP) was one of the pioneers of laser printers and has developed a Printer Control Language (PCL) to control output. There are several versions of PCL, so a printer may be compatible with one but not another. In addition, many printers that claim compatibility cannot accept HP font cartridges.
* **Postscript** – This is the de facto standard for Apple Macintosh printers and for all desktop publishing systems.

Most software can print using either of these PDLs. Postscript tends to be a bit more expensive, but it has some features that PCL lacks and it is the standard for desktop publishing. Some printers support both PCL and Postscript.

LCD, LED, Line and Thermal Printers

Similar to a laser printer but uses liquid crystals or light-emitting diodes rather than a laser to produce an image on the drum. Line printers are high-speed printers capable of printing an entire line at one time. A fast line printer can print as many as 3,000 lines per minute. The disadvantages of line p are that they can print only one font, they cannot print graphics, the print quality is low, and the very noisy. Thermal printers are printers that produce images by pushing electrically heated against special heat-sensitive paper. Thermal printers are inexpensive and are used in most calcu and many fax machines. They produce low-quality print, and the paper tends to curl and fade few weeks or months.

PLOTTER

Plotter is a device that draws pictures on paper based on commands from a computer. Plotters from printers in that they draw lines using a pen. As a result, they can produce continuous whereas printers can only simulate lines by printing a closely spaced series of dots. Multicolor use different-colored pens to draw different colors.

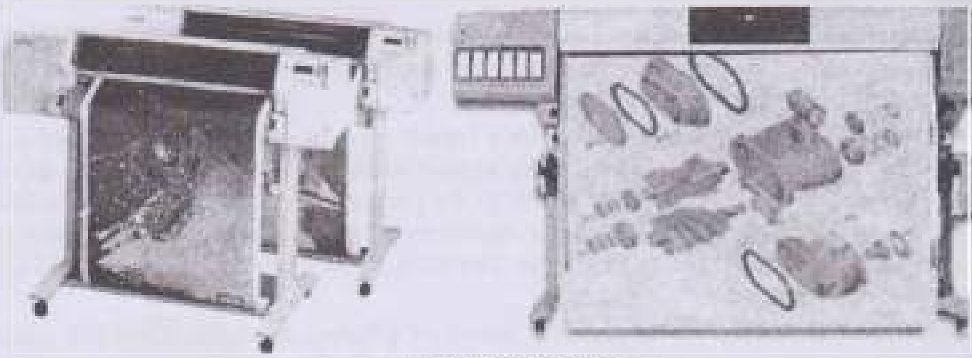


Figure 10.5 Plotters

In general, plotters are considerably more expensive than printers. They are used in eng applications where precision is mandatory.

MULTIMEDIA PROJECTOR

Multimedia projectors are self-contained data projection units. While most are primarily u computer-based presentations, many can also handle additional data sources such as VCR an players. All multimedia projectors have a light source, a lens, and at least one RGB (compute Multimedia means that a projector will display data from computers as well as pictur televisions and video recorders. Video-only projectors cannot be used with computers. Fig shows some multimedia projectors.

In the world of multimedia projectors, not all pictures are created equal. These project many rows of small elements called pixels to make the images we see. The amount of det projector can display, and the clarity with which it will be seen, depends on how many p projected. It is called projector resolution, and it is usually expressed in two sets of numbers 800 x 600). The first number refers to the pixels displayed horizontally across the image; the those displayed vertically from top to bottom. The more pixels there are, the higher the p resolution, and the more detail that can be seen in projected images. Projected images are when computer and projector resolution match. It is a good idea to keep your computer in you shop for a projector. The usual resolutions are 800 x 600 (SVGA), 1024 x 768 (XGA) and 12 (SXGA).

The multimedia projector will have data input and output ports. The more expensive a multimedia projector is the more input/output ports it is likely to have. Some projectors have an additional "**RGB In**" port which allows the user to connect more than one computer at a time to the projector. The "**RGB Out**" port allows you to connect a separate external monitor to your projector, so that the video from your computer can be seen on the projector and on a monitor at the same time. The "**Audio In**" sends audio data from your computer, VCR, or DVD player to the projector so that your audience can hear the sound that is part of your presentation or video recording. "**Audio Out**" sends audio data from your projector to an external sound system. If you are in a large room, you may want to connect to an external sound system.

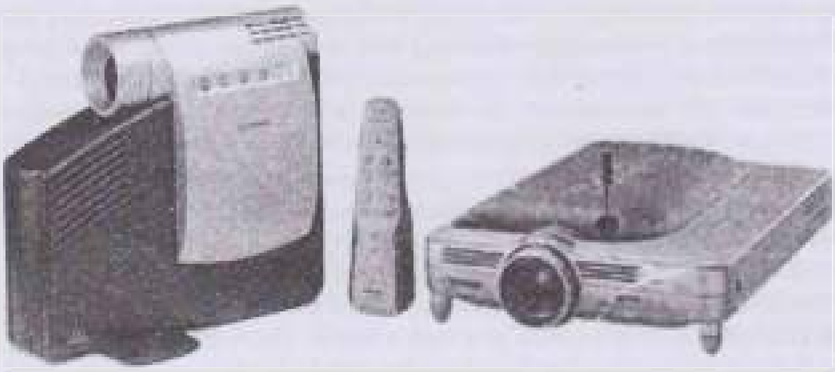


Figure 10.6 Multimedia Projectors

Big rooms and big groups require big images. Big images require a light output that is bright enough to spread across a large area. Light output is measured in units called ANSI lumens. More lumens mean more brightness, and generally speaking, more brightness translates into bigger images that look good even when the lights are on in the room.

Some other accessories for your projector are zoom lens, remote control, etc. A zoom lens allows you to control image size. Zoom in and your image gets smaller, zoom out and it gets larger. Zoom lenses are a particularly valuable feature for presenters who move their projector from room to room. Remote control allows you to operate your projector and adjust your image from anywhere in the room. Many remote controls use menu-based systems to adjust the projector's many features, but also have dedicated buttons to control frequently used features, such as power on/off and image source selection.

Multimedia projectors are used for presentations, educational programs, conferences, etc. The advantage of a multimedia projector over conventional Over-Head Projectors (OHP) is that they can be connected to a computer, VCR, CD, or DVD player and they can produce not only images but also sound.

SPEECH SYNTHESIZERS

Speech synthesis refers to a computer's ability to produce sound that resembles human speech. Although they cannot imitate the full spectrum of human cadences and intonations, speech synthesis systems can read text files and output them in a very intelligible, if somewhat dull, voice. Many systems even allow the user to choose the type of voice—for example, male or female. Speech synthesis systems are particularly valuable for seeing-impaired individuals.

A **Text-To-Speech (TTS)** synthesizer is a computer-based system that should be able to read any text aloud, whether it was directly introduced in the computer by an operator or scanned and submitted to an Optical Character Recognition (OCR) system. There is a fundamental difference between the system we are about to discuss here and any other talking machine (as a cassette-player for example) in the sense that we are interested in the automatic production of new sentences.

TTS systems were first developed to aid the visually impaired by offering a computer-generated spoken voice that would "read" text to the user. TTS should not be confused with voice response systems. Voice response systems synthesize speech by concatenating sentences from a database of prerecorded words and are used for different purposes than TTS systems, which form sentences and/or phrases based on a language's **graphemes** and **phonemes**. Voice response systems are limited to synthesizing sentences that contain only words that have been predetermined by the system. In the context of TTS synthesis, it is impossible to record and store all the words of the language. It is thus more suitable to define Text-To-Speech as the automatic production of speech, through a grapheme-to-phoneme transcription of the sentences to utter. Thus TTS systems are theoretically capable of "reading" any string of text characters to form original sentences.

Voice Response Systems are a form of speech synthesis in which sentences are formed by concatenating pre-recorded words from a database. Unlike a TTS system, which uses speech synthesis to form spontaneous sentences and/or phrases based on human phonetics, a voice response system operates with a limited vocabulary in situations where the sentences and/or phrases that are formed follow a strict predetermined pattern. For example, a train station may use a voice response system to notify passengers of schedule information or a train's status. The synthesized speech is created from a pool of words that are strung together based on the input of a human operator, and the pool only contains a limited number of words as there are a limited number of combinations of words that are necessary for the train station's purpose; financial institutions also use voice response systems to assist customers in getting account information over the telephone. The same principle applies here—since the financial institution only needs to provide the caller with a limited amount of information; it does not need to be able to generate spontaneous sentences in response to customer inquiries.

Hardware and Software Speech Synthesizers

A **hardware speech synthesizer** (also called external speech synthesizer) is a hardware device used for speech output. Typically, they are used with screen readers or OCR scanning software programs for people who are blind or visually disabled.

Figure 10.7 Hardware Speech Synthesizers

External speech synthesizers were used exclusively before the advent of sound cards in computers. Now, with multi-channel sound cards people who use screen readers or other speech [illegible] software can have both the "voice" of the computer and the system sounds audible at the same time. Some people who require the system sounds, or who prefer to leave their sound cards to perform other functions may want to use an external speech synthesizer instead of the internal sound card. For example, if they want to listen to a CD, watch a DVD, or do some audio/video conferencing, they might want to leave the sound card channels free to do so. This may also be a critical piece of equipment for people who are also composing music or using audio editing programs. Hardware speech synthesizer products have been a popular choice for use with screen reading programs. These devices have true phoneme speech synthesis chip which can blend phonemes into millions of smooth flowing vocal sounds. There are also "software speech synthesizers". Figure 10.7 shows two hardware speech synthesizers.

Software **speech synthesizer** programs enable you to use the sound card in the computer as the speech synthesizer for a screen reader. These software programs convert the text to speech and use the computer's sound card and speakers for reading it aloud. iSpeak and SpeakThis from AcuVoice, [illegible] from Stepware, Inc., DECTalk from Digital Equipment Corporation, Sayso and Tempo from [illegible] Speech, etc. are some of the popular software speech synthesizers.

SOUND CARDS AND SPEAKERS

A sound card is an expansion board that enables a computer to manipulate and output sounds. Sound cards are necessary for nearly all CD-ROMs and have become commonplace on modern personal computers. Sound cards enable the computer to output sound through speakers connected to the board, to record sound input from a microphone connected to the computer, and manipulate sound stored on a disk.

Nearly all sound cards support MIDI, a standard for representing music electronically. In addition, most sound cards are Sound Blaster-compatible, which means that they can process commands written for a Sound Blaster card, the de facto standard for PC sound. Sound cards use two basic methods to translate digital data into analog sounds:

- **FM (Frequency Modulation) Synthesis** mimics different musical instruments according to built-in formulas.
- **Wavetable Synthesis** relies on recordings of actual instruments to produce sound. Wavetable synthesis produces more accurate sound, but is also more expensive.

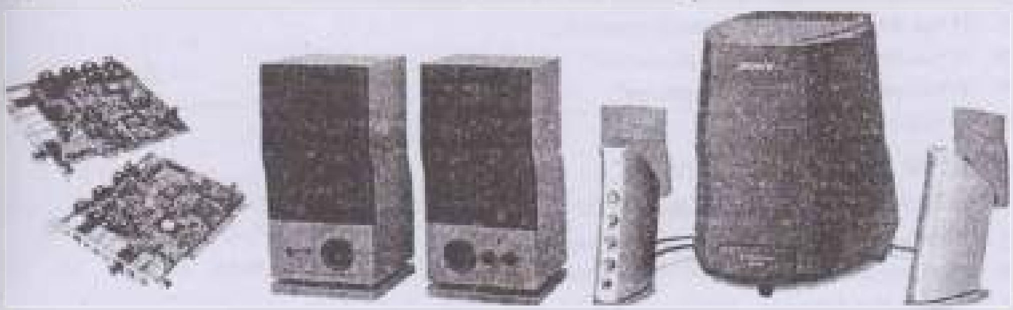


Figure 10.8 Sound Cards and Speakers

The sound cards translate digital sounds into the electric current that is sent to the speakers. With the right kind of software, you can do much more than simply record and play back digitized sound. Sound editing programs provide a miniature sound studio allowing you to view the sound wave and edit it. In editing you can cut bits of sound, copy them and amplify the parts you want to hear loudly, filter out static and create many exotic audio effects.

DUMB, SMART AND INTELLIGENT TERMINALS

A dumb terminal is a display monitor that has no processing capabilities. A dumb terminal is sim an output device that accepts data from the CPU. A smart terminal is a terminal that has so processing capabilities, but not as many as an intelligent terminal. Smart terminals have built-in lo for performing simple display operations, such as blinking and boldface.

Figure 10.9 Dumb, Smart and Intelligent Terminals

Intelligent terminal is a terminal (monitor and keyboard) that contains processing po Intelligent terminals include memory and a processor to perform special display operatio contrast, a dumb terminal has no processing capabilities; it must rely entirely on the central com A smart terminal has some processing capabilities, but not as much as an intelligent terminal.

REVIEW QUESTIONS

Short Answer Questions

01. What is an output device?
02. What is a monitor?
03. What is a CRT monitor?
04. What is a TFT monitor?
05. What is a pixel?
06. What do you mean by the terms VGA, SVGA, and XGA?
07. What do you mean by speech synthesis?
08. What are graphemes and phonemes?
09. What are voice response systems?
10. What are sound cards?

Descriptive Type Questions

01. What are the major output devices for a computer?
02. What is a monitor, and how does it work?
03. What are the different types of monitors?
04. What is the difference between a CRT monitor and a flat-panel monitor?
05. What is the difference between passive matrix and active matrix LCD technologies?
06. What are the different types of flat-panel monitors?
07. What are the advantages and disadvantages of flat-panel monitors?
08. How are monitors classified based on color?
09. How are monitors classified based on signals?
10. What are the different video standards?

11. What do you mean by VGA, SVGA, 8514/A XGA and TI 34010?
12. What are the different types of printers?
13. What is the difference between an impact printer and a non-impact printer?
14. What is the difference between a laser printer and an LCD printer?
15. What are thermal printers and how do they work?
16. What is a plotter and how does it work?
17. What is a multimedia projector and what are its main uses?
18. What do you mean by the resolution of a multimedia projector?
19. What are the main data input and output ports of a multimedia projector?
20. What is a Text-to-Speech synthesizer?
21. How is a speech synthesis system different from a voice response system?
22. What are dumb, smart and intelligent terminals?

Essay Questions

01. Explain the working principle of CRT and flat panel monitors.
02. Explain the different classification schemes of computer monitors.
03. What are the different types of printers? Explain the advantages, disadvantages, and uses of each.
04. What are multimedia projectors and how do they work?
05. What is a speech synthesizer? What are the different types of speech synthesizers and how do they work?

Fill in the Blanks

01. Any machine capable of representing information from a computer is __________.
02. CRT stands for __________.
03. Picture elements are known as __________.
04. Monitors can be classified based on their color capabilities as __________________.
05. A __________ is a special type of monochrome monitor capable of displaying different shades of gray.
06. The two types of LCD monitors are __________ and __________.
07. Color monitors are sometimes called __________ monitors.
08. An 8-bit monitor represents each pixel with __________ bits.
09. VGA stands for __________.
10. XGA stands for __________.
11. The different types of printers are ____________________.
12. An example of a non-impact printer is __________.
13. TTS stands for ____________.
14. ____________ systems synthesize speech by concatenating sentences from a database of prerecorded words.
15. TTS systems form sentences and/or phrases based on a language's ____________ and ____________.
16. A ____________ is a hardware device used for speech output.
17. iSpeak, Sayso, DECTalk, etc. are examples of ____________.
18. ____________ is an expansion board that enables a computer to manipulate and output sounds.
19. The two methods of translating digital data into analog sounds used by Sound cards are ____________ and ____________.
20. A ____________ is a display monitor that has no processing capabilities.

[Answers: (1) Output device (2) Cathode Ray Tube (3) Monochrome, grayscale and color (4) Pixels Grayscale (6) Active Matrix and Passive Matrix (7) RGB monitors (8) 8 (9) Video Graphics Array Extended Graphics Array (11) Dot matrix, Ink jet, Laser, Daisy wheel, Line, Thermal, LCD, LED (12) Ink jet Printer (13) Text-to-Speech (14) Voice response (15) Graphemes and Phonemes Hardware speech synthesizer (17) Software speech synthesizer (18) Sound card (19) FM Synth mimics and Wavetable Synthesis (20) Dumb terminal]

True or False

01. A gray-scale monitor is a special type of color monitor capable of displaying different shades gray.
02. All color computer monitors are RGB monitors.
03. CRT monitors have limited viewing angles.
04. Active matrix LCD displays are also called TFT displays.
05. The more bits per pixel, the more colors and shades of gray the monitor can display.
06. The resolution of a monitor indicates how densely packed the pixels are.
07. On color monitors, each pixel is composed of three dots—red, blue and green.
08. High-cost digital monitors are often called TTL monitors.
09. Bandwidth determines how many times per second the screen is to be refreshed.
10. Given two monitors that offer the same resolution, the interlacing one will be better.
11. VGA uses analog signals rather than digital signals.
12. Daisy-wheel printers can print graphics.
13. Dot-matrix printers are non-impact printers.
14. Ink jet and Laser printers are non-impact printers.
15. Plotters are more expensive than printers.
16. TTS systems were first developed to aid the visually impaired by offering a computer-gen spoken voice that would "read" text to the user.
17. A software speech synthesizer is also called external speech synthesizer.
18. Sound cards enable the computer to output sound through speakers connected to the board record sound input from a microphone is connected to the computer, and manipulate sound on a disk.
19. Wavetable synthesis produces more accurate sound, but is also more expensive.
20. A dumb terminal is simply an output device that accepts data from the CPU.
21. A smart terminal has some processing capabilities, but not as much as an intelligent terminal.

[Answers: (1) True (2) True (3) False (4) True (5) True (6) True (7) True (8) False (9) False (10) False True (12) False (13) False (14) True (15) True(16) True (17) False (18) True (19) True (20) True (21) True

CHAPTER 11

Introduction to Computer Software

TOPICS COVERED

- Introduction
- Computer software
- Hardware/software interaction
- Classification of software
- Operating systems
- Utilities
- Compilers and interpreters
- Word processors
- Spreadsheets
- Presentation software
- Image processors
- Database management systems

Key Points

▲ A computer needs both hardware and software for its proper functioning. Computer software is also called programs.

▲ A program is an organized list of instructions that, when executed, causes the computer to behave in a predetermined manner. Without programs, computers are useless.

▲ Programs are written in high-level languages, assembly languages or in machine code. Programs written in high-level and assembly languages should be translated to machine code before it can be executed. This is done using compilers, interpreters and assemblers.

▲ Software is often divided into two categories—system software and applications software.

▲ Systems software includes the operating system and all the utilities that enable the computer to function. This includes operating systems, compilers, and utilities for managing computer resources.

▲ Applications software includes programs that do real work for users. For example, word processors, spreadsheets, and database management systems fall under the category of applications software.

INTRODUCTION

A computer needs both hardware and software for its proper functioning. By software we mean computer instructions or data. Anything that can be stored electronically is software. The storage devices and display devices are hardware. Software and hardware are used as both nouns and adjectives. For example, you can say "The problem lies in the software," which means that there is a problem with the program or data, not with the computer itself. You can also say: "It's a software problem." The distinction between software and hardware is sometimes confusing because they are so integrally linked. Clearly, when you purchase a program, you are buying software. But to buy the software, you need to buy the floppy or CD-ROM (hardware) on which the software is recorded. In addition to software and hardware there is something called firmware, which is software (programs or data) that has been permanently written onto read-only memory (ROM). Firmware is a combination of software and hardware. ROMs and PROMs that have data or programs recorded on them are firmware.

COMPUTER SOFTWARE

Software is a set of instructions or statements that is carried out by the computer's CPU. Computer software is also called programs. A program is an organized list of instructions that, when executed, causes the computer to behave in a predetermined manner. Without programs, computers are useless.

A **program** is like a recipe. It contains a list of ingredients (called variables) and a list of directions (called statements) that tell the computer what to do with the variables. The variables can represent numeric data, text, or graphical images.

There are many programming languages—C, C++, Java, Pascal, BASIC, FORTRAN, COBOL, and LISP are just a few. These are all high-level languages. One can also write programs in low-level languages called assembly languages, although this is more difficult. Low-level languages are closer to the language used by a computer, while high-level languages are closer to human languages.

Eventually, every program must be translated into a machine language that the computer can understand. This translation is performed by compilers, interpreters, and assemblers. When you buy software, you normally buy an executable version of a program. This means that the program is already in machine language—it has already been compiled and assembled and is ready to execute.

HARDWARE/SOFTWARE INTERACTION

By telling the CPU what to do, programs operate at the hardware level. In other words the program tells the CPU to retrieve a specific piece of information from memory and to execute a specific interrupt. An **interrupt** is a signal informing a program that an event has occurred. When a program receives an interrupt signal, it takes a specified action (which can be to ignore the signal). Interrupt signals can cause a program to suspend itself temporarily to service the interrupt.

Interrupt signals can come from a variety of sources. For example, every keystroke generates an interrupt signal. Interrupts can also be generated by other devices, such as a printer, to indicate that some event has occurred. These are called hardware interrupts. Interrupt signals initiated by programs are called software interrupts. A software interrupt is also called a trap or an exception. PCs support 256 types of software interrupts and 15 hardware interrupts. Each type of software interrupt is associated with an interrupt handler—a routine that takes control when the interrupt occurs. For example, when you press a key on your keyboard, this triggers a specific interrupt handler. The complete list of interrupts and associated interrupt handlers is stored in a table called the interrupt vector table, which resides in the first 1 KB of addressable memory.

An interrupt is a preprogrammed set of steps that the CPU follows, such as adding two numbers. The results are returned to the computer's memory and the program tells the CPU what to do next. We have seen how the CPU, memory and programs interact to execute a task in Chapter 7. Now we will see how the computer executes the program that is written in a high-level language. The following steps happen in sequence:

- Once a programmer has decided how to solve a problem, they need to write the solution in a valid programming language (e.g. COBOL).
- Source code is the program created in a "human-readable" format, e.g. when we write code using COBOL.
- This "human-readable" format cannot be directly run by the computer, so when you go to run the program a compiler must first be used to translate the source code into executable code.
- The compiler translates the source code into another format, one which the computer can read or execute.
- Source code is generally portable (can be used on different machines) whereas executables rely on machine-specific information.
- Executable programs (as well as source code) are stored on secondary storage (usually disk drives).

- To execute a program it must be copied into main memory, and space set aside for variables, subroutine calls, etc.
- Every individual instruction, and every piece of data, exists at some unique location (or address) in memory.
- To execute a program, the computer keeps track of the memory address of the next instruction it must execute.
- Execution then consists of repeatedly **fetching** the next instruction to be executed, **decoding** the instruction (deciding what must be done), and **executing** the instruction (and deciding which instruction must be executed next). This is known as the **fetch-decode-execute** cycle.

Fetch-Decode-Execute Cycle

This cycle of events is being constantly repeated while the computer is turned on.

- When a program is running, a copy of it is stored in the memory.
- The CPU uses a register to keep track of which program instruction is going to be executed next.
- Using the communications bus and the value in the program counter, the CPU asks memory to look up (fetch) the next instruction.
- Long instructions may take several fetch stages.
- The instruction is stored somewhere within the CPU (possibly in an **instruction register**) and the program counter is adjusted to 'point at' the next instruction.
- The CPU decodes the instruction, to determine what action needs to take place.
- Finally, the CPU carries out, or executes the instruction.
- The cycle is now complete, and can start again for the next instruction.

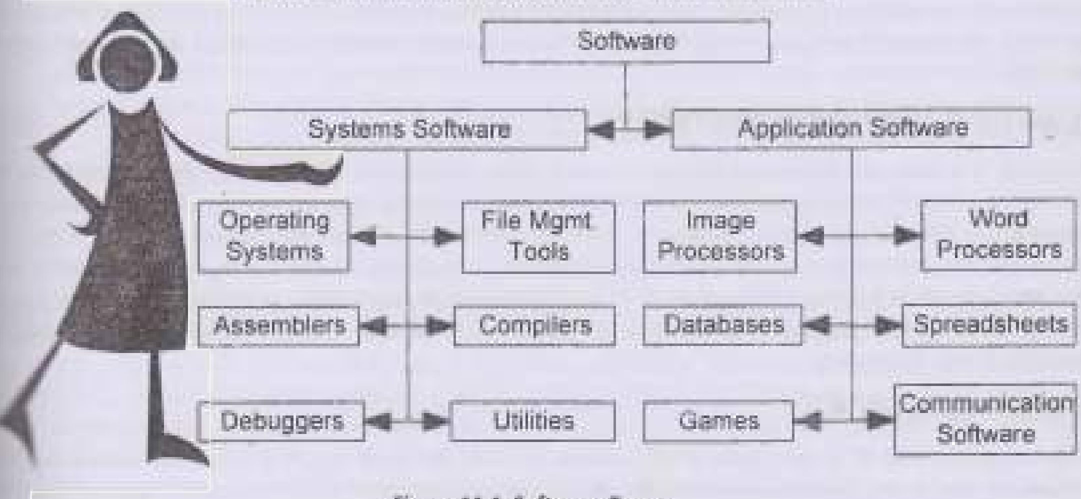


Figure 11.1 Software Types

CLASSIFICATION OF SOFTWARE

Software is often divided into two categories.

- **Systems software** – Includes the operating system and all the utilities that enable the computer to function.

- **Applications software** – Includes programs that do real work for users. For example, w processors, spreadsheets, and database management systems fall under the category applications software.

Systems software consists of low-level programs that interact with the computer at a very l level. This includes operating systems, compilers, and utilities for managing computer resources contrast, applications software (also called end-user programs) includes database programs, w processors, and spreadsheets. Figuratively speaking, applications software is placed on top of sys software because it is unable to run without the operating system and system utilities. Figure gives an overview of the software classification and the different software types. Now we will ha overview of these different classes of software – primarily operating systems, compilers, utilities, w processors, spreadsheets, database management systems, etc.

OPERATING SYSTEMS

Operating systems are the most important programs that run on a computer. Every general-pur computer must have an operating system to run other programs. Operating systems perform b tasks, such as recognizing input from the keyboard, sending output to the display screen, kee track of files and directories on the disk, and controlling peripheral devices such as disk drives printers. Most commonly used operating systems include Microsoft Windows, DOS, Linux, Mac OS/2, UNIX, MVS, etc. We will see more about operating systems in Chapter 14.

UTILITIES

Utility is a program that performs a very specific task, usually related to managing system reso Operating systems contain a number of utilities for managing disk drives, printers, and other de Utilities differ from applications mostly in terms of size and complexity. For example, w processors, spreadsheet programs, and database applications are considered applications because are large programs that perform a variety of functions not directly related to managing com resources.

COMPILERS AND INTERPRETERS

Compiler is a program that translates source code into object code. The compiler derives its name the way it works, looking at the entire piece of source code and collecting and reorganizing instructions. Thus, a compiler differs from an interpreter, which analyzes and executes each line source code in succession, without looking at the entire program. The advantage of interpreters they can execute a program immediately. Compilers require some time before an executable pr emerges. However, programs produced by compilers run much faster than the same pro executed by an interpreter.

WORD PROCESSORS

A word processor is a program that enables you to perform word processing functions. processors use a computer to create, edit, and print documents. Of all computer applications, processors are the most common. To perform word processing, you need a computer, the processing software and a printer. A word processor enables you to create a document, electronically on a disk, display it on a screen, modify it by entering commands and characters the keyboard, and print it on a printer.

Basic Capabilities of Word Processors

The greatest advantage of word processing over using a typewriter is that you can make changes without retyping the entire document. If you make a typing mistake, you simply take back the cursor and correct your mistake. If you want to delete a paragraph, you simply remove it, without leaving a trace. It is equally easy to insert a word, sentence, or paragraph in the middle of a document. Word processors also make it easy to move sections of text from one place to another within a document, or between documents. When you have made all the changes you want, you can send the file to a printer to get a hardcopy. Word processors vary considerably, but all word processors support the following basic features:

- **Insert text** — You can make use of this feature to insert text anywhere in the document.
- **Delete text** — By using this feature you can erase characters, words, lines, or pages as easily as you can cross them out on paper.
- **Cut and Paste** — Cut and paste allows you to remove (cut) a section of text from one place in a document and insert (paste) it somewhere else. To cut means to remove an object from a document and place it in a buffer. You can copy the buffer somewhere else in the document or in another document, which is called pasting. To move a section of text from one place to another, therefore, you need to first cut and then paste it. This is often called cut-and-paste.
- **Copy** — This facility allows you to duplicate a section of text. Copying refers to duplicating a section of a document and placing it in a buffer (sometimes called a clipboard). The term copy differs from cut, which refers to actually removing a section of a document and placing it in a buffer. After cutting or copying, you can move the contents of the buffer by pasting it elsewhere.
- **Page Size and Margins** — Allows you to define various page sizes and margins, and the word processor will automatically readjust the text so that it fits.
- **Search and Replace** — This is a feature supported by most word processors, which lets you replace a character string (a series of characters) with another string wherever the first string appears in the document. Most word processors have two search and replace modes. In the first mode, the word processor automatically makes all the replacements in the file. In the second mode, the word processor requires you to approve each replacement. This is safer because you may not want to make the change everywhere. Search and replace is sometimes called find and replace.
- **Word Wrap** — In word processing, word wrap is the feature that causes the word processor to force all text to fit within the defined margins. When you fill one line with text, the word processor automatically jumps to the next line so that you are not required to keep track of line lengths and to press the Return key after each line. The word processor divides lines in such a way that a word is never split between two lines (unless the word processor supports hyphenation). Word wrap also occurs if you change the margins. In this case, the word processor readjusts all the text so that it fits within the new margins. Some word processors allow you to turn off the word-wrap feature. This is useful for writing programs and other types of formatted text where you want complete control over new lines.
- **Print** — This feature allows you to send a document to a printer to get a hardcopy.

Advanced Features of Word Processors

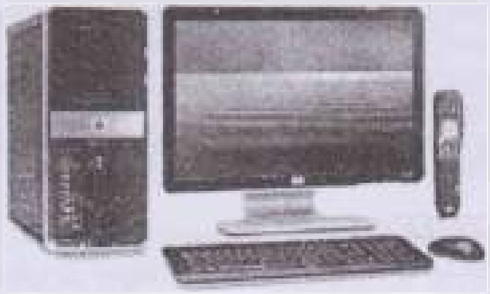
Word processors that support only these features (and maybe a few others) are called text editors. Most word processors, however, support additional features that enable you to manipulate and format documents in more sophisticated ways. These more advanced word processors are sometimes called full-featured word processors. Full-featured word processors usually support the following features

- ▲ **File Management** – Many word processors contain file management capabilities that allow you to create, delete, move, and search for files.
- ▲ **Font Specifications** – This feature allows you to change fonts within a document. For example, you can specify bold, italics, and underlining. Most word processors also let you change the font size and even the typeface.
- ▲ **Graphics** – One of the most important features of a word processor is the capability to embed illustrations and graphs into a document. Some word processors let you create the illustrations within the word processor; others let you insert an illustration produced by a different program.
- ▲ **Footnotes and Cross-References** – Word processors automate the numbering and placement of footnotes and enable you to easily cross-reference other sections of the document.
- ▲ **Headers and Footers** – Header is a line or lines of text that appears at the top of each page of a document. Once you specify the text that should appear in the header, the word processor automatically inserts it. Most word processors allow you to use special symbols in the header that represent changing values. For example, you can enter a symbol for the page number and the word processor will automatically replace the symbol with the correct number on each page. If you enter the date symbol, the word processor will insert the current date, which will change if necessary each time you print the document. Most word processors allow you to specify different headers, for example, one for odd-numbered pages (odd headers) and another for even-numbered pages (even headers). Footers are one or more lines of text that appear at the bottom of every page of a document. All features available for headers are available for footers also.
- ▲ **Page Numbering** – The word processor automatically keeps track of page numbers so that the correct number appears on each page.
- ▲ **Layout** – By using the layout feature one can specify different margins within a single document and to specify various methods for indenting paragraphs.
- ▲ **Macros** – A macro is a character or word that represents a series of keystrokes. The keystrokes can represent text or commands. The ability to define macros allows you to save yourself a lot of time by replacing common combinations of keystrokes.
- ▲ **Merges** – Merge feature allows you to merge text from one file into another. This is particularly useful for generating many files that have the same format but different data. Generating mailing labels is the classic example of using merges.
- ▲ **Spell Checker** – This is a utility that allows you to check the spelling of words. It will highlight any word that it does not recognize.
- ▲ **Tables of Contents and Indices** – This feature allows you to automatically create a table of contents and index based on special codes that you insert in the document.
- ▲ **Thesaurus** – Most word processors have a built-in thesaurus that allows you to search for synonyms without leaving the word processor.
- ▲ **Windows** – The Windows feature allows you to edit two or more documents at the same time. Each document appears in a separate window. This is particularly valuable when working on a large project that consists of several different files.

* **WYSIWYG** – WISIWYG is the abbreviation for 'what you see is what you get'. With WYSIWYG, a document appears on the display screen exactly as it will look when printed.

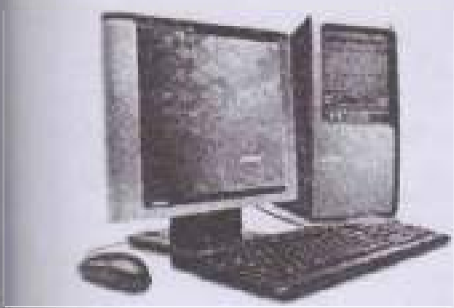
Classification of Digital Computers

MICROCOMPUTERS



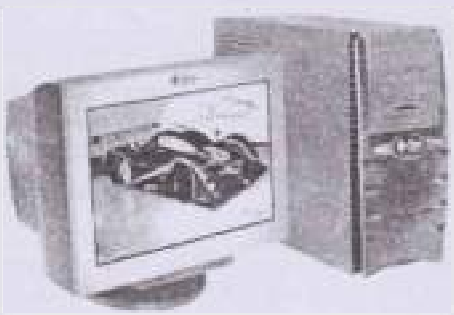
Microcomputers are small, single user systems that provide a simple processor and just a few input/output devices. The microcomputer is also known as the "Personal Computer". The name "Personal Computer" is largely related to IBM, which introduced and marketed the first widely available, commercialized microcomputer named the "IBM PC" where PC stood for Personal Computer. As the most dominant microcomputer in the introduction of microcomputers the IBM PC became the standard against which all microcomputers were compared and the branding that IBM created, the "PC" helped provide a name for the industry it grew.

PERSONAL COMPUTERS (PCS)



Until recently, PCs were desktop or portable machines. These machines ran comparatively easy-to-use applications software such as the word processors, spreadsheets, etc. They were usually easier to use and more affordable than workstations. However, they had less sophisticated video display screens, operating systems, and networking capabilities. Most important, they did not have the processing power that workstations did. Examples of personal computers are Dell Vostro, Compaq Presario, etc.

WORKSTATIONS



Workstations are, again, until recently, expensive, powerful machines used by engineers, scientists, and other professionals who processed a lot of data. People who need to run complex programs and display both work in progress and results graphically also use workstations. Workstations use sophisticated display screens featuring high-resolution color graphics and operating systems such as UNIX that permitted multitasking. Workstations also use powerful networking links to other computers. The most significant distinguishing factor, however, is the powerful processor, which could churn out results much faster than the PCs. The more powerful workstations are called super-micros. Examples of well-known workstations are those made by Sun, Apollo, Hewlett-Packard, Intel and IBM.

Figure 11.2 Sample Document Created Using a Word Processor

- **Mail Merging** – This is a feature supported by many word processors that enables you to [cut] mass mailings or mailing campaigns. To use a mail-merge system, you first store a set [cut] information, like a list of names and addresses, in one file. In another file, you write a letter substituting special symbols in place of names and addresses (or whatever other information will come from the first file). When you execute the merge command, the word processor automatically generates letters by replacing symbols in the second file with the appropriate data from the first file. The power and flexibility of mail merge systems varies considerably from one word processor to another. Some word processors support a full set of logical operators that enable you to specify certain conditions under which information should [cut] merged. Also, some merge systems allow you to merge data from several files at once. [cut] merge is sometimes called print merge.

The line dividing word processors from desktop publishing systems is constantly shifting. [cut] example Word 2000 now has most of the capabilities of a desktop publishing application. Some of [cut] popular word processors are Microsoft Word, OpenOffice Writer, Corel WordPerfect, Lotus Word [cut] etc.

SPREADSHEETS

A spreadsheet is a table of values arranged in rows and columns. Each value can have a predefined relationship to the other values. If you change one value, the related values will change as [cut] Spreadsheet applications (often referred to simply as spreadsheets) are computer programs that [cut] you create and manipulate spreadsheets electronically.

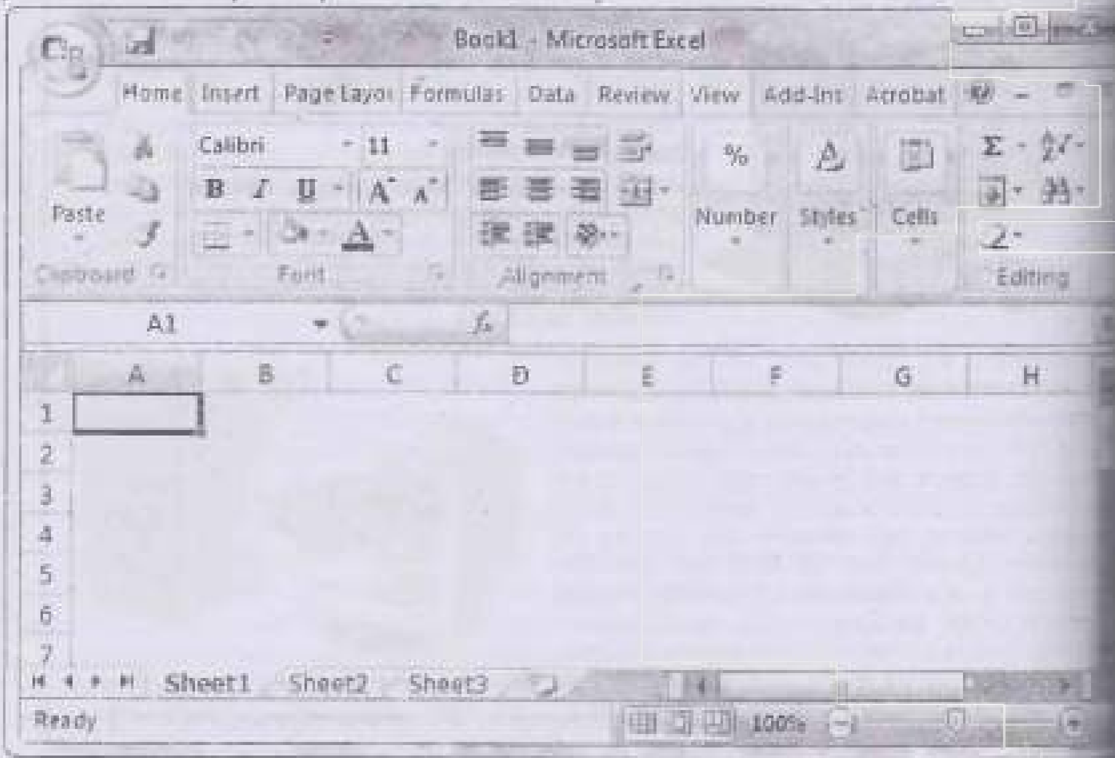


Figure 11.3 Blank Sheet of an Electronic Spreadsheet (Excel 2007)

In a spreadsheet application, each value is placed in a cell. You can define what type of data is in each cell and how different cells depend on one another. The relationships between cells are called formulas, and the names of the cells are called labels. Once you have defined the cells and the formulas for linking them together, you can enter your data. You can then modify selected values to see how all the other values change accordingly. Spreadsheets are used for performing all kind of tasks from a simple wage calculation to a complicated 'what-if' analysis for management decision-making. The power of spreadsheets is quite amazing and the variety of task that one can accomplish with it runs into hundreds. An electronic spreadsheet, or spreadsheet for short, is a table with rows and columns into which data is entered. Spreadsheet software makes it possible to enter data into a table format, manipulate them, store them, print them and create reports and graphs using them. All this can be done with relative ease compared to working by hand with the same rows and columns of data. As evident from the Figure 11.3, a spreadsheet is very much similar to a table. A table is made of rows and columns. In a spreadsheet the rows are labeled with numbers and columns with alphabets. The intersection of a row and a column is called a cell. The intersection of row 3 with column C is cell C3. This naming convention is followed in all spreadsheets. For example, the first cell, the cell obtained from the intersection of row 1 with column A is called A1.

	A	B	C	D	E	F	G	H
1				Salary Details				
2								
3	Name	Basic	HRA	TA	Deductions	Gross Pay	Tax (%)	Net Pay
4								
5	Alexis	3000	300	150	120	3330	10	2997.00
6	Mathews	5000	500	250	450	5300	15	4505.00
7	Ashwin	2000	200	100	100	2200	5	2090.00
8	Sumi	4500	450	225	425	4750	15	4037.50
9	Irene	1400	140	70	40	1570	5	1491.50
10								
11	Total	15900	1590	795	1135	17150		15121
12								

Figure11.4 Spreadsheet Showing the Salary Details

Whenever a problem or situation can be organized into rows and columns, a spreadsheet can be used. Consider the following example, which shows the salaries of employees of a company. The spreadsheet for that is shown in figure 11.4. The spreadsheet table can be explained as follows:

- The first row gives the title for the table—'Salary Details.'
- The second row is left blank for readability.
- The third row gives the labels that identify the contents of the columns, below them. For example, cell A3 has the label 'Name', B3 has the label 'Basic', H3 has the label 'Net Pay', etc.
- The fourth row is left blank to increase readability.
- The cells A5, A6, A7, A8 and A9 contain the employee names.
- Cells B5 to B9 give the basic pay, C5 to C9, the HRA, etc.
- The tenth row is left blank for readability and the eleventh row gives the column totals.

Here, the net pay is calculated as follows: Each employee, depending upon his designation and experience, will have a basic pay. HRA is 10% of the basic pay and TA is 5% of the basic pay. Depending on the loans taken from the company, there will be some amount, which will be deducted from the salary. The deduction amount will vary for each employee. The gross pay is calculated using the formula: basic pay+HRA+TA–deductions. The tax rate for each employee varies depending on the basic pay. The tax payable is calculated my multiplying the tax rate and the gross pay. Gross pay minus tax will get the net pay. With this example, we will describe the characteristics of spreadsheet software.

Characteristics of a Spreadsheet

Although spreadsheet software organizes data into rows and columns, it has many other characteristics, which makes it one of the most popular applications packages. A user must understand these characteristics so that he can develop applications using it and use it as a problem-solving and decision-making tool. These characteristics include:

- Table format
- Recalculations
- Data forms
- Presentation
- Storage and retrieval
- Standard format

B5*.1   B5+C5+D5-E5   F5-(F5*G5/100)

Name	Basic	HRA	TA	Deductions	Gross Pay	Tax (%)	Net Pay
Alexis	3000	300	150	120	3330	10	2997.00
Mathews	5000	500	250	450	5300	15	4505.00
Ashwin	2000	200	100	100	2200	5	2090.00
Sumi	4500	450	225	425	4750	15	4037.50
Irene	1400	140	70	40	1570	5	1491.50
Total	15900	1590	795	1135	17150		15121.00

B5+B6+B7+B8+B9   H5+H6+H7+H8+H9

Figure 11.5 Usage of formulas in spreadsheets

Table Format

We have seen that the spreadsheet resembles a table with rows and columns and is made of cells. We have also seen that the location or address of a cell can be identified by the column and row that intersect to form the cell.

Recalculations

Once the tables, numbers, and formulas have been entered, the spreadsheet software can automatically complete the calculated results. And results can be recalculated when revised numbers are entered.

	A	B	C	D	E	F	G	H
1				Salary Details				
2								
3	Name	Basic	HRA	TA	Deductions	Gross Pay	Tax (%)	Net Pay
4								
5	Alexis	3000	300	150	120	3330	10	2997.00
6	Mathews	5000	500	250	450	5300	15	4505.00
7	Ashwin	3500	350	175	100	3925	5	3728.75
8	Sumi	4500	450	225	425	4750	15	4037.50
9	Irene	1400	140	70	40	1570	5	1491.50
10								
11	Total	17400	1740	870	1135	18875		16759.75

Figure 11.6 Automatic Recalculation of Computed Entries

For instance, in our salary example, if the basic pay of one employee say Ashwin, is increased from 2000 to 3500, all you have to do is to change the value in the cell B7. The value in other cells (the computed entries) like C7, D7, F7, H7, B11, C11, D11, F11 and H11 will be automatically recalculated by the software and displayed. This is shown in the Figure 11.6.

Data Forms

Three different kinds of data can be entered into a spreadsheet. They are:

- **Labels or titles** — A label is a description. In the salary example (Figure 11.5), Name, Basic, HRA, TA, Net Pay, etc. are labels as are the names of the employees.
- **Numbers** — Numbers that the user enters directly into a cell are the second kind of data in a spreadsheet. For example, the entry in the cells B5 to B9 (Basic pay) or those in the cells E5 to E9 (Deductions) are data, which come under this category.
- **Calculated entries** — Calculated entries are figures that are derived or calculated from or using the existing entries (numbers or other calculated entries). Calculated entries are computed using a formula, an instruction that specifies the steps to obtain the desired mathematical result. The user enters the formula in the cell and the software calculates the value using the formula and puts it in the cell.

For example, as mentioned before, the HRA is 10% of the basic pay. So the entry in cell C5 (HRA for employee Alexis) is a calculated entry. The user enters the formula 'B5*0.1' (which says to multiply

the contents of the cell B5 with 0.1) in the cell C5. The spreadsheet software calculates the value an
puts it in the cell.

Another example of a calculated entry is the computation of gross pay. So the formula in the ce
F5 will be 'B5+C5+D5-E5'. This will instruct the computer to add the basic pay, HRA and TA (conten
of the cell B5, C5 and D5) and subtract the deductions (which is the cell E5) and put it in F5. It
important to realize that although the formula is entered in the cell, when the spreadsheet is desig
only the result of the formula is displayed when the cell is used. Figure 11.5 shows the formulas
in the salary example. Note that even though the formula 'B5+B6+B7+B8+B9' is entered in the cell
the cell only shows the computed value of the calculated entry, which is 15,900.

Presentation

Most spreadsheet users need to present the results of their analysis in a way that communicates th
information as effectively as possible. Sometimes a simple printout of all or a section of th
spreadsheet will suffice. In these cases, the spreadsheet's row-and-column format is consid
satisfactory. But more and more spreadsheet users are utilizing the graphic capabilities of
spreadsheets for information dissemination. Most of the commercial spreadsheet packages ha
capabilities that make it easy to create graphs and charts. For example, Figure 11.7 shows the Sa
Distribution pie graph of the net pay created in Excel 2007.

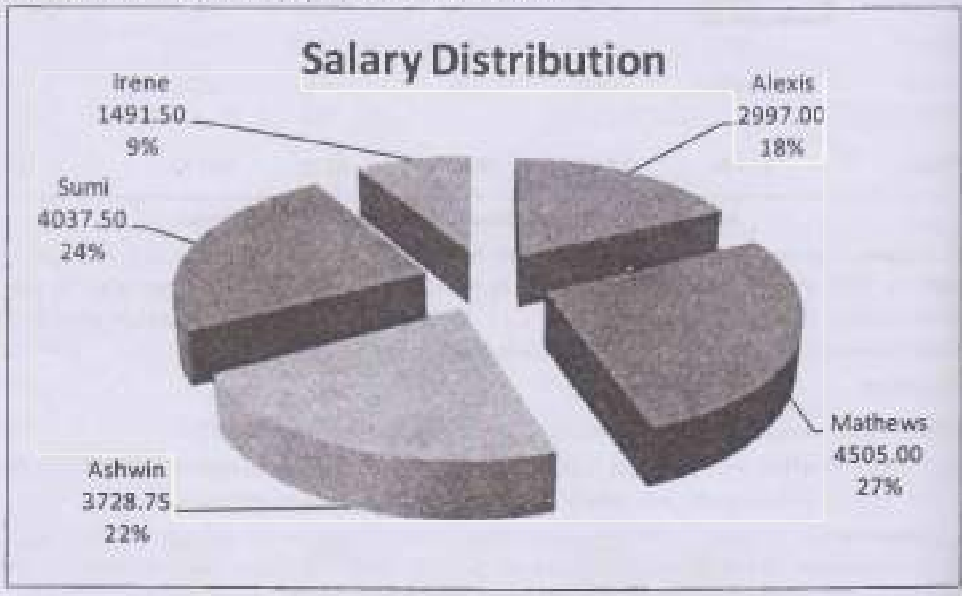


Figure 11.7 Use Of Graphs and Charts for better Presentation

Storage and Retrieval

The ability to store and retrieve data is central to any business information system. Consequen
important feature of spreadsheet software is its ability to store and retrieve the data with wh
works. In the salary application, for example, the spreadsheet may be stored on a hard or flopp
and retrieved several times. Each time, one or more of the values may be changed.

Standard Formats

Another important feature of the spreadsheet software is that it can be used as a standard form
which data can be downloaded from other computers and data sources. In this process, data

database can be downloaded into the spreadsheet and can then be manipulated, analyzed and used for decision-making, problem-solving and presentation purposes.

Spreadsheet Packages

VisiCalc was the first spreadsheet application, which was introduced, in the late 1970s. Bricklin, Frankston, and Fylstra developed VisiCalc for Apple computers. Frankston and Fylstra needed a computer tool to complete repetitive calculations associated with case studies at the Harvard Business School. Dan Bricklin did the programming. After gaining popularity as an Apple application, the product was sold to Lotus Development Corporation, and led to the development of the Lotus 1-2-3 spreadsheet for the PC in 1983. Lotus 1-2-3 was the first publicly available program to combine graphics, spreadsheet functions and data management (three functions, hence the name). Its relative ease of use and flexibility made it an enormous success and contributed to the acceptance of personal computers in business. Now, there are a number of spreadsheet applications in the market, IBM Lotus 1-2-3, Microsoft Excel, Corel Quattro Pro, OpenOffice Calc, etc. being the most popular. These applications support graphic features that enable you to produce charts and graphs from the data. Some spreadsheets are multidimensional, meaning that you can link one spreadsheet to another. A three-dimensional spreadsheet, for example, is like a stack of spreadsheets all connected by formulae.

PRESENTATION SOFTWARE

In today's extremely competitive business environment, the expectations that companies have of the professional skills of their employees continue to grow. Making a presentation to clients, colleagues, superiors, or your subordinates requires presentation skills, confidence, communication skills and knowledge of presentation software. The era of giving presentations using whiteboard and marker pens or overhead projectors and transparencies are over. Today a number of software packages are available to the users to conceive, create and deliver visually stunning and dazzling presentations. These applications vary in the level of technical skills required to create a presentation, the sophistication of the presentation, the infrastructure required to run them, the features that can be incorporated into the presentation, etc. There are many presentation packages from high-end solutions like Adobe Director, Adobe Flash to popular solutions like Microsoft PowerPoint, Lotus Freelance Graphics, etc. The time and effort required and the skill necessary to create a presentation in the high-end solutions like Director are quite high. But with the software packages like PowerPoint, one can create effective and attractive presentations without spending too much time and without the need of much training.

Advantages and Drawbacks

There are many advantages of using computer presentation packages. Some of them are given below:

* They result in professional-looking visuals.
* They can be used to incorporate multi-media and hyperlinks.
* They can create stand-alone informational and instructional units.
* They are quick to use.
* The developers need not know complex programming languages or coding.

The drawbacks in using the presentation graphic packages are the following:

* They seem to discourage spontaneity and flexibility because after the presentation is composed, the presenter is usually locked into its flow.
* The files created are generally not as widely readable as Web pages.

- They promote dull lecturing (chalk-and-talk) at people, and it takes special attention to [illegible] them with a learner-centered approach.
- They require that certain hardware and software are present and functioning.
- They tend to become the center of concentration for the audience, rather than paying at[illegible] to the speaker.
- The speaker tends to remain stationary (without a mobile mouse), tied to the computer.

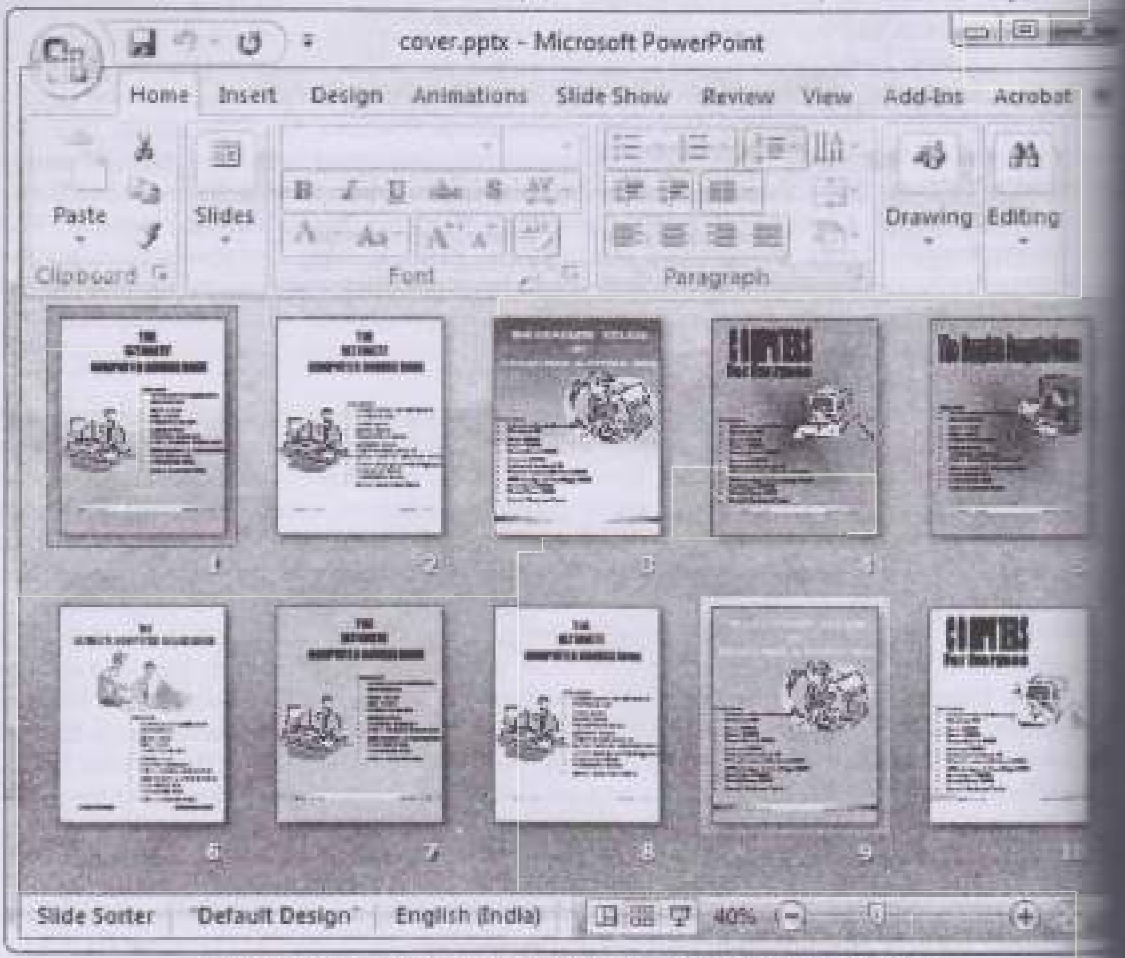


Figure 11.8 Presentation Graphics Software—Microsoft PowerPoint 2007

We have seen the advantages and drawbacks of presentation graphics. We have also [illegible] there are sophisticated as well as simple presentation tools. The presentation packages can [illegible] your message across. But, they can also confuse, bore, distract, overload and rob you of your [illegible] So choose the presentation package with care. Use them with care, not from habit or [illegible] everybody else is using them. Choose a presentation package that you are comfortable [illegible] something that you can use naturally without giving much attention to it. The presentation [illegible] should integrate with your presentation style, move your presentation, have a pro[illegible] appearance, be appropriate for the situation, help you in better communicating with the audience, and be technically sound.

Some other aspects of the presentation aids are that they should be easily available, easy to use and prepare. You should be able to create, practice and make the presentation without worrying too much about the presentation aid. Packages like PowerPoint, Freelance Graphics, Impress, etc. are ideal presentation aids—they are easy to learn, use and are popular (so availability and compatibility problems will not arise). These presentation software packages enable users to create highly stylized images for slide shows and reports. They are sophisticated enough to create high-impact presentations and have a very professional appearance. They include functions for creating various types of charts and graphs and for inserting text in a variety of fonts.

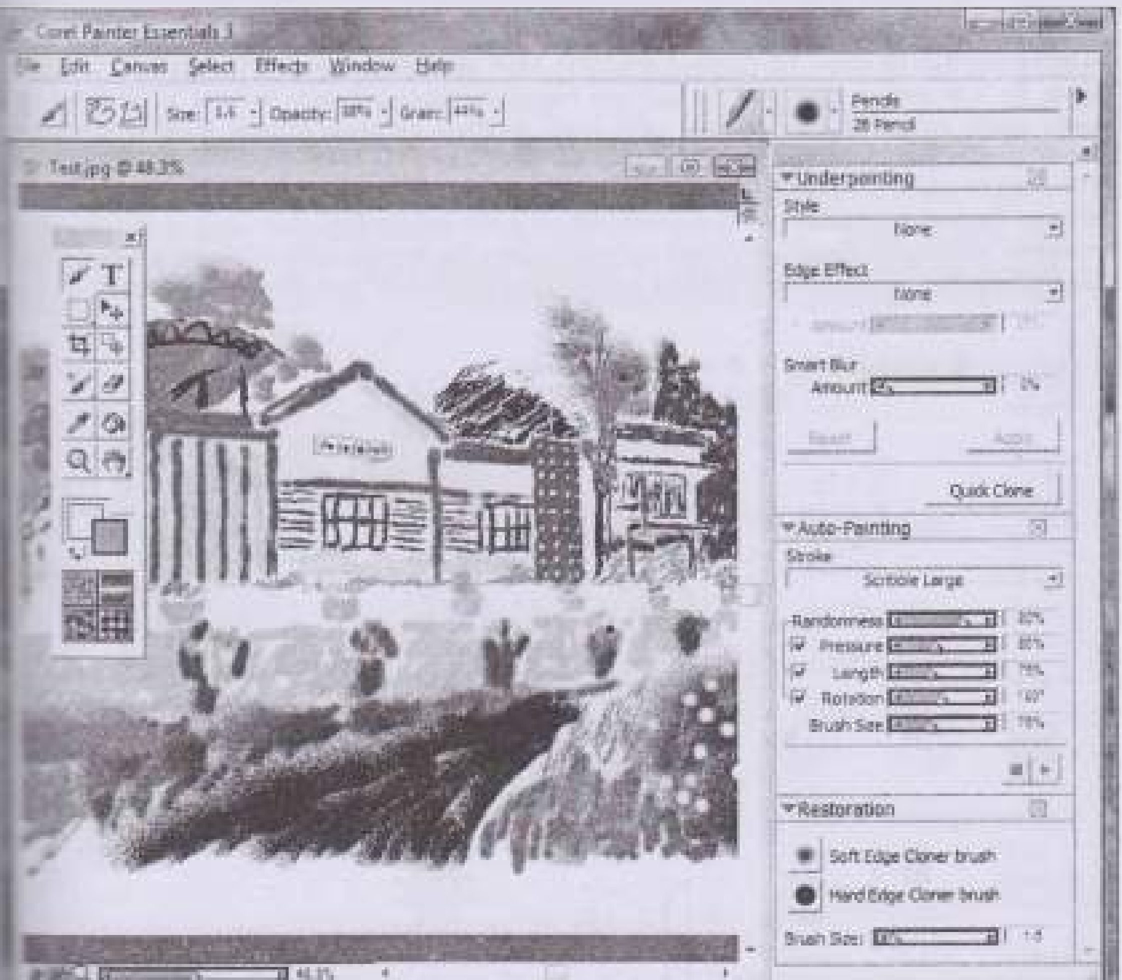


Figure 11.9 Paint Program —Corel Painter Essentials

Most systems enable you to import data from a spreadsheet application to create the charts and graphs. Also they have enough ammunition and firepower—features—to create very effective and visually stunning presentations without spending too much time. You do not need to be a tech wizard to create a good presentation with these packages. Once you have learned the basics, all need is the knowledge of the topic and a little aesthetic sense. Some of the popular present graphics software are Microsoft PowerPoint, IBM Lotus Freelance Graphics, OpenOffice Im Corel Presentations, etc.

IMAGE PROCESSORS

Image processors or graphics programs enable you to create, edit, manipulate, add special eff view, print, and save images.

Paint Programs

A paint program is a graphics program that enables you to draw pictures on the display screen, w is represented as bit maps (bit-mapped graphics). Most paint programs provide the tools in the fo icons. By selecting an icon, you can perform functions associated with the tool. In addition to tools, paint programs also provide easy ways to draw common shapes such as straight rectangles, circles, and ovals. Sophisticated paint applications are often called image-editing prog These applications support many of the features of draw programs, such as the ability to work objects. Each object, however, is represented as a bit map rather than as a vector image. S examples of paint programs are Windows Paint, Corel Painter, Ambient Design's ArtRage, Aut Sketchbook Pro, etc. Figure 11.9 shows a simple paint program—Corel Painter Essentials.

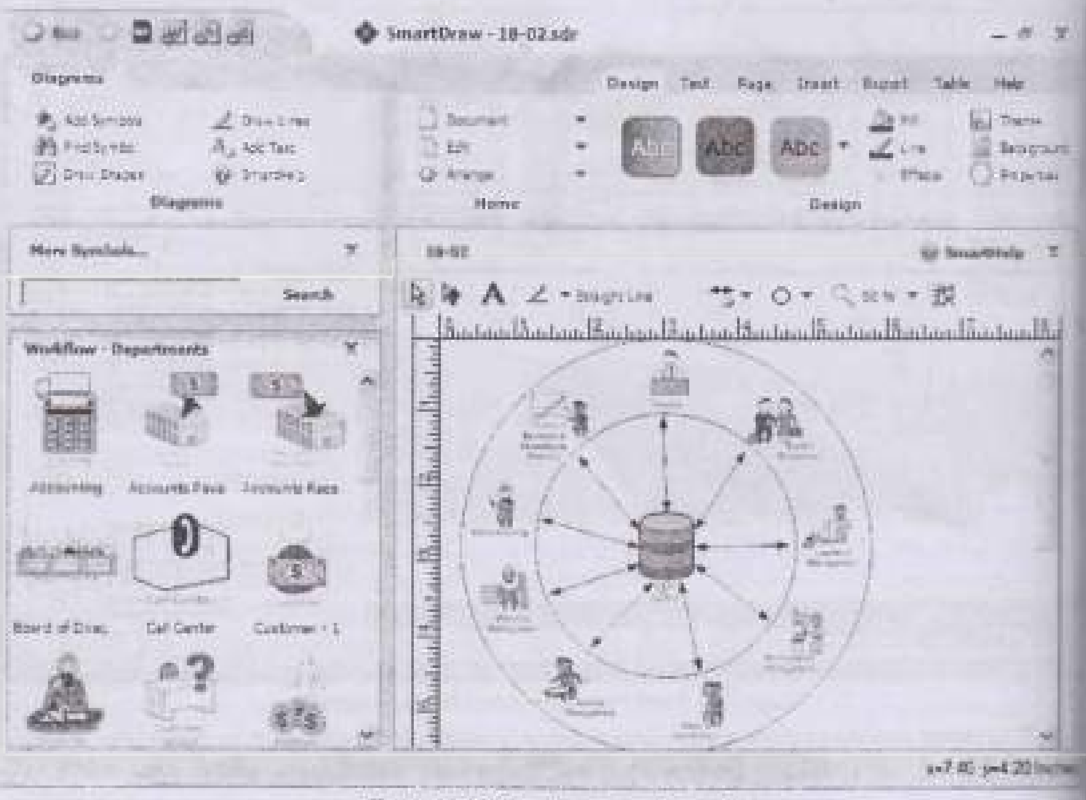


Figure 11.10 Draw Program—SmartDraw

Draw Programs

A draw program is another graphics program that enables you to draw pictures, then store the images in files, merge them into documents, and print them. Unlike paint programs, which represent images as bit maps, draw programs use vector graphics, which makes it easy to scale images to different sizes. In addition, graphics produced with a draw program have no inherent resolution. Rather, they can be represented at any resolution, which makes them ideal for high-resolution output. Some examples of draw programs are Adobe Illustrator, CorelDRAW, SmartDraw (see Figure 11.10), ConceptDraw, etc.

Image Editors

An image editor is a graphics program that provides a variety of special features for altering bit-mapped images. The difference between image editors and paint programs is not always clear-cut, but in general image editors are specialized for modifying bit-mapped images, such as scanned photographs, whereas paint programs are specialized for creating images. In addition to offering a host of filters and image transformation algorithms, image editors also enable you to create and superimpose layers. Some examples of image editors are Adobe PhotoShop, Corel Paint Shop Pro, etc.

Figure 11.11 An Entry-level Editing Program—Photoshop Elements

DATABASE MANAGEMENT SYSTEMS (DBMS)

A DBMS is a collection of programs that enable you to store, modify, and extract information from a database. There are many different types of DBMS, ranging from small systems that run on personal computers to huge systems that run on mainframes. The following are some examples of database applications—computerized library systems, automated teller machines, flight and railway reservation systems, computerized inventory systems, etc.

From a technical standpoint, DBMS can differ widely. The terms relational, network, flat, and hierarchical all refer to the way a DBMS organizes information internally. The internal organization can affect how quickly and flexibly you can extract information. Requests for information from a database are made in the form of a query, which is a stylized question. Different DBMS support different query languages, although there is a semi-standardized query language called Structured Query Language (SQL). Sophisticated languages for managing database systems are called fourth generation languages, or 4GLs for short. The information from a database can be presented in a variety of formats. Most DBMS include a report writer program that enables you to output data in the form of a report. Many DBMS also include a graphics component that enables you to output information in the form of graphs and charts. Some examples of database management systems are IDMS, IMS, DB2, Oracle, Sybase, Informix, Ingress, MS-SQL Server, MS-Access, etc. We will see more about database management systems in Chapter 20.

REVIEW QUESTIONS

Short Answer Questions

01. Give the names of few high-level programming languages.
02. Give the names of few operating systems.
03. Give the names of some popular word processors.
04. Give the names of few spreadsheets.
05. What are the three different kinds of data that can be entered into a spreadsheet?
06. Give the names of few presentation graphics.
07. Give the names of some paint, draw, and image editing programs.
08. Give the names of few database management systems.

Descriptive Type Questions

01. Why does a computer need both hardware and software?
02. What is computer software?
03. What do you mean by firmware?
04. What is a program?
05. What is an interrupt? What is its purpose?
06. What are the different types of software?
07. What is systems software?
08. What do mean by applications software?
09. What is a word processor?
10. What do you mean by 'Cut and Paste' and 'Copy and Paste'?
11. What is mail merging and word wrapping?
12. What is a spreadsheet?
13. What do you mean by table format in a spreadsheet? Explain.
14. What is the use of automatic recalculations in spreadsheets? Explain with examples.

- What are data forms of an electronic spreadsheet? Explain with examples.
- What is presentation software?
- What are the advantages and limitations of presentation software packages?
- What are image processors?
- How are image processing software classified?
- What is a database management system?

Essay Questions

- Explain the concept of computer software.
- Explain the concept of interrupts.
- Explain how the computer executes a program that is written in a high-level language.
- What id fetch-decode-execute cycle? Explain.
- What is a word processor? Explain the features and capabilities of a word processor.
- What is an electronic spreadsheet? Explain the features, characteristics, and capabilities of a spreadsheet.
- What is a presentation software program? Explain the features, characteristics, and capabilities of a presentation software package.

Fill in the Blanks

- A ________ is an organized list of instructions that when executed, causes the computer to behave in a predetermined manner.
- ________ is programs or data that has been permanently written onto read-only memory (ROM).
- ROMs and PROMs that have data or programs recorded on them are ________.
- ________ is a preprogrammed set of steps that the CPU follows.
- ________ transforms the high-level languages into machine code.
- ________ transforms the assembly language into machine code.
- ________ includes the operating system and all the utilities that enable the computer to function.
- ________ are programs that do real work for users.
- Applications software also called ________.
- Microsoft Windows, DOS, Linux, Mac OS, OS/2, UNIX, MVS, etc. are examples of ________.
- ________ is a program that performs a very specific task, usually related to managing system resources.
- ________ is a program that translates source code into object code.
- ________ analyzes and executes each line of source code in succession, without looking at the entire program.
- ________ uses a computer to create, edit, and print documents.
- ________ is the feature that causes the word processor to force all text to fit within the defined margins.
- ________ is the abbreviation for what you see is what you get.
- ________ is a table of values arranged in rows and columns.
- In a spreadsheet application, each value is placed in a ________.
- The characteristics of spreadsheets include ________, ________, ________, ________, ________ and ________.
- The different kinds of data can be entered into a spreadsheet are ________, ________, and ________.
- ________ are figures that are derived or calculated from or using the existing entries.
- ________ are computed using a formula or an instruction that specifies the steps to obtain the desired mathematical result.

23. ________ was the first spreadsheet application, which was introduced, in the late 1970s.
24. Bricklin, Frankston, and Fylstra developed VisiCalc for ________ computers.
25. ________ enable you to create, edit, manipulate, add special effects, view, print, and save
26. ________ is a graphics program that enables you to draw pictures on the display screen, represented as bit maps.
27. ________ is a graphics program that enables you to draw pictures, then store the images merge them into documents, and print them.
28. Adobe PhotoShop and Corel Paint Shop Pro are examples of ________.
29. ________ is a collection of programs that enable you to store, modify, and extract informat a database.
30. SQL stands for ________.
31. IDMS, IMS, DB2, Oracle, Sybase, Informix, Ingress, MS-SQL Server, MS-Access, etc. are exam ________.

[**Answers:** (1) Program (2) Firmware (3) Firmware (4) Interrupt (5) Compilers and Interp Assembler (7) System software (8) Applications software (9) End-user programs (10) Operating (11) Utility (12) Compiler (13) Interpreter (14) Word processor (15) Word wrap (16) WISIW Spreadsheet (18) Cell (19) Table format, recalculations, data forms, presentation, storage and and standard formats (20) Labels, numbers and calculated entries (21) Calculated entries (22) Ca entries (23) VisiCalc (24) Apple (24) Image processors (25) Paint program (26) Draw program (2 editors (28) DBMS (29) Structured Query Language (30) DBMSs]

True or False

01. A computer needs both hardware and software for its proper functioning.
02. Firmware is a combination of software and hardware.
03. Compilers, interpreters, and assemblers are programs that transform the object code code.
04. An interrupt is a signal informing a program that an event has occurred.
05. Execution of a program is performed using a fetch-decode-execute cycle.
06. Software is divided into two categories—system and application software.
07. Every general-purpose computer must have an operating system to run other programs.
08. Operating systems contain a number of utilities for managing disk drives, printers, devices.
09. Utilities differ from applications mostly in terms of size and complexity.
10. Compilers can execute a program immediately.
11. Interpreters require some time before an executable program emerges.
12. Programs produced by compilers run much slower than the same programs execu interpreter.
13. Mail merging is a feature supported by many word processors that enables you mailings or mailing campaigns.
14. Word processors are used for performing all kind of tasks from a simple wage calcu complicated 'what-if' analysis for management decision-making.
15. Once the tables, numbers, and formulas have been entered, the spreadsheet s automatically complete the calculated results.
16. A spreadsheet cannot automatically recalculate the results when revised numbers are
17. Three different kinds of data that can be entered into a spreadsheet are labels, nu calculated entries.
18. A spreadsheet label is a description like Name, Basic, HRA, TA, Net Pay, etc.

19. Microsoft Excel, IBM Lotus 1-2-3, Corel Quattro Pro, OpenOffice Calc, etc. are examples of spreadsheets.
20. Microsoft Word, OpenOffice Writer, Corel WordPerfect, Lotus Word Pro, etc. are database management systems.
21. Adobe Flash, Microsoft PowerPoint, IBM Lotus Freelance Graphics, OpenOffice Impress, Corel Presentations, etc. are examples of presentation software packages.
22. Some examples of image editors are Windows Paint, Corel Painter, Ambient Design's ArtRage, Autodesk Sketchbook Pro, etc.
23. Some examples of draw programs are Adobe Illustrator, CorelDRAW, SmartDraw, ConceptDraw, etc.
24. An image editor is a graphics program that provides a variety of special features for altering bit-mapped images.

Answers: (1) True (2) True (3) False (4) True (5) True (6) True (7) True (8) True (9) True (10) False (11) False (12) False (13) True (14) False (15) True (16) False (17) True (18) True (19) True (20) False (21) True (22) False (23) True (24) True]

CHAPTER 12

Introduction to Software Development

TOPICS COVERED

- Introduction
- Software development life cycle phases
- Software development process
- Overview of the SDLC Phases

Key Points

- Software development is that set of actions req… efficiently transforming a user's needs into an effective … solution. It defines the activities required for buil… software incorporating the methods and practices to be … It also includes the activities essential for planning the … tracking its progress and managing the complexities … building software.
- Software development life cycle is the period of … begins when a software product is conceived and ends … software is no longer available for use.
- The software life cycle typically includes a concep… requirements phase, design phase, implementation ph… phase, installation and checkout phase, operatio… maintenance phase and sometimes, retirement phase.
- Software development process model describe how … what order the different phases of the software develop… cycle are put together to conceive, design, develop and … a software product.

INTRODUCTION

A software product starts its life as an idea or concept. Software can be of two types—**generic products** (products that are produced by a software development organization and are sold in the open market) and **customized products** (products that are developed to meet the specific needs of a customer). Examples of generic products (also known as shrink-wrapped products or packaged software) include word processors, electronic spreadsheets, database management systems, … tools, web browsers, etc. Customized products are developed for a specific person or organ… meet a specific need—computerization of the operations of a bank, development of an … railway reservation system, development of a software tool to accomplish a specific task (like … generation, code generation, etc.), etc. In the case of generic products the organization that … the software controls the specification. In the case of custom products the client or organiz… which the product is being developed usually controls the specification. In other w… characteristics and features of the generic products are market-driven (collected through … research, surveys, demos, etc.) while the client decides those of customized products.

Irrespective of the type of the software product and the way in which the software pro… was conceptualized, the software product goes through a series of development phases. In mo… the product's features and functions are specified, then designed and implemented. The p… then put into operation and while it is operational, it is maintained. Finally, when the usefulnes… product is over or when the product becomes obsolete, it is decommissioned. The series … through which a software product goes through (from conceptualization until retirement) is … **software development life cycle** or **SDLC**.

IEEE Standard Glossary of Software Engineering Terminology (IEEE Std-610-1990) defines software development life cycle as follows: **Software development life cycle** is the period of time that begins when a software product is conceived and ends when the software is no longer available for use. The software life cycle typically includes a concept phase requirements phase, design phase, implementation phase, test phase, installation and checkout phase, operation and maintenance phase and sometimes, retirement phase. The phases listed above may overlap, be performed iteratively, be combined or be omitted depending upon the software development approach (methodology) used. A **software life cycle model** describes how and in what order the different phases of the software development life cycle are put together to conceive, design, develop and maintain the software product.

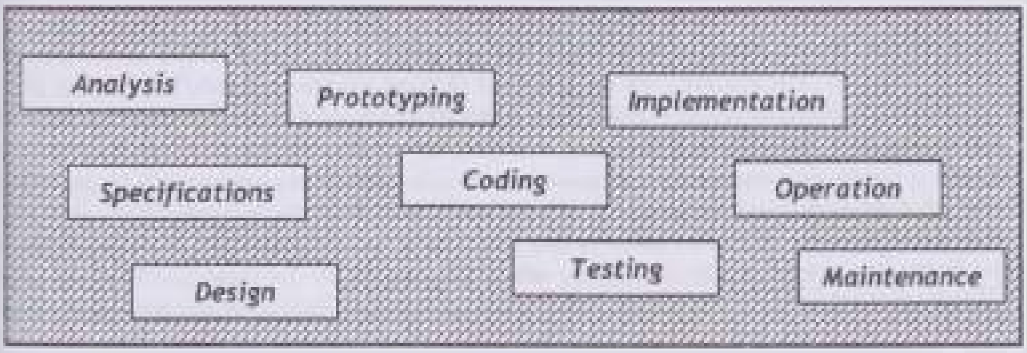


Figure 12.1 Different Phases (Stages) in the Software Development Life Cycle

The normal stages of software life cycle are shown in Figure 12.1. Each software product passes through these stages although the duration, sequence, number of iterations and exact effect of each stage may vary from product to product.

In other words, the life cycle of every software product is different. Some products will spend more years in the conceptual stage. There can be a variety of reasons for this—the idea may not be technically feasible due to some hardware limitations, the product idea may not be economically feasible at that point in time, the processing capability of the machines may not be good enough for the product to be commercially viable, etc. Other products may be quickly designed and implemented and may spend more years in the maintenance phase being modified repeatedly to fix the bugs (faults or errors) or for incorporation of new features and functionality required by the users. In many cases, after many years of maintenance, a stage will be reached when it will be cost effective to develop a completely new product rather than attempt to maintain the current version yet again.

According to **Lehman's Law of Continuing Change**, any large software system that is being used will undergo continual change because the system's use will suggest additional functionality. It will change until it becomes more cost-effective to rewrite it from scratch. This means that the software will be subject to constant changes other than the bug fixes and defects that are already in the software and which will be detected during and after its development.

This is not all; the software system that is perfectly developed and had met all the requirements and passed all the audits and reviews will also change. According to Lehman, even if a system were built in complete conformance to the requirements, the system would still evolve because the system is introduced into the real world and the environment into which the system is introduced is subject to change. So in order to adapt to the changes in the environment in which the system works, it has to change. In other words, no matter how perfectly you had built the system, it would have to be changed to meet the changes in the environment.

Any software system that undergoes continuous change will grow in complexity and will become more and more disorganized. Since all software systems being used will change and change causes instability, all software systems will become less and less reliable and maintainable with time. This is called **Lehman's Law of Increasing Entropy**. So we have seen that every software product has a lifetime. Just like any other commercial product, it starts as somebody's idea, need or inspiration and ends up being obsolete, unsupported and unused.

SOFTWARE DEVELOPMENT LIFE CYCLE PHASES

We have seen the different phases in the software development life cycle. We have also seen that depending on the development methodology, the sequence, duration, number of iterations, etc. of these phases will vary. We will now see an overview of these different phases. We will do so by using a real life analogy—the analogy of constructing a building. Like software development, the building construction also goes through several phases.

A person, a family or an organization decides to construct a building. It can be a home, an office, a shopping complex, or an auditorium. First somebody has to bring up the idea of constructing the building. You have been living in a rented house for quite some time and now you want a house of your own; the current office building might not be spacious enough or may not have the additional space for the new employees that you are planning to hire; the city does not have a good bookshop—the reasons that trigger the idea to construct could be many. But the fact remains that the concept is somebody's idea or inspiration or fulfillment of a need or capitalizing on a business opportunity. In this stage the idea to construct the building or house is just an abstract thought of a person or a group. It might have been communicated informally to others for comments and suggestions.

A similar phase in the software development life cycle is called the **concept phase** or **concept exploration phase**. Concept exploration phase is the period of time in the software development cycle during which the user needs are described and evaluated through documentation like statement of needs, advance planning report, feasibility studies, etc. It is in this phase that the users or developers identify the need for the software product and explore the possibility of developing it. This is usually the first phase in the software development life cycle.

Anybody wishing to put up a building will first try to determine whether the proposed structure is worth the money and effort it will require. Needs and benefits will be analyzed, preliminary cost and schedule estimated, specific functions and utility decided on, building land sought, legal implications examined and different modes of construction evaluated.

The purpose of the **analysis phase** for software is to determine whether it would be profitable to embark on the development of a new product. If so, we must assemble the necessary resources for the development effort. The analysis stage starts with conception of a new product. It is necessary to justify demand for software by market research or by a request for proposal from a potential client. It is also necessary to validate the desirability of the product in terms of goals, plans, needs of the software organization and its personnel.

Once the need for the product is clear, one must define its nature in more detail. This is done by analyzing the user requirements, such as a general definition of the function of the product, its scope, the nature of its interface to the users, hardware requirements, existing products, the speed, the precision, the capacity and the cost of the product. This **requirements analysis** provides a basis for the rest of the analysis stage. It also allows us to decide whether such a product is within the reach of the organization's capabilities.

One cannot sensibly address software design without realizing that it springs from requirements, a customer's need that is to be satisfied or a problem that is to be solved. In fact, when a software project gets into trouble, the difficult part is not solving the problem but understanding what the problem is. In order to develop the products that the client wants and meet the requirements, the requirements analysis phase should be done with great care and thoroughness. The most difficult part of building a software system is deciding precisely what to build. No other part is as difficult. No other part of the work so cripples the resulting system if done wrongly. No other part is more difficult to rectify later.

Understanding the needs to be met by the software is the first step towards its functional specification. This is usually accomplished by a process called **Systems Analysis**, in which the analysts consult with, interview and observe people in the user organization. The purpose is to understand fully the needs and constraints of the possible software solution, as well as the current structure and function of user operations.

Next step in the software development process is determining the costs and benefits of undertaking the project. Cost is made up of labor, new equipment purchase, diversion of existing facilities, purchase of software components from other sources, and loss of opportunities (opportunity costs) because of the inability to undertake other projects. Benefits are composed of sales of the product, improvement of the organization's market stance because of the product, development of new skills within the organization and possibility of further product development based on this project. The risk factors or probabilities associated with cost and benefit calculations must be evaluated as well.

From the cost estimation, we will be able to tell with a reasonable level of accuracy, whether the project is profitable and if so how many people will be needed at what points in the project. Thus, it is possible to produce a schedule of the project, together with plans for hiring or reallocating specific personnel and the acquisition of new hardware and software. If the cost-benefit analysis still looks promising, further planning is needed to establish management methods for the project. The final result will be a document of all the activities and results, as well as a proposal for the project.

Returning to the building ***construction*** *example, we must now specify what kind of building we want, number of rooms, what are the* ***facilities*** *and* ***features*** *that we need, the budget allocated for the construction, the amount of space that the building will require, the kind of materials that should be used, the general style and function of the structure, its safety and security provisions, etc. These are written down before we start to draw blueprints. This document is an important part of the contract between the builder and the client.*

The **software requirements specification phase** is the period of time in the software development life cycle during which the requirements for the software product are defined and documented. This phase crystallizes a precise description of the software's function, the exact nature of the environment in which it is to function, and the constraints on its performance. This description furnishes the basis of the contract, moral and legal, between the software developer and the user, and should be accompanied by a detailed plan for the acceptance test by which the purchaser will validate the software.

By firmly understanding the user's needs and environment, the development team can proceed with a detailed software specification. The process of developing the software specification is done in cooperation and consultation with the client. If there are no clients (i.e., if the product is developed for the general market) then the specification is developed in consultation with the marketing department of the organization. Nothing can be worse than producing the wrong software; so communication and mutual understanding among the various groups involved is crucial for the success of the project. It is also important to establish priorities, guidelines and constraints for the different functions to guide the details that are to be coded. For example, the choice of the programming language may have a significant effect on the ease of coding. Standards for in-line documentation will improve the maintainability. Code optimization will improve the performance.

Another important factor to be considered in the development is the multi-platform support. Most products are meant to run in a variety of hardware and software configurations, requiring many different versions. In order to produce a number of different implementations, the specifications and the design should be as generic and portable as possible.

Besides the actual code, the coding phase may produce modifications of specifications, design documentation and unit tests to accommodate errors that have been detected. The final version of the user documentation like user manuals, installation guides, training materials, error guides, etc. will be produced.

When a construction work is being carried out, the work is monitored by supervisors, so as to ensure that the work is defect free, of the required quality and meets the specifications. Local governments employ building inspectors, who inspect a building (along with the architect) before giving the final approval. Finally the purchaser of the building is likely to make an acceptance tour, looking for evident defects in finish and completion.

Dependability is one of the most important attributes of good software. Good specification, design and development practices should reduce the number of errors in the product; but it is foolish to assume any software to be coded defect free and perfect. **Testing** is conducted to find and eliminate errors. In most cases testing involves more effort than the coding. Refusal to accept this fact and not giving enough time for the testing phase is the cause of project overruns and undependable software. The testing stage goes beyond simply running the system to see whether it works and looks right. There are different types of testing methodologies, alpha and beta testing, black box and white box testing, top-down and bottoms-up testing, pragmatic testing, etc. Whatever be the methodology used, testing can be broadly classified into three kinds—unit, integration and system testing.

- Unit testing investigates the correctness of the individual modules and looks for structural weaknesses in them.
- Integration tests the interactions of the different modules in the system and the functionality of the integrated subsystems.
- System and acceptance tests determine whether the final product complies with the user's original specifications. The system testing is done by the quality assurance team or an external auditing authority. The acceptance testing is done by the user or the customer.

Plans for these tests should include not only the data and actions to be used in testing, but also the acceptable responses of the software. Testing should be carried out by those individuals responsible for the design and coding of the software as well as the specially designated quality assurance personnel and the representatives of the client. The primary objective of testing is to uncover and correct the defects in the specification, design or code, so that all the documentation produced till then and those that are affected by the changes made during the testing could be updated.

Now it is time to move into the new building. Furnishings must be purchased, minor mismatches should be corrected, and the builder can review the building process to evaluate what went wrong and how the construction could have been made more efficient.

When software has been tested and accepted, it is ready for use. But it should be **installed** at the customer's site. This may seem to be just copying the files and manuals. However, it is necessary to coordinate with the installation of the new hardware as well. Often there will be some amount of **end-user training**. At this point, a return to the acceptance test may be needed to ensure that the software works well in the client's environment as it did at the developers. After training, while the moves into the new system, the software organization has to maintain a high degree of support client. This is a critical time, and problems are sure to crop up. Even if the software organization responsible for the difficulties, their software is sure to be blamed, if they are unable to support.

It is very tempting for the development team to install the product and then forget it. How project **debriefing** process is vital to evaluate the successes and failures of the project. The debrie done as part of the project windup phase. The purpose of these debriefing sessions is to doc what has been learned from the project in order to provide a basis for future efforts. This called a project legacy or project completion report. This will form the basis for the corporate so that every time 'reinventing the wheel' can be avoided.

The client will need support throughout the entire useful lifetime of the software. Natural level of support and effort involved decreases with time as the users become experts and the organization adapts to the new software. However, some problems will arise, requiring modification of the product. This **maintenance** effort revisits all the other stages of the softw cycle. Changes may be required to eliminate errors, to provide additional functionality or to allo product to be used in a new environment. Each modification requires planning, specification, coding, testing, installation, etc.

Having discussed about the software life cycle, a natural question that arises is 'wh software die?' or 'when is a software product retired?' After installation, and as time passes, the of the software decreases, either in absolute terms or relative to other options available. Re maintenance actions tend to complicate the original clean and simple design of the product. Ad maintenance may not be economical. The **retirement phase** of a software product is the period in the software life cycle during which support for the product is terminated. But predicting the a software product is very difficult. It depends on a lot of environmental factors such advancements in technology, new and cheaper competitive products, etc. Sometimes a product may 'l've' for many years, but sometimes the life span can be only a few months and cases it might not be used at all.

SOFTWARE DEVELOPMENT PROCESS

Software development is that set of actions required in efficiently transforming a user's needs effective software solution. It defines the activities required for building the software, incorp the methods and practices to be adopted. It also includes the activities essential for plann project, tracking its progress and managing the complexities while building the softw objectives of software process management are to produce products according to pla simultaneously improving the organization's capability to produce better products. So the required for a software development project includes the following:

- ▲ A structured framework of organized activities needed to create a software devel process for the life cycle of a product.
- ▲ A detailed description of the activities required to manage the development of a product, from requirements analysis definition through implementation and mainte
- ▲ Supporting documents including requirements definition, systems analysis, documents, user manuals, training documents, installation manuals, error guides, etc.

Dozens of process models are available for software projects to utilize—waterfall mod model, throwaway prototyping, incremental development, operational prototyping, programming, etc. to name just a few. There is no such thing as a process model that works for all projects in an organization. Every project must select a process that makes the most sense for it. The selection should be based on corporate culture, risk willingness, application area, volatility of requirements, and the extent to which requirements are well understood.

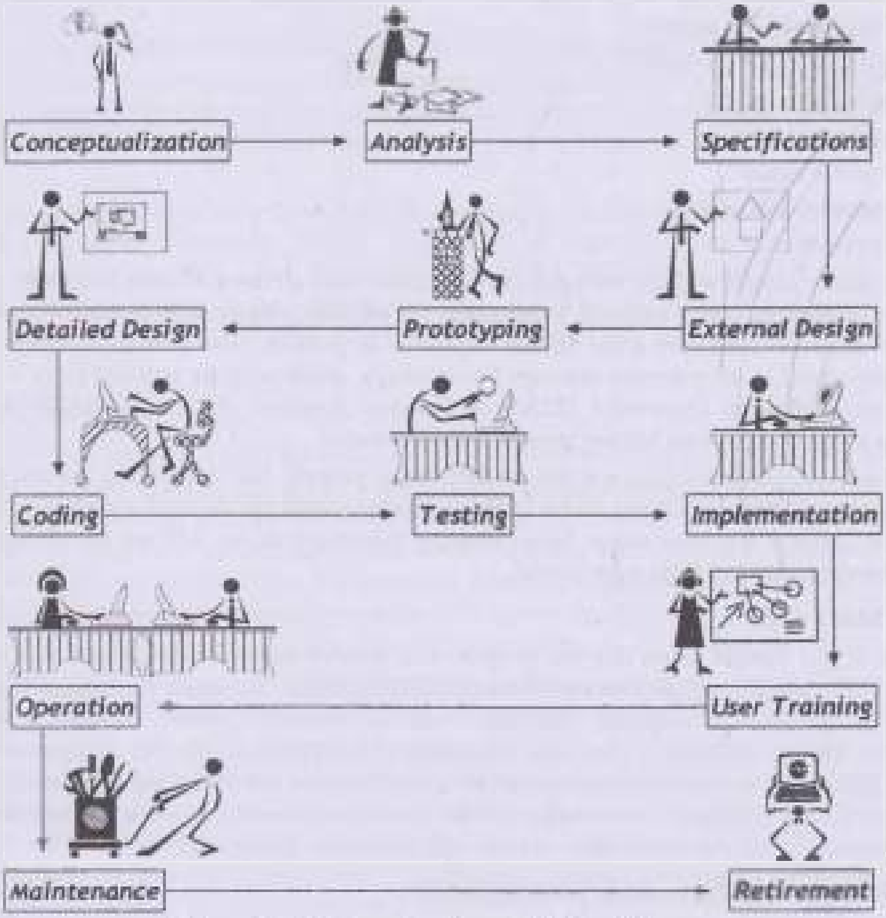


Figure 12.2 Software Development Life Cycle Phases

Study the project's characteristics and select a process model that make the most sense. For example, when building a prototype, you should follow a process that minimizes protocol, facilitates rapid development and does not worry about quality audits and documentation. When building a life critical product, the opposite is true; i.e., you should choose a development process that has procedures, quality audits, performance reviews and best practices that ensure the development of a bug free product.

OVERVIEW OF SDLC PHASES

There are certain phases that the software goes through before, during and after the development process. The various phases or steps in the Software Development Life Cycle (SDLC) are:

- Project start-up

- Requirements analysis and specification
- Systems Analysis
- High-level Design
- Low-level (detailed) Design
- Coding and Unit testing
- System/Integration testing
- Acceptance testing
- Implementation
- Project windup
- Project Maintenance
- Retirement

All the above phases will not be there in all projects. Also all the activities described in each [illegible] will not be present in many projects. Depending on the size, nature and complexity of the [illegible] many of the activities and even some phases might not be present. Also in many projects the act[illegible] could be performed in an informal manner. For example, small projects will not have a very de[illegible] Requirements Definition Document (RDD) or Systems Analysis Document (SAD). Also in [illegible] projects the alpha and/or beta testing phases could be absent.

The phases described below are for a fairly large project; but depending on the nature [illegible] project and organizational policies, some of these phases might get clubbed together, omitted or [illegible] be practiced under a different name. Now, keeping this in mind, we will see the different pha[illegible] software development in a little more detail.

Project Start-Up

This phase is the curtain raiser for the project. The project team is formed and the project [illegible] identified. The project is organized—modules identified, the key members are enlisted and the [illegible] who will carry out the support functions such as internal quality assurance, config[illegible] management, etc. are identified. The senior members of the project team will sit together and [illegible] the project plan so as to ensure completion of the project within the cost, time and resource cons[illegible] based on the details available. This phase also sets up the hardware and software environment [illegible] next phase covering the hardware, system software, standards and guidelines.

Requirements Analysis and Specification

It is in this phase that the user requirements and specifications are captured and documented. D[illegible] this phase, a detailed plan for the phase is prepared. The high-level activities for this pha[illegible] expanded so that each activity spans not more than one or two person-weeks. The depend[illegible] between the various activities of this module are identified and the activities are scheduled. Pla[illegible] housekeeping activities like backup/recovery and security are formulated. The resources requi[illegible] estimated and the team members are allocated the tasks.

One of the main tasks of this phase is to understand the current system (manual or compute[illegible] This is not applicable for a new product development project where the task is to underst[illegible] functions that the software is supposed to perform. The task should be undertaken with a vi[illegible] examining its adequacy and identifying problem areas. The main tasks that are performed [illegible] phase are understanding the current system by discussing with the users and studyi[illegible] documentation available. The main areas that are studied are organization objectives, act[illegible] procedures, rules and standards, files and interfaces etc.

Every existing system, whether manual or computerized, will have some problems or inadequacies. That is why it is being redesigned. Even if the system is functioning smoothly, there could be areas that could be improved in a computerized system. The existing problems and constraints are identified. They are documented for future reference and the findings are discussed with the client or user.

The next step in this phase is the definition of the user requirements. The main activities that are performed in this phase are diagnosing existing problems and defining the user requirements. To do this, the context of the problems has to be understood, the scope of the problems has to be assessed and the user requirements, application requirements and information requirements have to be determined.

Once the user requirements have been defined, the next step in this phase is the preparation of the Requirements Definition Document (RDD). The RDD is sometimes known as the Software Requirements Specification (SRS). Once the initial draft of the RDD is created, it is given to all the parties of the software project (users, clients, project team, and the support functions), for their feedback and suggestions. After incorporating the suggestions from all quarters, the final RDD is prepared.

Systems Analysis

In the system analysis phase the proposed system is defined after analyzing various alternatives. The main tasks that are performed in this phase are studying the approved RDD, generating alternatives (solutions or designs) for the proposed system, evaluating alternatives, performing impact or cost-benefit analysis for tangible costs and intangible costs, selecting an alternative, determining system requirements with respect to reliability, performance, security, backup/restore, error recovery, other quality factors, etc., discussing the proposed system with the client, etc.

In some cases the project management may decide to develop a prototype of the system to demonstrate the understanding of the user requirements and the functionality that will be provided in the proposed system. Prototyping is required if lack of clear understanding of the user requirements is considered as a major risk in the project. Once the prototype is developed and the feedback is obtained, the next step is to prepare the Systems Analysis Document (SAD), where the proposed system's functionality is documented. While preparing the SAD, a usability plan is prepared. Usability plan is prepared when the system that is being built uses commercial-off-the-shelf (COTS) packages for performing some tasks in the system. The usability plan will compare the available packages and will be of help in identifying the one that is best suited for the system—cost-effectiveness, amount of customization, method of integration of the selected package into the software system, etc. This plan is needed only if the system uses off-the-shelf packages.

High-level Design

In this phase the system design objectives are defined. Sometimes a prototype is developed to demonstrate the user interface design, screens, navigation and other features of the system. Developing a prototype in HLD phase is required if it is desired to demonstrate to the user, the design features of the system such as system architecture, user interfaces and system functionality. Sometimes a prototype is developed during the system analysis phase to demonstrate the understanding of the user requirements and the functionality that will be provided in the proposed system. If such a prototype exists, then this prototype is refined during the HLD phase to demonstrate the user interface design, screens, navigation and other features of the system.

The system components like modules, programs, functions and routines are also identified in this phase. The system components are identified hierarchically to the level required. The inputs and outputs of the system are defined. These include menus, screens, navigation, levels of help and help screens, reports, error messages, user interface and so on. The programs for each component are identified and classified. The programs can be classified as on-line/batch, reports, transactions, drivers, functions, libraries, etc. The performance requirements for each component are established and the components that can be reused are identified.

The next step in this phase is to define the system architecture. The system architecture is established in terms of security, data access, communication, restart/recovery, audit, and user interface. The system architecture deals with issues like whether the proposed system will be a client/server system, a mainframe system, or will it be a geographically distributed system, what technology should be used, how the communications network should be set up, etc. The program dependencies and interfaces are identified and the system architecture for each class of programs is finalized and documented.

Another task in this phase is the finalization of the database/file design. The database/file design is derived from a data model or data store identified during analysis. This should include control, access and organization of the database/files. The contents of each of the tables/files in the database and the access path are defined. The necessary normalization of the database tables is performed to ensure processing efficiency.

The final task in this phase is the preparation of the HLD document. The HLD document is prepared as per documentation standards for HLD. The documents that have been prepared so far, like the design objectives document, the system architecture document, the database design document, etc. are used as the input for the HLD document. The system test plan is a part of the HLD document. So while the HLD is compiled, the system test plan (STP) and system test specification (STS) are also prepared, which will form part of the HLD document. The preparation of the initial draft of user documents such as user manual, capabilities manual and tutorials are started in this phase.

Low-level Design or Detailed Design

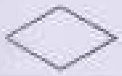
In this phase the copy libraries, common routines and program skeletons to be used are finalized. The HLD is analyzed to understand the system architecture, components, programs and their interfaces. The standards prepared for LLD phase are studied. The component libraries to be used for each of the programs in the system are identified, so are the common routines and the input and output for the common routines. If program skeletons or templates are planned to be used for various types of programs, then the scope and contents of such skeletons and templates are decided. The specifications for the component libraries, common routines and skeletons are written.

The major task in this phase is writing the specification for each program in the system. Writing program specification is essential for projects involving development in procedural languages. For each program and reusable routine identified in the system, the program logic is determined, the structure chart is prepared (if necessary), the inputs, outputs, error messages and help messages are finalized and the program specification is prepared. As a part of the program specification, the Unit Test Specification (UTS) and Unit Test Plan (UTP) are prepared. The last step of this phase is the preparation of the LLD document consisting of program specification for all the programs, component libraries, skeletons and templates of the system.

Flowcharts and Pseudocodes

There are many techniques for developing and representing the program design. One of the most commonly used methods is the use of flow charts. The flowcharts graphically represent the needed to solve a programming problem. A program flowchart represents the detailed sequence of steps, needed to solve the problem. Program flowcharts are frequently used to visualize the logic and steps in processing. There are only a few standard flowchart symbols necessary to solve almost any programming problem. These are shown in Table 12.1.

Table 12.1 Common Flowcharting Symbols

Symbol	Description
	The **input/output symbol** is used to represent any input or output operation. It may represent the point in a program where the data (input) is required or where the information (output) is to be displayed.
	The **process symbol** represents some type of data manipulation or arithmetic operation.
	The **decision symbol** represents a logical comparison operation. Based on the comparison, one of the two paths will be taken.
	The **connector symbol** is used when several symbols displayed at one point might cause confusion and reduce understanding. The symbol directs the reader's attention to another area of the flowchart where the program flow continues.
	The **predefined process** symbol is often used to represent a process that is used several times in the same program. This process is defined only once and reference by this block thereafter.
	The **terminal symbol** represents the start or end of a program. It is also used to indicate a program interruption point where information can enter or leave.
	The **direction of flow symbols** indicates the next step in the program.

Now we will see an example of a flowchart. The flowchart shown in Figure 12.3 shows how the employee's salary is calculated and paychecks are printed. The explanation of the flowchart is given below:

1. This opens the employees' personnel file.
2. This reads the employee's last name, first name, week ending date, hourly pay rate, etc.

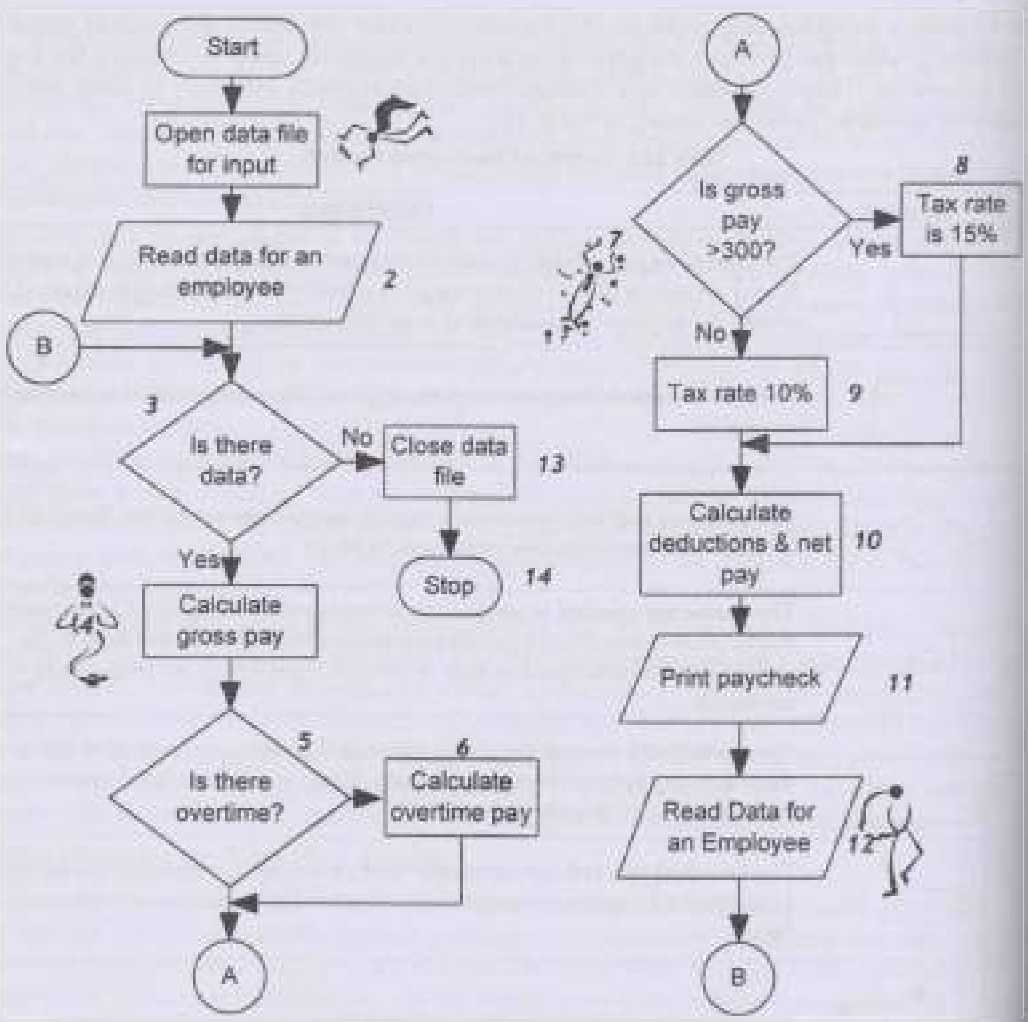


Figure 12.3 Flowchart to Print Paycheques

3. This is the "Last record" decision point. If the answer is "Yes," the program pro calculations.
4. This multiplies hours worked with pay rate to get gross pay.
5. This asks if the employee worked overtime.
6. If the answer is "Yes," overtime pay is calculated and added to gross pay.
7. This asks if the gross pay for the week is above Rs 300.
8. If the answer is "Yes," a tax rate of 15% is calculated.
9. If the answer is "No," a tax rate of 10% is calculated.
10. This calculates and subtracts deductions, such as union dues and other taxes and c net pay.
11. This prints out the employee's paycheck.

12. This reads the employee file for the next employee – name, week ending date, hourly pay rate, etc. When all the employees' files have been read and the answer to the "Last record" decision is "No," the program begins to terminate.
13. This closes all the employees' personnel file.
14. This stops the program.

An alternative or a supplement to flowcharts, pseudocode is a narrative rather than a graphical form of describing structured program logic. It allows the program designer to focus on the logic of the program and not on the details of programming or flowcharting. A pseudocode to a program, says one writer, "Is as beautiful as a sentence outline is to a research paper." Just as an outline contains enough specifics to ensure that you will not overlook any pertinent details when you are drafting your research paper, so a pseudocode will contain enough specifics as to what information or calculations are needed to be performed within the major "outline" areas – the modules – that no major points will be missed. The end users might find pseudocode helpful because it allows them to get a preview of the program before the programmer actually starts putting it into flowchart or code form. The pseudocode for the 'Paycheck printing program' whose flowchart is shown in Figure 12.3 is given below.

```
Start
Open employee personnel file.
Read first employee's last name, first name, week ending date, hours worked,
pay rate and address.
DO WHILE employee data exists
   Multiply hours worked with pay rate to get gross pay.
   IF hours worked are greater than 40 (overtime), THEN
      Subtract 40 from hours worked to get the overtime hours.
      Multiply overtime hours with half the pay rate to get overtime pay.
      Add overtime pay to gross pay.
   END IF.
   IF gross pay is greater than 300 THEN
      Tax rate is 15%
   ELSE
      Tax rate is 10%
   END IF.
   Calculate union dues at 2% of gross pay.
   Multiply gross pay with tax rate to get tax.
   Subtract union dues and tax from gross pay to get net pay.
   Write employee's paycheck.
   Read next employee's last name, first name, week ending date, hours
   worked, pay rate and address.
END DO.
Close employee personnel file.
Stop.
```

Coding and Unit Testing

During this phase the programs, copy libraries, functions and other program elements are coded (or generated) and tested (unit testing). The main people who are involved in this phase are the a regression fault to the point where it would be safer to recode than to maintain. Another reason for retiring a software product is that technological advancements have made the existing system obsolete.

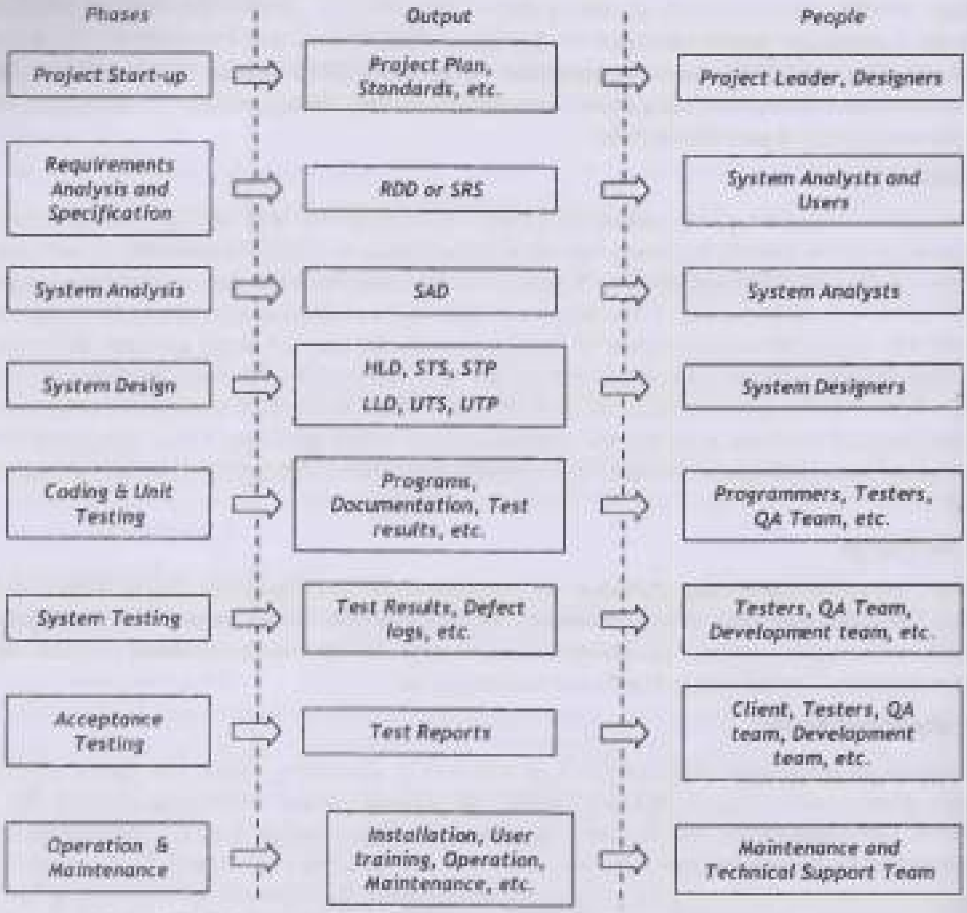


Figure 12.4 Phases, Output and People of the Software Development Life Cycle

The hardware on which the product runs have to be replaced by a different (more powerful or less expensive) machine with a different operating system and it is cheaper to rewrite from scratch than to modify the product. In each of these instances the current product is retired and a new version will be developed and the life cycle continues. True retirement (removal of the product) is a rare event that occurs when a product has outgrown its usefulness. The client organization no longer requires the functionality provided by the product and it is finally removed from the computer on which it has been in operations mode for many years.

REVIEW QUESTIONS

Short Answer Questions

01. What do you mean by generic software products?
02. What are customized software products?
03. Give examples for generic software products.

24. Give a few examples for customized software products.
25. What happens during the concept or concept exploration phase of software development?
26. What is the purpose of the analysis stage?
27. What are the activities in the analysis stage?
28. What is requirements analysis? When, how and why is it done?
29. Why the requirements analysis is said to be the most important phase of software development?
30. What are the tasks accomplished during the systems analysis stage?
31. How is the cost and benefits of undertaking the project determined?
32. What are the major costs of software development?
33. What are the main benefits of a software development project?
34. How will one decide whether a software development project is profitable or not?
35. What happens during the software requirements specification phase?
36. What do you mean by external design of the software?
37. What is a prototype and why is it used?
38. What is the use of the preliminary design of the software product?
39. What is the use of the detailed design of the software product?
40. What is the difference between the preliminary and detailed designs?
41. What happens during the development or coding phase?
42. What is testing? Why is it performed and how is it helpful?
43. What are the different kinds of testing?
44. What do you mean by unit testing?
45. What is integration testing?
46. What is system testing?
47. What is the primary objective of testing?
48. What is software installation?
49. What is the need of end-user training?
50. What do you mean by project debriefing?
51. What happens during the maintenance phase?
52. What do you mean by retirement phase?

Descriptive Type Questions

1. What do you mean by software development life cycle? Explain.
2. What is the IEEE definition of software development life cycle?
3. What is a software life cycle model?
4. What are the common phases of the software development life cycle?
5. Why is the order of SDLC phases different for different products?
6. What is Lehman's law of continuing change? Explain how it affects software development.
7. Why does the software change while it is used?
8. What are the implications of the continuous change that the software has to undergo?
9. What does Lehman's law of increasing entropy mean?
10. Explain the need and importance of prototyping?
11. What do you mean by software development? What are the activities involved during software development?
12. What are things required for the process of a software development project?
13. What are the different software process models? How does one select a process model for a software project?

14. What are the various phases in the software development life cycle?
15. What are the activities that are performed during the project start-up phase?
16. Explain the requirements analysis and requirements specification phase in detail.
17. What are the activities that are performed during the systems analysis phase?
18. Explain the high-level design phase in detail.
19. What are the activities that are performed during the low-level design phase?
20. What are the major tasks performed during the coding and unit testing phase?
21. Explain the system testing phase in detail.
22. What are the activities that are performed during the acceptance testing phase?
23. What are the major tasks performed during the implementation phase?
24. Explain the project wind-up phase in detail.
25. What are the activities that are performed during the maintenance phase?
26. What are the major tasks performed during the retirement phase?

Essay Questions

01. Explain the differences between generic and customized software products with examples.
02. Why is the sequence, duration, number of iterations of the SDLC phases different for different software products? Explain with examples.
03. Explain the software development phase using the analogy of a building construction.
04. Explain the various SDLC phases with the help of a diagram.

Fill in the Blanks

01. The two types of software are _______ and _________.
02. ________ products are produced by software development organizations and are sold in the market.
03. ________ products are developed to meet the specific needs of a customer.
04. Word processors, electronic spreadsheets, database management systems, imaging tools, browsers, etc. are examples of ________.
05. In the case of _______ products the organization that develops the software controls the specification.
06. In the case of _______ products the client or organization for which the product is developed usually controls the specification.
07. The series of steps through which the software product goes through – from conceptualization to retirement – is called _________.
08. SDLC stands for _________.
09. _________ describes how and in what order the different phases of the software development cycle are put together to conceive, design, develop and maintain the software product.
10. _________ states that any large software system that is being used will undergo continual change because the system's use will suggest additional functionality. It will change until it becomes cost-effective to rewrite it from scratch.
11. According to _________, software systems that are currently being used will change and change causes instability, all software systems will become less and less reliable and maintainable with time.
12. In the ________ phase the user needs are described and evaluated through documents like statement of needs, advance planning report, feasibility studies, etc.
13. The purpose of the _________ phase is to determine whether it would be profitable to embark on the development of a new product.

14. __________ allows us to decide whether such a product is within the reach of the organization's capabilities.
15. In the _______ phase a clear understanding of the needs to be met by the software is accomplished.
16. ________ phase crystallizes a precise description of the software's function, the exact nature of the environment in which it is to function, and the constraints on its performance.
17. _________ is a preliminary model of the system that serves as a model for the later stages or the final and complete version of the system.
18. _________ is a software development technique in which a preliminary version of part of or the entire software is developed to give the users a better understanding of the system.
19. In the ________phase the design is converted into code.
20. The three types of testing are ________, ________, and ________ testing.
21. ________ testing investigates the correctness of the individual modules and looks for structural weaknesses in them.
22. ________ tests the interactions of the different modules in the system and the functionality of the integrated subsystems.
23. ________ and ________ tests determine whether the final product complies with the user's original specifications.
24. ________ phase of a software product is the period of time in the software life cycle during which support for the product is terminated.
25. It is during the _______ phase the project team is formed and the project leader identified.
26. The user requirements and specifications are captured and documented during the _________ phase.
27. RDD stands for _________.
28. SRS stands for _________.
29. SAD stands for _________.
30. COTS stands for _________.
31. STP stands for _________.
32. STS stands for _________.
33. UTP stands for _________.
34. UTS stands for _________.
35. _______ testing is done when the system or product has a lot of new previously untested features.
36. _______ testing is required when some level of customer evaluation is needed prior to the final release of the product.
37. _______ testing is the formal testing that is conducted to determine whether or not a system satisfies its acceptance criteria and to enable the customer to determine whether or not to accept the system.

[Answers: (1) Generic and customized (2) Generic (3) Customized (4) Generic products (5) Generic (6) Customized (7) Software development life cycle (8) Software development life cycle (9) Software life cycle model (10) Lehman's Law of Continuing Change (11) Lehman's Law of Increasing Entropy (12) Concept exploration (13) Analysis (14) Requirements analysis (15) Systems analysis (16) Software requirements specification (17) Prototype (18) Prototyping (19) Coding (20) Unit, Integration and System (21) Unit (22) Integration (23) System and acceptance (24) Retirement (25) Project Start-up (26) Requirements analysis and specification (27) Requirements Definition Document (28) Software Requirements Document (29) Systems Analysis Document (30) Commercial-off-the-shelf (31) System Test Plan (32) System Test Specification (33) Unit Test Plan (34) Unit Test Specification (35) Alpha (36) Beta (37) Acceptance]

True or False

01. A software product starts its life as an idea.
02. Customized products are also called shrink-wrapped products.
03. Some examples of customized products are computerization of the operations of a ba... development of an airline or railway reservation system, etc.
04. The characteristics and features of the generic products are market-driven.
05. The characteristics and features of the customized products are decided by the client.
06. SDLC includes a concept phase, requirements phase, design phase, implementation phase... phase, installation and checkout phase, operation and maintenance phase and some... retirement phase.
07. A software system that is perfectly developed and which had met all the requirements and pa... all the audits and reviews will not change.
08. Concept exploration is usually the first phase in the software development life cycle.
09. The purpose of the requirements analysis phase is to understand fully the needs and cons... the possible software solution, as well as the current structure and function of user operations.
10. Standards for in-line documentation will improve the maintainability.
11. Code optimization will improve the performance.
12. Waterfall model, spiral model, throwaway prototyping, incremental development, ope... prototyping, extreme programming, etc. are examples of software process models.
13. The project start-up phase is a kind of a curtain raiser for the project.
14. One of the main tasks of project start-up phase is to understand the current system.
15. In the requirements analysis phase the proposed system is defined after analyzing ... alternatives.
16. Prototyping is required if lack of clear understanding of the user requirements is consid... major risk in the project.
17. STP is prepared during the HLD phase.
18. UTPs are created during the LLD phase.
19. Among all the life cycle phases, coding is the phase that will involve most number of people.
20. Unit testing is done during the coding phase.
21. Acceptance testing is carried out only if the system is developed for a particular client/cu...
22. The final phase in the life cycle of a software product or system is retirement.

[**Answers:** (1) True (2) False (3) True (4) True (5) True (6)True (7) False (8) True (9) False (10) ... True (12) True (13) True (14) False (15)False (16) True (17) True (18) True (19) True (20) True ... (22) True]

CHAPTER 13

Programming Languages

TOPICS COVERED

- Introduction
- Machine languages
- Assembly languages
- High-level languages
- Types of high-level languages
- Compilers and interpreters
- Compilation process

> **Key Points**
>
> ▲ The computer understands only the machine language. To communicate with the computer, you should develop a language that can be understood by both you and the computer. This is what a programming language is—a set of rules that provides a way of instructing the computer to perform certain operations.
>
> ▲ Machine language is the lowest level of programming language where the information is represented as 0s and 1s. Assembly languages use abbreviations or mnemonic code to replace the 0s and 1s of machine languages. High-level languages are sometimes used to refer all languages above the assembly level—procedure-oriented, problem-oriented and natural languages.
>
> ▲ Problem-oriented (fourth generation) languages are classified as personal computer applications software, query languages, report generators, decision support systems, financial planning languages and application generators.
>
> ▲ Compilers and interpreters translate high-level languages into machine language. In a compiled language, a translation program is run to convert the entire program into a machine language code. In an interpreted language, a translation program converts each program statement into machine code just before the program statement is to be executed. Compiler languages are better than interpreted languages as they can be executed faster and more efficiently once the object code has been obtained.

INTRODUCTION

If you want to get something done by a person, you will tell him what to do in a language that he understands. Similarly, if you want to make the computer to do some task for you, you have to tell the computer what to do in a language that the computer understands. The language that the computer understands is machine language, which in the printed form is apt to be an incomprehensible page after page of ones and zeros. How can you then communicate with the computer?

To communicate with the computer is to develop a third language—a language that can be understood by both you and the computer. This is what a programming language is—a set of rules that provides a way of instructing the computer to perform certain operations. The choice of programming language is, however, an important one. There are more than 150 programming languages in existence and these are just the ones that are still being used; we are not counting the ones that for one reason or other, are considered obsolete. How do you know whether to use JOVIAL instead of HEARSAY, DOCTOR instead of STUDENT and COBOL instead of SNOBOL? Actually, it is not as difficult as it looks because certain languages are used for certain disciplines.

Programming languages are said to be lower or higher, depending on whether they are closer to the language the computer itself uses (lower, which means 0s and 1s, as we shall explain) or to the language that people use (higher, which means more like English). In this chapter we shall consider [illegible] levels (or generations) of language.

1. Machine Languages/First-generation Languages
2. Assembly Languages/Second-generation Languages
3. Procedural Languages/Third-generation Languages
4. Problem-oriented Languages/Fourth-generation Languages
5. Natural Languages/Fifth-generation Languages

The characteristics and trends of these five levels are summarized in the Table 13.1. The high-le languages—such as Pascal, BASIC, and COBOL—are the ones used to code applications programs we shall emphasize on them. The closer the level is to human speech, the more it is described "user-friendly" language. The term user-friendly, incidentally, is one that is used a great throughout the computer industry.

Table 13.1 Programming Languages — Characteristics and Trends

	First Generation	Second Generation	Third Generation	Fourth Generation	Fifth Generation
	Trend: Towards conversational natural programming languages →				
Software Trends	User-written Programs Machine Languages	Packaged Programs Symbolic Languages	Operating Systems High-level Languages	Database Management Systems Fourth Generation Languages Microcomputer Packages	Natural Languages Multi-purpo Graphic-interfaced Expert-assis Packages
	Trend: Towards easy to use multi-purpose application packages →				

MACHINE LANGUAGES

We think of computers as being quite complicated, but actually their basis is very simple. They the concept of electricity being turned "on" and "off." From this on/off, yes/no, two-state sy sophisticated ways of representing data have been constructed using the binary system of nu The binary system is based on two digits—0 and 1.

By contrast, the decimal system that we all use is based on ten digits—0 through 9. The num 2 and 3 in the decimal system are represented in the binary system as 1, 10 and 11 respectively. L of the alphabet are also represented as numbers. In one system, the letter A is represented as 10 Commas, semicolons and other special characters are also represented as bunches of 0s and 1s. early days of computers, with machines as the ENIAC, which uses vacuum tubes, one could ac see the tubes lit up or unlit, corresponding to the 1/0 binary state—the switch was either on or addition, in those early days there was no such thing as software. There was only hardwar electrical on/off switches. Whenever a program was to be run, all the switches had to be sometimes as many as 6,000 switches for a single program. Then for the next program the switch to be reset, a process that might take weeks. Since those days, machine switches have been replac machine programming—programs with statements consisting of 0s and 1s that electrically switches, with 0 representing off and 1 representing on. This has made changing from one prog another considerably easier. Still, programming directly in machine language—the lowest le programming language, in which information is represented as 0s and 1s—is very tedious and consuming. A programmer must keep track of a tremendous amount of detail. Moreover, he/she understand the technical operations of the computer. For example, consider a line from a program segment, which multiplies two numbers.

```
11110010  01110011  11010010  00010000  01110000  00101011
```

Clearly, working with this kind of code is not for everybody. Programming in machine code has one advantage over programming at other language levels—its execution is very fast and efficient because the computer can accept the machine code as it is. However, in addition to the complexity and sheer tedium involved in working at this level, there is a severe disadvantage to machine language—there is no one standard machine language. Rather, there are machine languages.

The languages are machine-dependent, and the programs written in machine language for one computer model will not, in all likelihood, run on a different model computer. Although the machine language for a particular computer is supplied by the manufacturer, few applications programs are written in machine languages.

ASSEMBLY LANGUAGES

Working with 0s and 1s is a monotonous and tedious task and the chances of programmers making mistakes were more. In the 1950s, to reduce programming complexity and provide some standardization, assembly languages were developed. Assembly languages, also known as symbolic languages use abbreviations or mnemonic code—codes more easily memorized—to replace the 0s and 1s of machine languages. The machine language segment we saw above is as follows:

```
11110010  01110011  11010010  00010000  01110000  00101011
```

This could be expressed in assembly language statement as:

```
PACK   210(8,13),02B(4,7)
```

Assembly languages do not replace machine languages. In fact, for an assembly language program to be executed, it must be converted to machine code. The assembly language program is referred to as source program whereas the machine language program is an object program.

Assembly language code is very similar in form to machine language code. In fact, the first assembly languages had a one-to-one correspondence—15 assembly statements, for example, would be translated into 15 machine statements. This one-to-one correspondence was still so laborious. However, assembly language instructions called macro instructions were devised, which executed batches of one-to-one instructions. That is, one line of assembly language code would correspond to many lines of machine language code.

Assembly languages offer several advantages:

- They are more standardized and easier to use than machine languages.
- They operate very efficiently, although not as efficient as the machine languages.
- They are easier to debug because programs locate and identify syntax errors.

However, there are still some disadvantages:

- Assembly language programs are usually very long.
- Though less abstract than machine languages, assembly language programs are still complex.
- Though more standardized than machine languages, assembly languages are still machine dependent.

HIGH-LEVEL LANGUAGES

High-level Languages assisted programmers by further reducing the number of computer operation details they had to specify, so that they could concentrate more on the logic needed to solve the problem. To see this, you need only to look at the code segments, in which the same instruction—"Calculate gross pay" — is expressed in three different languages: machine, assembly and COBOL.

Machine Language:

```
11110010   01110011   1101   001000010000   0111   000000101011
11110010   01110011   1101   001000011000   0111   000000101111
11111100   01010010   1101   001000010010   1101   001000011101
11110000   01000101   1101   001000010011   0000   000000111110
11110011   01000011   0111   000001010000   1101   001000010100
10010110   11110000   0111   000001010100
```

Assembly Language:

```
PACK    210(8,13),02B(4,7)
PACK    218(8,13),02F(4,7)
MP      212(G,13),21D(3,13)
SRP     213(5,13),03E(0),5
UNPK    050(5,7),214(4,13)
IO      054(7),X'FO'
```

COBOL:

```
MULTIPLY HOURS-WORKED BY PAY-RATE
GIVING GROSS-PAY ROUNDED.
```

TYPES OF HIGH-LEVEL LANGUAGES

Languages are often referred to as generations, the idea being that machine languages were the first generation and assembly languages were the second-generation. High-level languages are sometimes used to refer all languages above the assembly level. Here we will subdivide high-level languages into three generations.

- Procedure-oriented or third-generation
- Problem-oriented or fourth-generation
- Natural or fifth-generation

Procedure-oriented Languages

High-level languages are often classified according to whether they solve general problems or specific problems. General-purpose programming languages are called procedural languages or third-generation languages. They are languages such as Pascal, BASIC, COBOL, and FORTRAN, which are designed to express the logic, the procedure of a problem. Because of their flexibility, procedural languages are able to solve a variety of problems.

Procedure-oriented languages have many advantages over machine and assembly languages:

- The program statements resemble English and hence are easier to work with.
- Because of their English-like nature, less time is required to program a problem.
- Once coded, programs are easier to understand and modify.
- The programming languages are machine-independent.

However, procedure-oriented languages still have some disadvantages compared to machine and assembly languages:

- ▲ Programs execute more slowly.
- ▲ The languages use computer resources less efficiently.

Problem-oriented Languages

Third-generation languages, such as BASIC or Pascal, require you to instruct the computer in a step-by-step fashion. Fourth-generation languages, also known as problem-oriented languages, are high-level languages designed to solve specific problems or develop specific applications by enabling you to describe what you want rather than step-by-step procedures for getting there. Fourth-generation languages may be categorized into several kinds of application development tools:

- ▲ Personal computer applications software
- ▲ Query languages and report generators
- ▲ Decision support systems
- ▲ Application generators

Personal Computer Applications Software

You have already been introduced to application software for PCs, but the ones we are particularly concerned with here are word processors, spreadsheets, database managers, business graphics and integrated packages. Learning to use Lotus 1-2-3, dBase or PowerPoint can help you develop your own applications.

Query Languages and Report Generators

Query languages allow people who are not programmers to search a database using certain selection commands. Query languages, for example, are used by airline or railway reservations personnel needing ticket information. Report generators are designed for people needing to prepare reports easily. Examples of query languages and report generators include QBE, SQL, HAL, ANSWER/DATABASE, DATATRIEVE, EASYTRIEVE PLUS, Honeywell PDQ, INQUIRE, INTELLECT, QMF, RPG III, etc.

Decision Support Systems

Decision support systems are interactive software designed to help managers make decisions. Financial planning languages are particular kinds of decision support systems that are employed for mathematical, statistical and forecasting procedures among other uses. Both types of languages find applications in developing complicated business model - hypothetical representations of management problems. Some examples of decision support systems and financial planning languages include Application System, Command Center, EXPRESS, FCS, IFPS, Info Center/1, Metaphor, SPSS-X, STRATAGEM, SYSTEM W, etc.

Application generators

An application generator consists of a software system with a number of program modules, preprogrammed for various functions. So that the programmer or user can simply state which function is needed for a particular application, and the system will select the appropriate modules and run a program to meet the user's needs. How is this shortcut possible? The answer is that many applications tend to perform in the same way. A module to calculate pay and print a paycheck clearly will work in many different industries. Producing reports – that is, information output – and updating files are also routine data processing operations. Thus, an application generator will select the pre-coded modules and alter them for your particular application. Where your application is unique, the application generator will provide a module that permits you to enter program code that will attend to these unique parts. Some examples of application generators are CA-UNIVERSE, FOCUS, FUSION, INGRESS, MAPPER System, NOMAD 2, SAS, CESP, IDEAL, LINC II, MANTIS, MARK V, NATURAL, PACBASE, RAPID/3000, TELON, UFO, etc. The Table13.2 summarizes some of the major differences between third-generation languages (3GLs) and fourth-generation languages (4GLs).

Table 13.2 Differences between 3GLs and 4GLs

Third-generation languages	Fourth-generation languages
Intended for use by professional programmers.	May be used by a non-programming end user as well as a professional programmer.
Requires specification of how to perform tasks.	Requires specification of what task is to be performed (system determines how to perform the task).
All alternatives must be specified.	Default alternatives are built-in; an end user need not specify these alternatives.
Requires large number of procedural instructions.	Requires far fewer instructions.
Code may be difficult to read, understand and maintain.	Code is easy to understand and maintain because of English-like commands.
Language developed for batch operation.	Language developed primarily for on-line use.
Can be difficult to learn.	Easy to learn.
Difficult to debug.	Easy to debug.
Typically file-oriented.	Typically database-oriented.

Natural Languages

Natural languages are still in the developmental stages, but they promise to have profound effect, particularly in the areas of artificial intelligence and expert systems. Two popular natural languages are LISP and PROLOG. Natural languages have two characteristics:

- They are designed to make the connections that humans have with computers more natural — more humanlike.
- They are designed to allow the computer to become "smarter" — to actually simulate the learning process by remembering and improving upon earlier information.

COMPILERS AND INTERPRETERS

For a high-level language to work on the computer it must be translated into machine language. There are two kinds of translators—compilers and interpreters—and high-level languages are called either compiled languages or interpreted languages.

In a compiled language, a translation program is run to convert the programmer's entire high-level program, which is called the source code, into a machine language code. This translation process is called compilation. The machine language code is called the object code and can be saved and either run (executed) immediately or later. Some of the most widely used compiled languages are COBOL, C, C++, FORTRAN, etc.

In an interpreted language, a translation program converts each program statement into machine code just before the program statement is to be executed. Translation and execution occur immediately, one after another, one statement at a time. Unlike the compiled languages, no object code is stored and there is no compilation. This means that in a program where one statement is executed several times (such as reading an employee's payroll record), that statement is converted to machine language each time it is executed. The most frequently used interpreted language is BASIC.

Compiler languages are better than interpreted languages as they can be executed faster and more efficiently once the object code has been obtained. On the other hand, interpreter languages do not need to create object code and so are usually easier to develop—that is, to code and test.

COMPILATION PROCESS

The objective of the compiler is to transform a program written in a high-level programming language from source code into object code. Programmers write programs in a form called source code. Source code must go through several steps before it becomes an executable program.

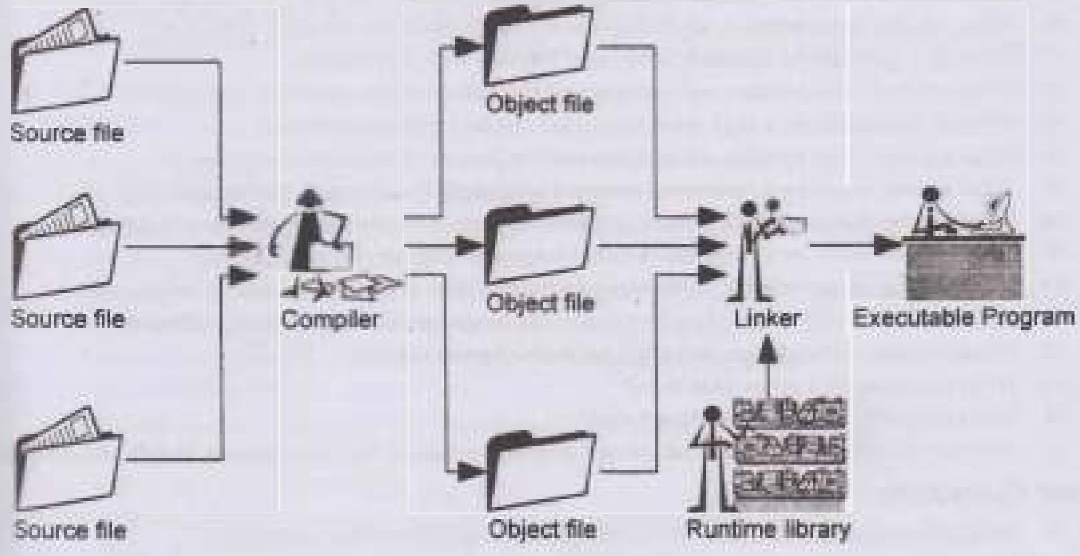


Figure 13.1 Compilation Process

The first step is to pass the source code through a compiler, which translates the high-level language instructions into object code. The final step in producing an executable program, after the compiler has produced object code, is to pass the object code through a linker. The linker combines modules and gives real values to all symbolic addresses.

Every high-level programming language comes with a compiler. In effect, the compiler is the language, because it defines which instructions are acceptable. Because compilers translate source code into object code, which is unique for each type of computer, many compilers are available for the same language. For example, there is a FORTRAN compiler for PCs and another for Apple Macintosh computers. In addition, the compiler industry is quite competitive, so there are actually many compilers for each language on each type of computer. More than a dozen companies develop and sell C compilers for the PC.

REVIEW QUESTIONS

Short Answer Questions

Q1. What is the language that the computer understands?

Q2. What is a programming language?

03. Name the five generations of programming languages.
04. Give the names of a few high-level languages.
05. How are high-level languages classified?
06. Give examples of procedure-oriented languages?
07. What do you mean by PC application software? Give examples.
08. What are query languages and report generators? Give examples.
09. What are decision support systems and financial planning languages? Give examples.
10. What are application generators? Explain with examples.

Descriptive Type Questions

01. What do you mean by machine language? Explain with an example.
02. What are the characteristics, advantages and limitations of the machine language?
03. What do you mean by assembly language? Explain with an example.
04. What are the characteristics, advantages and limitations of the assembly language?
05. What do you mean by a high-level language? Explain with an example.
06. What are the characteristics, advantages and limitations of high-level languages?
07. What do you mean by a procedure-oriented language? Explain with an example.
08. What are the characteristics, advantages and limitations of procedure-oriented languages?
09. What do you mean by a problem-oriented language? Explain with an example.
10. What are the characteristics, advantages and limitations of problem-oriented languages?
11. Explain the different types of problem-oriented languages and application generators.
12. What are natural languages and what are their characteristics?
13. What is a compiler? What does it do?
14. What is an interpreter? What does it do?
15. How are compilers different from interpreters and what are their advantages and disadvantages?

Essay Questions

01. Explain the characteristics and trends in the case of programming languages.
02. Explain the difference between third and fourth-generation languages.
03. What are compilers and interpreters? What are their features, advantages and limitations?
04. Explain the compilation process with the help of a diagram.

Fill in the Blanks

01. _________ is a set of rules that provides a way of instructing the computer to perform certain operations.
02. Pascal, COBOL and BASIC are _________ languages.
03. In machine language information is represented as _________ and _________.
04. Assembly languages are also known as _________.
05. Procedure-oriented languages are also known as _________ generation languages.
06. Problem-oriented languages are also known as _________ generation languages.
07. _________ are known as fifth-generation languages.
08. QMF and SQL are examples of _________.
09. TELON and UFO are examples of _________.
10. LISP and PROLOG are two popular _________ languages.

[**Answers:** (1) Programming language (2) High-level languages (3) 0s and 1s (4) Symbolic language (5) Third (6) Fourth (7) Natural (8) Query languages (9) Application generators (10) Natural]

True or False

01. JOVIAL and DOCTOR are two programming languages.
02. Machine languages are called second-generation languages.
03. In assembly languages instructions are written as a series of 0s and 1s.
04. Machine language is machine dependent.
05. Assembly languages are machine independent.
06. COBOL is a fifth-generation language.
07. QMF is a query language.
08. SPSS-X is an application generator.
09. LISP is a natural language.
10. Compiler translates machine code into high-level languages.

[Answers: (1) True (2) False (3) False (4) True (5) False (6) False (7) True (8) False (9) True (10) False]

Multiple Choice

01. Which of the following is represented as a series of 0s and 1s?
    (1) Machine language (2) Assembly language (3) High-level languages (4) None of the above
02. Which of the following is machine independent?
    (1) Machine language (2) Assembly language (3) High-level languages (4) All of the above
03. Which of the following is more English-like?
    (1) Machine language (2) Assembly language (3) High-level languages (4) None of the above
04. Which of the following is the lowest level programming language?
    (1) Machine language (2) Assembly language (3) Natural languages (4) None of the above
05. Fifth-generation languages are also called_________.
    (1) Machine language (2) Assembly language (3) Natural languages (4) None of the above
06. Which of the following is not a procedural language?
    (1) COBOL (2) LISP (3) FORTRAN (4) Pascal
07. Which of the following is a personal computer application software?
    (1) COBOL (2) PowerPoint (3) BASIC (4) None of the above
08. Which of the following is a report generator?
    (1) BASIC (2) LISP (3) TELON (4) RPG III
09. Which of the following is an application generator?
    (1) EXPRESS (2) Metaphor (3) MANTIS (4) PROLOG
10. Which of the following is an interpreted language?
    (1) COBOL (2) C (3) C++ (4) BASIC

[Answers: (1) Machine language (2) High-level language (3) High-level language (4) Machine language (5) Natural languages (6) LISP (7) PowerPoint (8) RPG III (9) MANTIS (10) BASIC]

CHAPTER 14

Operating Systems

TOPICS COVERED

- Introduction
- Functions of an operating system
- Classification of operating systems

Key Points

- An operating system manages and coordinates the functions performed by the computer hardware, including the CPU, input/output devices, secondary storage devices, and communication and network equipment.
- The operating system software must keep track of each hardware resource, determine who gets what, when the user will have access to the resource, allocate how much of the resource the user will be given, and terminate access at the end of the use period.
- Examples of popular microcomputer operating systems are Windows, Linux, and OS/2 for PCs, Mac OS for Apple computers, etc. Some examples of operating systems for minicomputers are UNIX, OS/400, etc. An example of an operating system for a mainframe is OS/z.
- The main functions of operating systems include job management, batch processing, on-line processing, data management, virtual storage, and input/output management.
- One way of classifying the operating systems is based on their use—desktop, server, mainframe, etc.
- Another way of classifying the operating systems is based on their capabilities and features—multi-user, multiprocessing, multitasking, multithreading, real time, etc.

INTRODUCTION

An operating system manages and coordinates the functions performed by the computer hardware, including the CPU, input/output devices, secondary storage devices, and communication and network equipment. Operating systems are the most important program that runs on a computer.

Every general-purpose computer must have an operating system to run other programs. Operating systems perform basic tasks, such as recognizing input from the keyboard, sending output to the display screen, keeping track of files and directories on the disk, and controlling peripheral devices such as disk drives and printers.

The operating system software must keep track of each hardware resource, determine who gets what, when the user will have access to the resource, allocate how much of the resource the user will be given, and terminate access at the end of the use period.

Operating systems vary in complexity from those that support single user microcomputers to those that handle multi-user mainframes. Their complexity depends on the computer system's size and scope, together with the type of performance provided to its users. A single stand-alone microcomputer will have a relatively simple operating system, whereas a mainframe that supports hundred of users accessing the system simultaneously will have one that is far more complex.

The primary purpose of an operating system is to maximize the productivity of a computer system by operating it in the most efficient manner and minimizing the amount of human intervention required. An operating system also simplifies the job of computer programmers, since it includes programs that perform common input/output and storage operations and other standard processing functions.

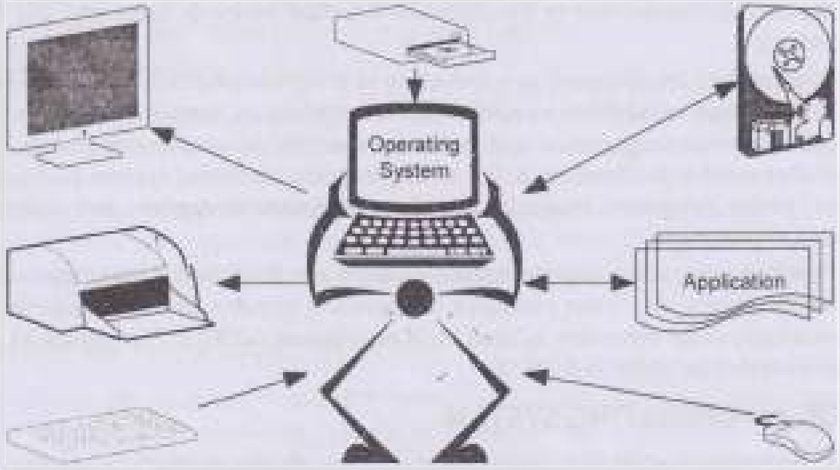


Figure 14.1 Functions of the Operating System

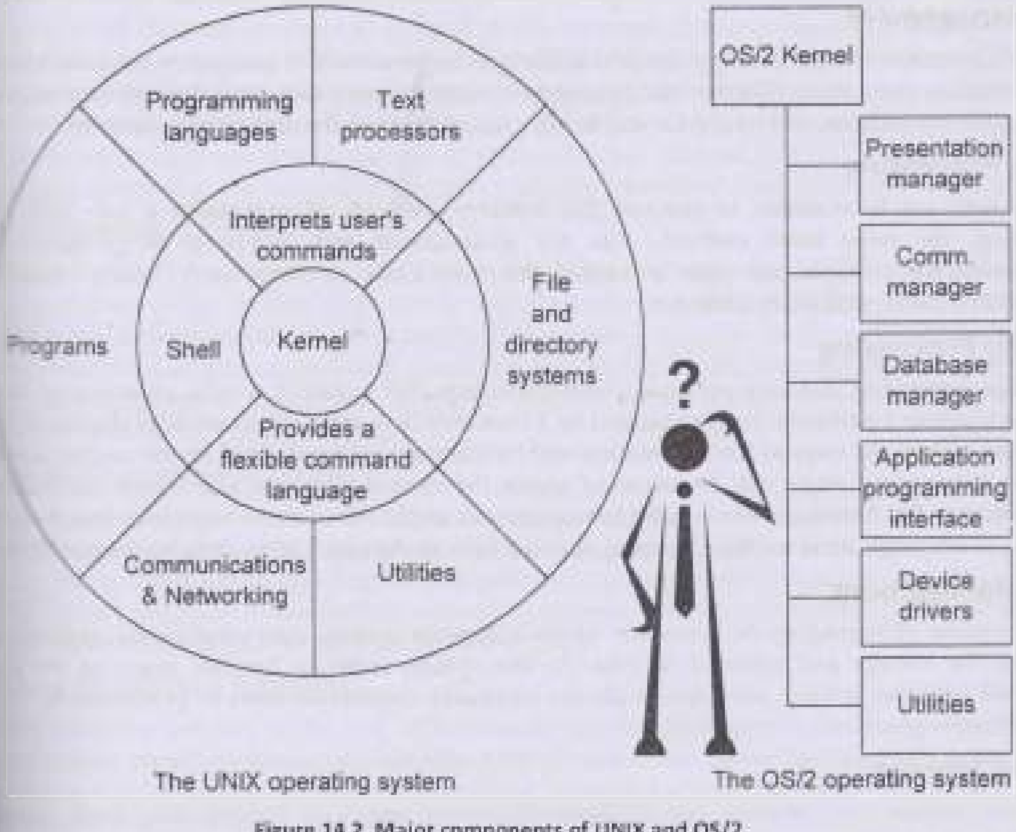


Figure 14.2 Major components of UNIX and OS/2

... have any hands-on experience on a computer, you know that the operating system must be ... and activated before you can accomplish other tasks. This emphasizes that operating systems are the most indispensable component of the software interface between users and the hardware of their computer systems.

Many operating systems are designed as a collection of program modules, which can be organized in combination with various capabilities around a central module, or kernel. Such operating systems can be tailored to fit the processing power and memory capability of a computer system and the type of processing jobs that need to be done on it. For example, some operating system packages include a selected number of utility programs, language translator programs (compilers and interpreters), and even some application programs.

Examples of popular microcomputer operating systems are Windows, Linux, and OS/2 for PCs, Mac OS for Apple computers, etc. Some examples of operating systems for minicomputers are UNIX, OS/400, etc. An example of an operating system for a mainframe is OS/z. The Figure 14.2 shows the programs that are included in UNIX and OS/2.

FUNCTIONS OF AN OPERATING SYSTEM

Even the simplest operating system in a minicomputer or mainframe performs a number of resource management tasks or functions. These functions include job management, batch processing, on-line processing, data management, virtual storage, and input/output management.

Job Management

Job management software manages the jobs waiting to be processed. It recognizes the jobs, identifies their priorities, determines whether the appropriate main memory and secondary storage capability they require is available, and schedules and finally runs each job at the appropriate moment.

Batch Processing

System software is available to support the different methods of processing a job. With batch processing, the most basic method, data are accumulated and processed in groups. Payroll applications, for example, are often processed this way. Once in every week, hourly records are grouped and the payroll software is run.

On-line Processing

In on-line processing, data are processed instantaneously. For example, a sales person may need to find out whether a particular item requested by a customer is in stock for immediate shipment. Using an on-line system the request for information will be instantly acknowledged by the on-line software and the appropriate steps will be taken to access the central database and return the requested information to the terminal from which the request was made. All of these steps take less than a few seconds, at the most. Most on-line operating systems have multi-user and multitasking capabilities.

Data Management

In the process of managing the resources of the computer system, operating system software also manages the storage and retrieval of data. As the system software handles many of the details associated with this process, such details are not a primary concern for users or programmers writing application programs.

Virtual Storage

Operating systems also manage the allocation of main memory to specific jobs. Some operating systems have a feature called virtual storage. With this software it is possible to increase the capacity of main memory without actually increasing its size. This is accomplished by breaking a job into sequences of instructions, called pages or segments, and keeping only a few of these in main memory

...time; the remainder are kept on secondary storage devices. As a result, relatively large jobs can be ...ed by a CPU that in fact contains a relatively small memory.

...t/Output Management

...ting systems also manage the input to and output from a computer system. This applies to the ... of data among computers, terminals, and other devices such as printers. Application programs ... the operating system extensively to handle input and output devices as needed. For large systems, ... operating system has even greater responsibilities and powers. It is like a traffic policeman — it ... sure that different programs and users running at the same time do not interfere with each ... The operating system is also responsible for security, ensuring that unauthorized users do not ... the system.

...ASSIFICATION OF OPERATING SYSTEMS

... way of classifying the operating systems is based on their use—desktop, server, mainframe, etc. ... way of classifying the operating systems is based on their capabilities and features—multi-... multiprocessing, multitasking, multithreading, real time, etc. We will see each of these in the ...ing sections.

...ktop Operating Systems

...ting systems that run on desktop computers are the most common. Generally the operating ... in this category include Windows, Mac OS and DOS. Windows in its many versions (XP and ... is currently the leading desktop operating system, running on over 90% of all new systems sold. ... OS runs on Apple Macintosh and Power PC and was the first widely used operating systems with ...ical interface. DOS was first introduced in 1980 with IBM's original IBM PC. This rapidly dying ... operating system is at the low end of the scale, with character-based interface, single tasking, etc.

...er Operating Systems

...ters in a modern organization's networks are connected to one another not directly but through ... computers called servers that provide security to the networks and route traffic from one ... to another, complicated tasks requiring special operating systems. These powerful 32 or 64-bit ... systems are secure, multitasking, multithreading and open. All have recently had graphical ... interfaces developed for them. Some examples of server operating systems are UNIX, Windows ... 2008, eComStation(formerly OS/2), etc.

...frame Operating Systems

... days when mainframes and minicomputers dominated the computing world, each computer ... developed its own operating system. For example, some IBM mainframe computers use an ... system called OS/z and Digital Equipment Corporation minicomputers use one called ...MS. These companies developed not only their own operating systems but also the applications ... on top of them. These are called proprietary systems.

...i-user Operating Systems

...-user operating systems allow two or more users to run programs at the same time. Some ... systems permit hundreds or even thousands of concurrent users. The operating systems of ...es and minicomputer are multi-user systems. Examples are z/OS, UNIX, etc. Another term ...-user is time-sharing.

Multiprocessing Operating Systems

Multiprocessing refers to a computer system's ability to support more than one process (program) at the same time. Multiprocessing operating systems enable several programs to run concurrently. Z/OS and UNIX is two of the most widely used multiprocessing systems, but there are many others, including eComStation for high-end PCs. Multiprocessing systems are much more complicated than single-process systems, because the operating system must allocate resources to competing processes in a reasonable manner. Multiprocessing also refers to the utilization of multiple CPUs in a single computer system. This is also called parallel processing.

Multitasking Operating Systems

Multitasking allows more than one program to run concurrently. Multitasking is the ability to execute more than one task at the same time, a task being a program. The terms multitasking and multiprocessing are often used interchangeably, although multiprocessing sometimes implies that more than one CPU is involved. In multitasking, only one CPU is involved, but it switches from one program to another so quickly that it gives the appearance of executing all of the programs at the same time. There are two basic types of multitasking: Preemptive and Cooperative

In **preemptive multitasking**, the operating system parcels out CPU time slices to each program. In **cooperative multitasking**, each program can control the CPU for as long as it needs it. If a program is not using the CPU, however, it can allow another program to use it temporarily. eComStation, Windows Vista, Windows Server 2008, the Amiga operating system and UNIX use preemptive multitasking, whereas Microsoft Windows Vista and the MultiFinder (for Macintosh computers) use cooperative multitasking.

Multithreading Operating Systems

Multithreading allows different parts of a single program to run concurrently. Multithreading is the ability of an operating system to execute different parts of a program, called threads, simultaneously. The programmer must carefully design the program in such a way that all the threads can run at the same time without interfering with each other.

Real-time Operating Systems

Real-time operating systems are systems that respond to input immediately. This category includes operating systems designed substantially for the purpose of controlling and monitoring external activities with timing constraints. They are used for such tasks as navigation, in which the computer must react to a steady flow of new information without interruption. Most general-purpose operating systems like DOS and UNIX are not real-time because they can take a few seconds, or even minutes, to react. Some examples of real-time operating systems are:

- ▲ Basic Real-time Monitor (Real-time OS for the Phillips P-855 and P-860)
- ▲ BLMX (Board-level multitasking executive for National Semiconductor 8080 and Z-80 based CPU boards)
- ▲ BSO/RTOS (Small real-time OS for Z80, 6809, 8086, 68000. Boston Systems Office)
- ▲ C Executive (Memory-based real-time UNIX-like executive for the PDP-11 or VAX)
- ▲ CCP (Communications Control Program. Limited OS for the IBM System/3)
- ▲ CTOS (Real-time, multitasking, multiprocessing OS for 8086 family)
- ▲ CTRON (Specification for a version of TRON for communication and network control)

- DES RT (Real-time, Unix-like OS for 16-bit microprocessor families and Micro-VAX, DGC MV series)
- DMERT (The Duplex Multiple Environment Real Time Operating System)
- FADOS (Operating System for the Fast Amsterdam Multiprocessor (FAMP). A distributed, Real-time OS based on a network of M68000s with a UNIX host)
- iRMX (Real-time multitasking executive for Intel 8086 family CPUs)

Operating systems provide a software platform on top of which other programs, called applications programs can run. The applications programs must be written to run on top of a particular operating system. Your choice of operating system, therefore, determines to a great extent the applications you can run. As a user, you normally interact with the operating system through a set of commands. For example, the DOS operating system contains commands such as COPY and RENAME for copying files and changing the names of files, respectively. The commands are accepted and executed by a part of the operating system called the command processor or command line interpreter. Graphical user interfaces (GUIs) allow you to enter commands by pointing and clicking at objects that appears on the screen. Microsoft Windows is an operating system, which uses a graphical user interface.

REVIEW QUESTIONS

Short Answer Questions

1. What is the primary purpose of an operating system?
2. How does the operating system simplify the job of computer programmers?
3. What is a kernel?
4. Give some examples of microcomputer operating systems.
5. Name a few operating systems for the minicomputers and mainframes.
6. What are the functions of an operating system?
7. How are operating systems classified based on their use?
8. How are operating systems classified based on their capabilities and features?
9. What do you mean by time sharing?
10. What do you mean by multitasking?
11. What is multithreading?
12. Name a few real time operating systems.

Descriptive Type Questions

1. What is an operating system?
2. What are the tasks performed by operating systems?
3. What do you mean by job management?
4. What is batch processing?
5. What do you mean by on-line processing?
6. How is on-line processing different from batch processing?
7. What do you mean by data management?
8. What is virtual storage?
9. What do you mean by input/output management?
10. What is a desktop operating system? Explain with an example.
11. What are server operating systems? Give a few examples.
12. What are mainframe operating systems?

13. What are multi-user operating systems? Explain.
14. What are multiprocessing operating systems?
15. What are the two types of multitasking?
16. What are multitasking operating systems?
17. What are multithreading operating systems?
18. What are real time operating systems?

Essay Questions

01. Explain the functions of an operating system.
02. Explain the classification of operating systems based on their use.
03. Explain the classification of operating systems based on their features and capabilities.

Fill in the Blanks

01. __________ is the most important program that runs on a computer.
02. The central module of an operating system is called __________.
03. DOS, Windows and eComStation are operating systems for the __________.
04. The most commonly used operating system for the IBM mainframe is __________.
05. The __________ software of the operating system manages the jobs waiting to be processed.
06. In __________ data are processed instantaneously.
07. __________ operating systems allow two or more users to run programs at the same time.
08. __________ operating systems enable several programs to run concurrently.
09. __________ allows more than one program to run concurrently.
10. __________ allows different parts of a single program to run concurrently.

[Answers: (1) Operating Systems (2) Kernel (3) Microcomputer (4) OS/z (5) Job management (6) [illegible] processing (7) Multi-user (8) Multiprocessing (9) Multitasking (10) Multithreading]

True or False

01. Every general-purpose computer must have an operating system to run other programs.
02. The primary purpose of an operating system is to maximize the productivity of a computer [illegible]
03. Many operating systems are designed as a collection of program modules.
04. PS/2 is the operating system for Apple computers.
05. The most popular microcomputer operating system is z/OS.
06. DOS and Windows are operating systems for the PC.
07. UNIX and OS/400 are examples of operating systems for the minicomputers.
08. Another term for multi-user is time-sharing.
09. z/OS is a multi-user operating system.
10. Multitasking is also called parallel processing.

[Answers: (1) True (2) True (3) True (4) False (5) False (6) True (7) True (8) True (9) True (10) [illegible]

Multiple Choice

01. Which of the following is the most important program in a computer
    (1) Word processor (2) Spreadsheet (3) Presentation graphics (4) None of the above
02. What is the primary purpose of the operating system?
    (1) Productivity maximization (2) Coding (3) Testing (4) Maintenance
03. Which of the following is not an operating system?
    (1) z/OS (2) UNIX (3) DOS (4) DB2
04. Which is the operating system for IBM PS/2 computers?

(1) CICS/2 (2) DB/2 (3) OS/2 (3) None of the above

05. Which of the following is not a multi-user operating system?
(1) DOS (2) UNIX (3) Z/OS (4) All the above

06. Which of the following is a multiprocessing system?
(1) Z/OS (2) UNIX (3) OS/2 (4) All of the above

07. Which of the following operating systems allows multitasking?
(1) OS/2 (2) Windows (3) Amiga (4) All of the above

08. Which of the following is not a real-time operating system?
(1) BLMX (2) CCP (3) CTOS (4) DOS

[**Answers:** (1) None of the above (2) Productivity Maximization (3) DB2 (4) OS/2 (5) DOS (6) All of the above (7) All of the above (8) DOS]

CHAPTER 15

General Software Features and Trends

TOPICS COVERED

- Introduction
- Ease of use
- Graphical User Interface (GUI)
- More features
- Need for powerful hardware
- Software quality and reliability
- Software security
- Multiplatform capability
- Compatibility with other software
- Object Linking and Embedding (OLE)
- Groupwork capabilities
- Open source software
- Distributed computing
- Service Oriented Architecture (SOA)
- Embedded systems
- Mail enabling
- Web enabling
- Cloud computing
- Network computing
- Software-as-a-Service (SaaS)
- Mobile computing

Key Points

- Software is instructions to the computer. A [illegible] instructions that perform a particular task is called a prog[illegible]
- The two major categories are system softw[illegible] application software.
- System software is made up of control programs, [illegible] the operating system, communications software and [illegible] manager.
- Application software is any program that processes [illegible] the user (inventory, payroll, spreadsheet, word processor, [illegible]
- In today's world, software projects are becoming [illegible] more complex – in size, sophistication, and technologies [illegible]
- Some of the features of the new software are [illegible] graphical user interface, more features, need for [illegible] hardware, better quality and reliability, better [illegible] multiplatform capability, compatibility with other softw[illegible] enabling, web enabling, etc.
- Some of the technologies that drive the [illegible] development are collaborative computing, [illegible] computing, cloud computing, network computing, and [illegible] computing.
- Some of new trends are open source software, [illegible] oriented architecture, software-as-a-service, etc.

INTRODUCTION

Software is instructions to the computer. A series of instructions that perform a particular task [illegible] a program. The two major categories are **system software** and **applications software**. System [illegible] is made up of control programs, including the operating system, communications soft[illegible] database manager. Applications software is any program that processes data for the user ([illegible] payroll, spreadsheet, word processor, etc.). A common misconception is that software is also [illegible] not; software tells the hardware how to process the data.

In today's world, software projects are becoming more and more complex – in size, soph[illegible] and technologies used. Now most software products cater to millions of users, they suppor[illegible] national languages and come in different sizes and shapes – desktop, standard, professional, [illegible] and so on. For example, operating systems, word processors, and even Enterprise Resource [illegible]

ERP) packages support multiple languages (and in the case of ERP systems, multiple currencies!). Almost all application software products (like word processors, ERP packages, and even SCM tools) support more than one hardware and/or software platform. For example, we have ERP systems that run on mainframes and client/server systems; different versions of web browsers for the PC and Mac; we have database management systems that run on MVS, UNIX, Windows NT, Linux and so on. The competition and the advancements in technology are driving software vendors to include additional functionality and new features to their products—just to stay in business.

The Information Technology is revolutionizing the way we live and work. It is changing all aspects of our life and lifestyle. The digital revolution has given mankind the ability to treat information with mathematical precision, to transmit it at very high accuracy and to manipulate it at will. These capabilities are bringing into being a whole world within and around the physical world. The amount of calculational power that is available to mankind is increasing. Computers and communications are becoming integral parts of our lives. The driving force behind all these advancements is the computer software. Computer software is becoming more and more complex and the amount of software that is being developed each year is increasing at an exponential rate. Also the software is being used to control a range of activities from mission critical applications like controlling the operations of satellites and Intercontinental Ballistic Missiles (ICBMs), managing the functioning of banks and hospitals, handling the airline and railway reservation systems, etc. to performing mundane tasks like operating a door locking system or for desktop publishing.

Another aspect of software that has changed is the complexity. In the early days of software development, computer programs were typically less than 1000 machine instructions in size and required only one programmer to write and seldom took more than a month to complete and the entire development costs were often less than $5000. But today, some of the large systems exceed 25 million source code statements and usually require thousands of programmers and may take more than five years to complete, with the development costs in the range of $500 million.

In the early days of software development all the parts or modules of a software system were developed in the same place. But the different components of today's complex software systems are not even built by the same organization. Many software systems are built jointly by different organizations working from different parts of the world. They may communicate via the Internet, using e-mail or videoconferencing technologies. So in this distributed development environments where face-to-face communication is rare, managing and coordinating the development process is a difficult task.

This increasing demand for new software, the necessity to modify or maintain the existing software and the increasing complexity of software development process and the critical nature of the applications in which software is being used, all necessitates that the software development cannot be done as it was done during the early days. Software has become the central component in many complex activities. For this reason, the challenge of producing it requires specialized and powerful techniques. It is not possible to rely on luck, guesswork and innate talent for dependable results.

Software systems are subject to constant changes—during design, development and even after development. The pioneering work in this area has been done by Lehman and Belady and is detailed in a set of laws called Lehman's Laws. According to Lehman's Law of Continuing Change, any large software system that is being used will undergo continual change because the system's use will suggest additional functionality. It will change until it becomes more cost-effective to rewrite it from scratch. This means that the software will be subject to constant changes other than the bug fixes and errors that are already in the software and which will be detected during and after its development. That is not all; the software system that is perfectly developed and which had met all the requirements and passed all the audits and reviews will also change. According to Lehman, even if a system wa built in complete conformance to the requirements, the system would still evolve because the sys introduced into the real world and the environment into which the system is introduced is subj change. So in order to adapt to the changes in the environment in which the system works, it ha change. In other words, no matter how perfectly you had built the system, it will have to be chang meet the changes in the environment. So it is clear that the only constant thing about the softwa change. If the changes are not managed then it will lead to chaos and confusion. So a mechanis managing the change and controlling it is required.

Now we have seen that software products and systems are becoming larger, more compl more sophisticated. In this chapter we will discuss some of the trends that will play a vital role development of software products of today and tomorrow.

EASE OF USE

The software systems and applications are becoming more and more easy to use. In fact, so developers and system analysts go to great lengths to ensure that the products they develop ar friendlier than their competitor's products. Also, if one analyzes the newer versions of the products, one can see that with each new version, software applications become more and mo friendly. The user interfaces are more intuitive, the error messages are more descriptive, th context sensitive help, there are tutorials and Computer-based Training (CBT) to teach how to software, and there are wizards and templates to help the user when he/she encounters a prob software systems have come a long way in the case of ease of use and in the future we w software that are more user friendly which will provide expert advice and assistance in perform tasks using the software.

GRAPHICAL USER INTERFACE (GUI)

GUI or Graphical User Interface has now become the de facto standard for most of the s applications. Gone are the days of the crude character based interfaces of UNIX and DOS ap Today's software applications and products provide the users with intuitive, graphical and eas interfaces. Now the users do not have to remember the cryptic system commands or shortcut k were a must in the character based era. Now almost any task can be accomplished by a mou For example, in a DOS environment, to copy a file one needs to know the command for copyi its exact syntax, etc., whereas in the Windows environment, you just have to drag the files you copy from the source to destination. Similarly, almost all the tasks could be performed b clicks. The user is presented with dialog boxes and step-by-step instructions to perform th without any problem. In fact, in many cases, the software guides the users using icons, dial and other graphical elements so that even a novice can perform the task without any assistance.

Today, the GUI standards have evolved and this has helped users in reducing the learni of a new software application and increased the ease of use. Microsoft and Apple have develo standards, which is used in all their products. All the companies that make products for the operating system follows the Microsoft's GUI standards, while all applications made for follow Apple's GUI standards. In addition to standardizing the GUI, the major software dev companies have made the interface uniform across product families. This makes learning and application very easy if one is familiar with another application in that product family. For the interfaces of all the products in the Microsoft Office—Word, Excel, PowerPoint, Outlo

Publisher, etc.—has the same interface. So if you know how to use Word, then learning Excel or PowerPoint is relatively easy.

MORE FEATURES

The number of new software companies and the number of new software products are increasing day by day. Software marketplace is witnessing a fierce battle for survival. Each organization is fighting for its survival and in order to survive they have to be constantly innovative and be always ahead of the competition. In this race for survival among software vendors, the ultimate winner is the end-user. The end-user will get better products; products which are loaded with features at affordable prices. The software products are becoming 'feature-rich' with each version. Consider the example of Microsoft Word. With each new version, Microsoft has introduced new features and the product has become easier to use and has evolved from a word processor into a full-featured desktop publishing program.

NEED FOR POWERFUL HARDWARE

We have seen that the software vendors are incorporating more and more features into their products with every new version. This has given the users better and easy to use products, which in turn has made the life of the users easy as more and more tasks are getting automated and the programs are becoming more and more intelligent. But all the efficiency and improvements have a price. These new software programs need more powerful machines to run. They need more main memory, more secondary storage, and faster and powerful processors. For example, a few years back, a machine with a Pentium IV processor was considered enough to run most of the programs that a person needs like a word processor, a spreadsheet, presentation software and a web browser and an e-mail client. But if one tries to run the latest applications or the latest versions of the same software programs that ran on a Pentium IV machine, on the same machine, either the machine will crash (or hang) or the programs will run agonizingly slow. Today's software programs need faster and powerful processors, more RAM, more disk space, etc. For example, today an entry-level computer will have a configuration that is more powerful than an advanced machine a few years back. The hardware prices have nose-dived and hence the users are not very much affected by the demand for more powerful machines by the new software applications.

SOFTWARE QUALITY AND RELIABILITY

As we increasingly integrate software into mission and safety critical systems, we need robust applications that are highly reliable and fault tolerant. In order to achieve the desired reliability strict quality assurance procedures, new testing methods, new programming methodologies, etc. are used.

Many fields of software engineering like software configuration management, quality assurance, project management, etc. are playing crucial roles in making the software applications bug free, reliable, and safe for use in mission critical applications. The need for mission critical and zero defect software applications will continuously increase and the software engineering fields that deal with improving software quality will evolve further and best practices and certification processes that ensure that the software is built in the best possible method and meet the stringent operational requirements will gain prominence.

SOFTWARE SECURITY

Software security is becoming one of the most important and critical issue for software development. As the number of security threats and attacks increase, the software applications need to be more secure. Software security is the idea of engineering software so that it continues to function correctly under malicious attack. Most technologists acknowledge this undertaking's importance, but they some help in understanding how to tackle it.

The software security field is a relatively new one. The field's recent appearance is one reason best practices are neither widely adopted nor obvious. A central and critical aspect of the security problem is a software problem. Software defects with security ramifications—including implementation bugs such as buffer overflows and design flaws such as inconsistent error handling—promise to be with us for years. All too often, malicious intruders can hack into systems by exploiting software defects. Internet-enabled software applications present the most common security encountered today, with software's ever-expanding complexity and extensibility adding further the fire. By any measure, security holes in software are common, and the problem is growing.

Software security is about building secure software: designing software to be secure, making that software is secure, and educating software developers, architects, and users about how to secure things. On the other hand, application security is about protecting software and the that software runs after development is complete. Issues critical to this subfield include code (as the Java virtual machine does), protecting against malicious code, obfuscating code, down executables, monitoring programs as they run (especially their input), enforcing the use policy with technology, and dealing with extensible systems.

Application security follows naturally from a network-centric approach to security, by standard approaches such as penetrate and patch and input filtering (trying to block malicious and by providing value in a reactive way. Put succinctly, application security is based finding and fixing known security problems after they have been exploited in fielded systems.

Software security—the process of designing, building, and testing software for security—and expunges problems in the software itself. In this way, software security practitioners build software that can withstand attack proactively. Consider the following example: although is some real value in stopping buffer overflow attacks by observing HTTP traffic as it arrives 80, a superior approach is to fix the broken code and avoid the buffer overflow completely. security ensures that the applications and data are safe from any threats by ensuring that the is built without vulnerabilities and backdoors preventing the hackers from exploiting a coding flaw.

MULTIPLATFORM CAPABILITY

Today's software applications are not developed for just one platform. Most of the applications supports multiple platforms—both hardware and software platforms. There are applications that support hardware platforms ranging from mainframes to PCs and different platforms like MVS, Solaris, AIX, UNIX, Windows and so on. For example, IBM's DB2 database is available for a variety of hardware and software platforms. Another important today's software application is that they support multiple languages and multiple currencies. vendors are providing their applications in many languages like English, Arabic, Japanese, etc.

COMPATIBILITY WITH OTHER SOFTWARE

Now the competition for each market segment in the software marketplace is rather fierce. many software vendors battling for the market share in the same segment. For example, word processor or spreadsheet market. We have more than a dozen vendors in each of these What does this intense competition mean? It means that the users will get better products. creates many problems to the software vendors. In order to woo users from the competition, software vendors are making their software compatible with their competitors. Thus users of a software can migrate or convert all his/her existing files to the other system without any trouble. For example, you can import WordPerfect documents, text documents, HTML documents and so on into a Microsoft Word document. Also you can create these documents—WordPerfect, HTML, plain text, etc.—using Word. So by incorporating the feature to create and use documents from/for other applications, Microsoft is providing the users of other word processing packages the capability to easily shift to Word. Almost all vendors practice this technique to stay and survive in business. Also as newer versions of the software are released, most vendors maintain backward compatibility—compatibility with earlier versions. For example, Microsoft Word 2007 supports most of previous versions of Word like Word 2003, 2002 and 1997. These two features—backward compatibility and compatibility with other products make it easier for the users, as they can choose the application they want and still use the old files they have created using other applications or using older versions of the same application.

OBJECT LINKING AND EMBEDDING (OLE)

For a software system to interact with other software systems such as tools or components there needs to be some mechanism. For example, an application that you have created could call an external display tool to display the on-line help, or it could embed a spreadsheet from a spreadsheet program or an image from a graphic program. One of the methods to integrate external tools into an application is using the Object Linking and Embedding (OLE) architecture. It is used to link or embed a component from another application running on your computer. OLE is a compound document standard developed by Microsoft Corporation. It enables you to create objects with one application and then link or embed them in a second application. Embedded objects retain their original format and links to the application that created them. When an embedded object (document, drawing, etc.) is clicked, the application that created it is launched, and the object can be edited. Changes made to the embedded object affect only the document that contains it. Support for OLE is built into the Windows and Macintosh operating systems. This embedding and linking of components enables applications to share components.

GROUPWORK CAPABILITIES

In today's complex business environment, working as a team is absolutely essential. Also the automation of workflow using computers reduces paperwork and leads to paperless offices where paper documents and forms are replaced by electronic documents. The two technologies that are at the center of these trends—collaborative working, information sharing, electronic forms, document and image management—are groupware and workflow automation.

Groupware is an umbrella term describing the electronic technologies that support person-to-person collaboration. Groupware includes e-mail, Electronic Meeting Systems (EMS), Desktop Video Conferencing (DVC) as well as systems for workflow and Business Process Re-engineering (BPR).

Technologies, which support collaboration, are in greater demand today than ever before and in recognition of that fact, vendors are integrating collaboration technologies into their products. Distributed workforces, information overload, and getting products to market as quickly as possible are a few of the motivational aspects pushing collaboration technology development. In this chapter we will discuss many of the issues fundamental to groupware strategy and success. Groupware supports the efforts of teams and other paradigms, which require people to work together, even though they may not actually be together, in either time or space. Groupware maximizes human interaction while minimizing technology interference.

The terms 'groupware' and 'collaborative computing' are often used interchangeably when in fa they are different. Groupware is basically a subset of collaborative computing. Collabora computing refers to the technology that is the hardware, software and structures that support gro working. Groupware is the software system that allows communication, coordination and the shar of information between individuals and groups. It provides support to groups of people engaged common task and facilitates this by providing a shared interface.

Before the advent of workflow automation, all workflow was manually implemented. Typica the steps in a task required the participants to review a file with forms and documents. Aft participant has completed the review and filled out the pertinent sections of the form, the containing the form and documents was manually routed to the person who has to perform the step. The participants were trained about the rules, which dictate the routing or instructions w provided in the file folder itself. To track the status of the task one had to go around and ask whe was. There was no easy means of finding tasks, which are late or lost in the paperwork. And no had any idea about the cost of the process.

The pervasive use of personal computers, networks and e-mail has made it possible to autom workflow. Computer software provides an excellent means of replacing paper forms with intellig electronic forms. Databases provide a means of storing vast amounts of information, which used reside in file cabinets. Networking has spawned e-mail, which in turn provides an excellent almost instantaneous means of routing information. Finally the inherent computing capabilit computers provides a virtually unlimited resource to control, monitor and measure workf processes.

OPEN SOURCE SOFTWARE (OSS)

Open Source Software (OSS) began as a marketing campaign for free software. OSS can be defin computer software for which the human-readable source code is made available under a copy license (or arrangement such as the public domain) that meets the Open Source Definition. T permits users to use, change, and improve the software, and to redistribute it in modified unmodified form. It is very often developed in a public, collaborative manner. In general, open so refers to any program whose source code is made available for use or modification as users or developers see fit. Historically, the makers of proprietary software have generally not made s code available. Open source software is usually developed as a public collaboration and made f available.

Open Source is also a certification mark owned by the Open Source Initiative (OSI). Develop software that is intended to be freely shared and possibly improved and redistributed by others use the Open Source trademark if their distribution terms conform to the OSI's Open S Definition. To summarize, the Definition model of distribution terms require that:

- The software being distributed must be redistributed to anyone else without any restricti
- The source code must be made available (so that the receiving party will be able to impr modify it)
- The license can require improved versions of the software to carry a different name or ve from the original software

Open Source is the result of a long-time movement towards software that is developed improved by a group of volunteers cooperating together on a network. Many parts of the operating system were developed this way, including today's most popular version, Linux. Linu applications from the GNU project, which was guided by Richard Stallman and the Free S ndation. The Open Source Definition, spearheaded by Eric Raymond (editor of The New Hacker's ctionary), is an effort to provide a branded model or guideline for this kind of software distribution redistribution. The OSI considers the existing software distribution licenses used by GNU, BSD (a -distributed version of UNIX), X Window System, and Artistic to be conformant with the Open Definition.

rior to its acquisition by AOL, Netscape, in an effort to stay viable in its browser competition Microsoft, made its browser source code (codenamed Mozilla) freely available, encouraging to improve it. Possible enhancements will presumably be incorporated into future versions. pen source movement has gained momentum as commercial enterprises have begun to consider as an open alternative to Windows operating systems.

open source suite of business applications from OpenOffice.org that runs on Windows, Mac, and various Unix versions. Founded by Sun which is its main supporter, OpenOffice.org is a edition of Sun's StarOffice. Compatible with Microsoft Office files, OpenOffice includes a word or, spreadsheet, presentation graphics and drawing program and provides access to popular . In 2000, Sun turned over the source code of StarOffice to the OpenOffice.org community, is made up of thousands of developers.

day hundreds of open source software catering to every need of computer users is available. source software is becoming popular and more and more people are using it. But whether completely replace the commercial software is something only time will tell.

RIBUTED COMPUTING

al, distributed computing is any computing that involves multiple computers remote from that each has a role in a computation problem or information processing. Distributed is a type of computing in which different components and objects comprising an can be located on different computers connected to a network. For example, a word application might consist of an editor component on one computer, a spell-checker object computer, and a thesaurus on a third computer. In some distributed computing systems, three computers could even be running a different operating system.

the requirements of distributed computing is a set of standards that specify how objects te with one another. There are currently two main distributed computing standards: and DCOM. CORBA stands for Common Object Request Broker Architecture, an architecture pieces of programs, called objects, to communicate with one another regardless of what ng language they were written in or what operating system they are running on. CORBA ped by an industry consortium known as the Object Management Group (OMG). DCOM Distributed Component Object Model, an extension of the Component Object Model (COM) COM components to communicate across network boundaries. DCOM uses the Remote Call (RPC) mechanism to transparently send and receive information between COM (i.e., clients and servers) on the same network.

are many different types of distributed computing systems and many challenges to successfully designing one. The main goal of a distributed computing system is to connect resources in a transparent, open, and scalable way. Ideally this arrangement is drastically lerant and more powerful than many combinations of stand-alone computer systems.

most organizations use distributed systems because of their advantages including improvements, high reliability and availability. But designing and developing distributed is very difficult because of the complexities involved. Different parts of a distributed application reside on different systems that could be running multiple operating systems. In a distributed system, databases from different vendors, application modules written in different languages and programming environments, different hardware platforms, different network topologies, etc. must be seamlessly integrated. This is a very difficult task and developing software applications in such an environment—the distributed computing environment—is a challenge. But the benefits of distributed applications far outweigh the developmental challenges and in future we will see more and more distributed applications.

SERVICE ORIENTED ARCHITECTURE (SOA)

SOA is the modularization of business functions for greater flexibility and reusability. Instead of building monolithic applications for each department, an SOA organizes business software in a granular fashion so that common functions can be used interchangeably by different departments internally and by external business partners as well. The more granular the components (the more pieces), the more they can be reused.

SOA provides methods for systems development and integration where systems group functionality around business processes and package these as interoperable services. SOA also describes IT infrastructure which allows different applications to exchange data with one another as they participate in business processes. Service-orientation aims at a loose coupling of services with operating systems, programming languages and other technologies which underlie applications. SOA separates functions into distinct units, or services, which developers make accessible over a network in order that users can combine and reuse them in the production of business applications. These services communicate with each other by passing data from one service to another, or by coordinating an activity between two or more services. SOA concepts are based on and evolving from older concepts of distributed computing and modular programming.

SOA is a way of thinking about IT assets as service components. When functions in a large application are made into stand-alone services that can be accessed separately, they are beneficial to several parties. An SOA is implemented via Application Programming Interface (API) that allows components to communicate with each other. The most popular interface is the use of XML over HTTP, known as "Web services." However, SOAs are also implemented via .NET and J2EE/RMI as well as CORBA and DCOM, the latter two being the earliest SOA interfaces, then known as "distributed object systems."

EMBEDDED SYSTEMS

An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular kind of application device. Industrial machines, automobiles, medical equipment, cameras, cellular phones, PDAs, household appliances, airplanes, vending machines, and toys are among the myriad possible hosts of an embedded system.

Embedded systems that are programmable are provided with a programming interface, and embedded systems programming is a specialized occupation. Certain operating systems or language platforms are tailored for the embedded market, such as EmbeddedJava and Windows XP Embedded.

Increasingly, applications such as pacemakers, power-plant controllers, and flight-critical avionics systems embed intelligence in physical devices and systems. Because these applications are inextricably connected to the physical environment, developers must design them to satisfy physical demands and limitations—such as dynamics, noise, power consumption, and physical size—in a timely manner. So the development of software programs for these sophisticated and mission-critical systems is a complex and challenging task and the complexity will continue to increase as the systems become more and more sophisticated and complex.

E-MAIL ENABLING

The mail enabling of an application is the process through which e-mail is gradually replacing many of the single purpose applications now used on personal computers. In its simplest form, a mail-enabled application is a Windows program that has a 'Send' command in its 'File' menu. For example, the Microsoft Word 2007 has a 'Send' menu item where you can choose to send the document to a mail recipient, fax recipient and so on as shown in Figure 15.1.

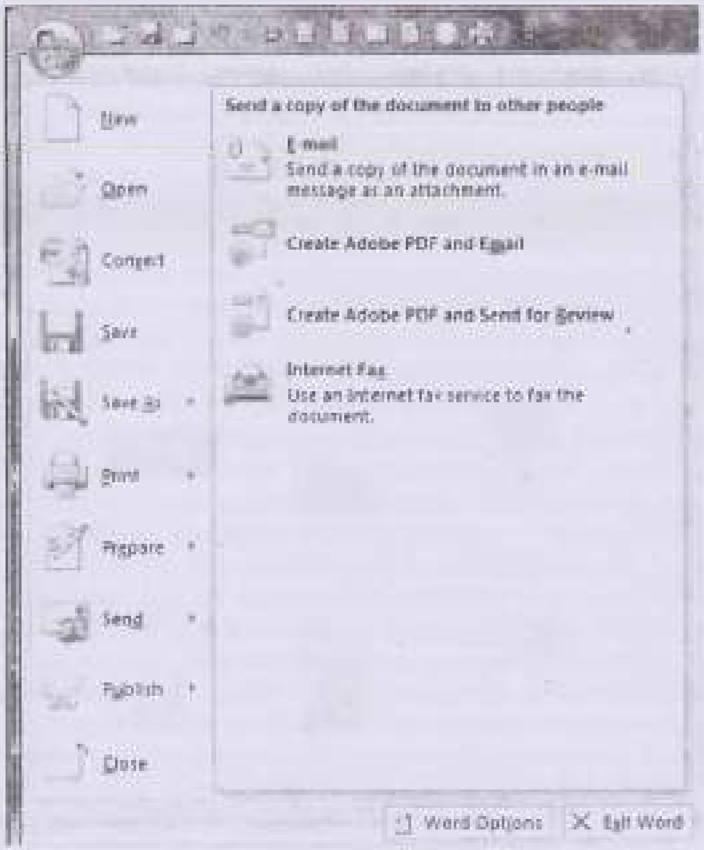


Figure 15.1 Mail-enabled Application

If you choose the mail recipient, then the document will be sent as an attachment using your default e-mail client to the address you specify. This is the most rudimentary form of mail enabling. The advanced and more sophisticated mail-enabled applications support networked and group applications like workflow management, document routing, process scheduling and electronic conferences. One step in this evolution has been the development of application suites, whose components can exchange information with one another. The next step is for the applications on multiple desktops and systems to talk to one another. Mail enabled applications are designed to operate on e-mail. At the outset, at least, these are the familiar word processors, spreadsheets, and

CHAPTER 21

Computer Networks

TOPICS COVERED

- Introduction
- Overview of a network
- Communications processors
- Communications media
- Telecommunications software
- Types of networks
- Network topology
- Network protocols
- Network architecture

Key Points

- Telecommunication is the sending of information in form from one place to another using electronic or light emi media.
- A communications network is any arrangement wh sender transmits a message to a receiver over a cha consisting of some type of medium. The network consists of basic components: terminals, telecommunication proces telecommunication channels and media, computers telecommunications software.
- Communications processors enhance data communica between two points. Communication processors include following: modems, multiplexers, message swit concentrators and controllers, and front-end processors.
- Communication channels are the means by which da transmitted between the sending and receiving devices network. A channel makes use of a variety of media. T include twisted-pair wire, coaxial cables and fiber optic cable of which physically link the devices in a network.
- Telecommunication software controls and supports communications occurring in a telecommunications network.
- The two basic types of networks are: Local area net (LAN) and Wide area network (WAN).
- The basic characteristics of a network are determined topology, protocol, and architecture.

INTRODUCTION

People need to communicate electronically in today's world. They need to exchange data and information electronically with one another. A good communications system is a must for every organization. Organizations depend on interconnected networks of computers to service their information processing needs. We live in a networked or connected world. A network is a group of two or more computer systems linked together.

Telecommunications is the sending of information in any form from one place to another electronic or light emitting media. Data communications is a more specific term that describ transmitting and receiving of data over communications links between one or more computer and a variety of input/output terminals. All forms of telecommunications now rely heavi computers and computerized devices.

OVERVIEW OF A NETWORK

Generally a communications network is any arrangement where a sender transmits a messa receiver over a channel consisting of some type of medium. The following figure illus conceptual model of a network. From the Figure 21.1 we can see that the network consists of fiv components:

Terminals

Terminals include video display terminals and other end-user workstations. Any input/output device that uses a network to transmit or receive data is a terminal. This includes microcomputers, telephones, fax machines, etc.

Telecommunications Processors

These are devices, which support data transmission and reception between terminals and computers. These devices such as modems, multiplexers and front-end processors, perform a variety of control and support functions in a network. For example, they convert data from digital to analog and back, code and decode data, and control the accuracy and efficiency of the flow of data between computers and terminals in a network.

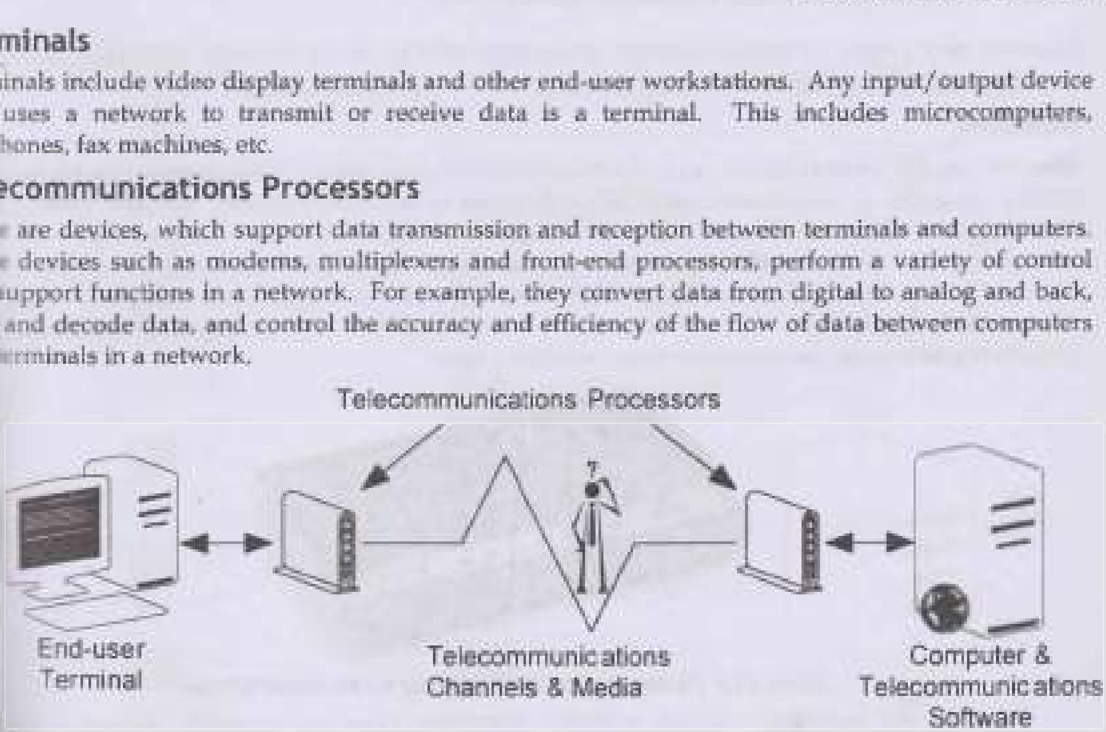


Figure 21.1 Components of a communications network

Telecommunications Channels and Media

The media over which data are transmitted and received are called telecommunications channels. Telecommunications channels use combinations of media, such as copper wires, coaxial cables, fiber optic cables, microwave systems and communications satellite systems to interconnect the other components of a network.

Computer

Networks interconnect computers of all sizes and types so that they can carry out their information processing assignments. For example, a mainframe computer may serve as a host computer for a large organization's network, assisted by minicomputers acting as network servers for smaller networks of end-user microcomputer workstations.

Telecommunications Software

Telecommunications software consists of programs that reside in host computer systems, communications control computers and end-user computers. This controls the telecommunications functions of the computer systems and manages the functions of networks. No matter how large and complex the real-world networks may appear to be, these five basic categories of components must be present to support a network.

TELECOMMUNICATIONS PROCESSORS

Telecommunications processors resemble computer CPUs in that they have similar circuitry, have instructions, and can be programmed, but their purpose is limited — to enhance data communications between two points. Communications processors include the following: modems, mult message switchers, concentrators and controllers, and front-end processors.

Modems

Modems are the most common type of communications processors. They convert the digital from a computer or transmission terminal at one end of a communications link into analog which can be transmitted over ordinary telephone lines. A modem at the other end communications line converts the transmitted data back into digital form at the receiving The process is known as modulation and demodulation, and the word modem is a abbreviation of those two words. Modems come in several forms including small stand-alo plug-in circuit boards, and microelectronic modem chips.

Figure 21.2 US Robotics USR5686E 56Kbps V.92 External Modem

Modems are necessary because ordinary telephone lines are primarily designed continuous analog signals, such as the human voice. Since data transmissions from compu digital form, devices are necessary to convert digital signals into appropriate analog tra frequencies, and vice-versa.

Multiplexers, Concentrators, and Controllers

Like message switchers, a **multiplexer** allows several terminals to use one line to communic CPU. However, it allows the terminals to send their messages simultaneously. A multiplexe words, collects messages from various senders, puts them in order, and transmits the broadband channel at very high speeds to the receiver. A **concentrator** is essentiall multiplexer — it can be programmed, has more processing capability, and is more flexi multiplexer. **Controllers** or cluster controllers, link groups of terminals or other de communications channel. The controller polls the status of each terminal and transfers d terminal to the host computer when necessary. Multiplexers, concentrators and cont frequently used at terminal sites having heavy input and output requirements.

Message Switchers

A message switcher is a processor that receives data messages from terminals, deter destination, and routes them one at a time to the CPU. It distributes the messages comi CPU to the appropriate terminal. The advantage of message switchers is that it reduces lo transmission costs, since only a single line is needed. Although only one terminal at communicate with the CPU, message switchers are efficient, with low speed termin intermittently used at remote sites.

Coaxial Cable

Coaxial cables consist of a sturdy copper or aluminum wire wrapped with spacers to insulate and protect it. The insulation minimizes the interference and distortion of the signals the cable carries. Groups of coaxial cables may be bundled together in a big cable for ease of installation. These high quality lines can be placed underground and laid on the floors of lakes and oceans. They allow high speed data transmission.

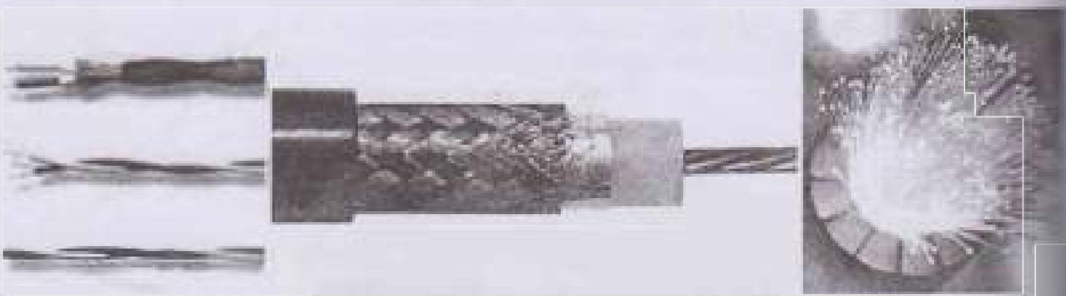


Figure 21.4 Twisted-pair Wire, Coaxial Cable and Fiber Optic Cable

Fiber Optic Cables

Fiber optics use cables consisting of one or more hair-thin filaments of glass fiber wrapped in a protective jacket. They can conduct light pulses generated by lasers at transmission rates as high as two billion bits per second. This is about ten times greater than coaxial cables and 200 times greater than twisted-pair wires. Fiber optic cables provide substantial size and weight reduction as well as increased speed and greater carrying capacity. A half-inch diameter fiber optic cable can carry up to 50,000 channels, compared to about 5,500 channels for a standard coaxial cable. Fiber optic cables are not affected by and do not generate electromagnetic radiation; therefore, multiple fibers can be placed in the same cable. Fiber optic cables have a minimal need for repeaters for signal retransmission, unlike electrical wire media. Fiber optics also has a much lower data error rate than other media.

Figure 21.5 A Microwave Tower and a Communications Satellite

Microwave Systems

Terrestrial (earth bound) microwave systems transmit high-speed radio signals in a line-of-sight path between relay stations spaced approximately 25 to 35 miles apart. Because the waves cannot bend with the curvature of the earth, they are relayed via antennas usually placed on top of buildings, towers, hills and mountain peaks. Microwave transmission consists of high frequency radio waves that travel in straight lines through the air rather than through wires.

Communications Satellites

Communications satellites in space orbiting 36,000 Km above the earth are also used as microwave relay stations because they rotate at the precise point and speed above the equator that makes them appear stationary to microwave transmitters on the ground. Among the hundreds of satellites now orbiting the earth and handling voice, video and data communications many are those launched by INTELSAT, short for International Telecommunications Satellite Consortium. INTELSAT (currently known as Intelsat Ltd.) began with the Early Bird satellite in 1965 and now forms a worldwide communications system for over 100 countries. As of 2007, Intelsat owns and operates a fleet of 52 communications satellites. It accounts for most long-distance international communications. Some other satellite communications service providers are Eutelsat, Inmarsat, Intersputnik, Intelsat Americas, SES S.A., COMSAT, etc.

TELECOMMUNICATIONS SOFTWARE

Software is a virtual component of all telecommunications networks. Communications control software including programs stored in the host computer as well as in the front-end computers and other communications processors. This software controls and supports the communications occurring in a telecommunications network. Telecommunications software packages for large computer networks are frequently called telecommunications monitors or teleprocessing (TP) monitors. Local Area Networks (LANs) rely on software called network operating systems. Many communications software packages are also available for microcomputers.

Functions of Telecommunications Software

Telecommunications software packages provide a variety of communications support services. The number and type of terminals, computers, communications processors, and communications activities involved determine the capabilities of the programs required. The telecommunications software provides several major functions such as:

- **Access control** – This function establishes the connections between terminals and computers in a network. The software works with a communications processor (such as a modem) to connect and disconnect communications links and establish parameters such as transmission speed, mode, and direction. This function may also involve automatic telephone dialing and redialing, logging on and off with appropriate account numbers and security code, and automatic answering of telephone calls from another computer.
- **Transmission control** – This function allows computers and terminals to send and receive commands, messages, data, and programs. Some error checking and correction of data transmissions may also be provided. Data and programs are usually transmitted in the form of files, so this activity is frequently called file transfer.
- **Network control** – This function manages communications in a network. Software determines transmission priorities, route messages, polls terminals in the network, and forms

waiting lines (queues) of transmission requests. It also logs statistics of network activity and resource usage and detects and corrects errors.

Error control — Error control involves detection and correction of transmission errors. Errors are usually caused by distortions in the communications channel, such as line noise and power surges. Communications software and processors control errors in transmission by several methods, including parity checking. Besides parity bits, additional control codes are usually added to the message itself. These specify such information as the destination of the data, their priority, and the beginning and end of the message, plus additional error detecting information. Most error correction methods involve retransmissions. A signal is sent back to the computer or terminal to retransmit the previous message.

Security control — Security control protects a communications network from unauthorized access. Access control software and other types of programs restrict access to data and the computing resources in the network. This restriction usually involves control procedures that limit access to all or part of a network by various categories of users. Automatic disconnection and callback procedures may also be used. Data transmissions can also be protected by coding techniques called encryption. Data is scrambled into a coded form before transmission and decoded upon arrival.

S OF NETWORKS

re many different types of networks. However from an end-user's point of view there are two pes:

Local-area networks (LANs) — The computers are geographically close together (that is, in the same building).

Wide-area networks (WANs) — The computers are farther apart and are connected by telephone lines or radio waves.

ddition to these types, the following characteristics are also used to categorize different types of orks.

Topology — The geometric arrangement of a computer system. Common topologies include bus, star, and ring.

Protocol — The protocol defines a common set of rules and signals that computers on the network use to communicate. One of the most popular protocols for LANs is called Ethernet. Another popular LAN protocol for PCs is the IBM token-ring network.

Architecture — Networks can be broadly classified as using either peer-to-peer or client/server architecture.

puters on a network are sometimes called nodes. Computers and devices that allocate s for a network are called servers.

Area Network (LAN)

a computer network that spans a relatively small area. Most LANs are confined to a single or group of buildings. However, one LAN can be connected to other LANs over any distance hone lines and radio waves. A system of LANs connected in this way is called a wide-area (WAN).

LANs connect workstations and personal computers. Each node (individual computer) has its own CPU with which it executes programs, but it is also able to access data and devices on the LAN. This means that many users can share expensive devices, such as laser printers as well as data (see Figure 21.6). Users can also use the LAN to communicate with each other, by sending e-mail or engaging in chat sessions.

There are many different types of LANs — token-ring networks, Ethernets, and ARCnets being the most common for PCs. Most Apple Macintosh networks are based on Apple's AppleTalk network system, which is built into Macintosh computers.

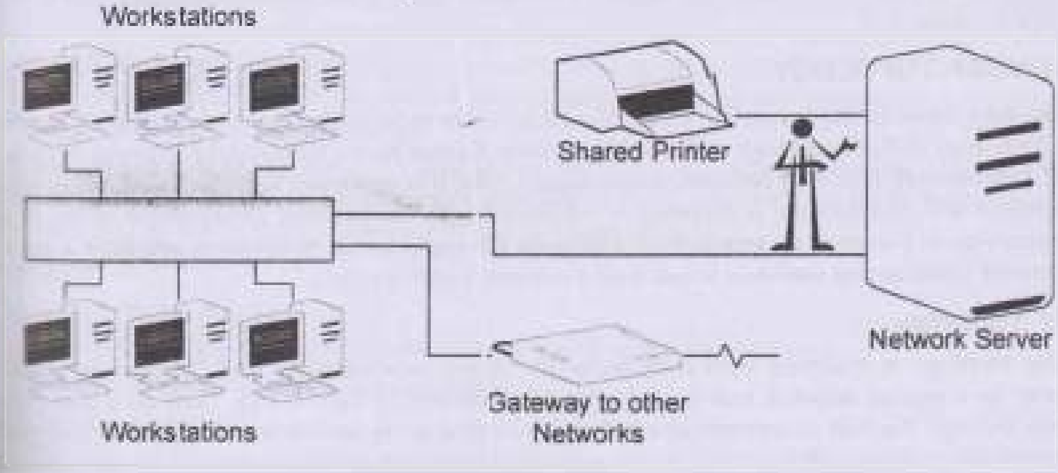


Figure 21.6 Local Area Network

LANs are capable of transmitting data at very fast rates, much faster than data can be transmitted over a telephone line; but the distances are limited, and there is also a limit on the number of computers that can be attached to a single LAN.

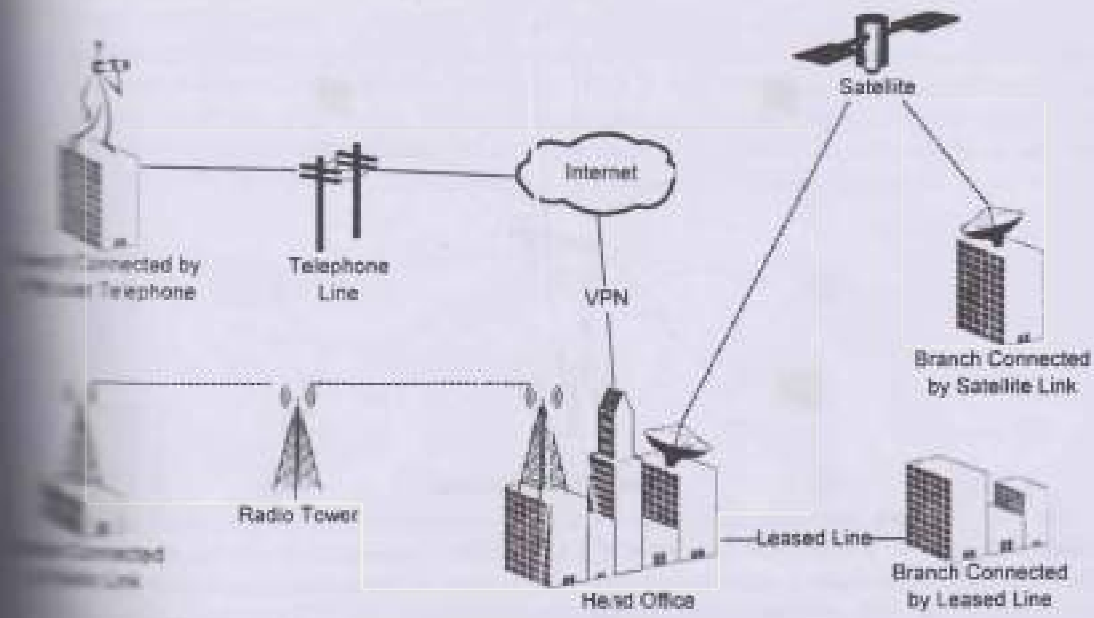


Figure 21.7 Wide Area Network

Wide Area Network (WAN)

A WAN is a computer network that spans a relatively large geographical area. Typically, a WAN consists of two or more local-area networks (LANs). Computers connected to a wide-area network are often connected through public networks, such as the telephone system. They can also be connected through leased lines or satellites. The largest WAN in existence is the Internet. A typical WAN set-up is shown in Figure 21.7.

NETWORK TOPOLOGY

A topology refers to the manner in which the cable is run to individual workstations on the network. The dictionary defines topology as the configurations formed by the connections between devices on a local area network (LAN) or between two or more LANs. It is important to make a distinction between a topology and architecture. A topology is concerned with the physical arrangement of the network components. In contrast, an architecture addresses the components themselves and how a system is structured (cable access methods, lower level protocols, topology, etc.).

Star Topology

A star topology is designed with each node (file server, workstations, and peripherals) connected directly to a central network hub or concentrator as shown in Figure 21.8. Data on a star network passes through the hub or concentrator before continuing to its destination. The hub or concentrator manages and controls all functions of the network. It also acts as a repeater for the data flow. This configuration is common with twisted pair cable; however, it can also be used with coaxial cable or fiber optic cable.

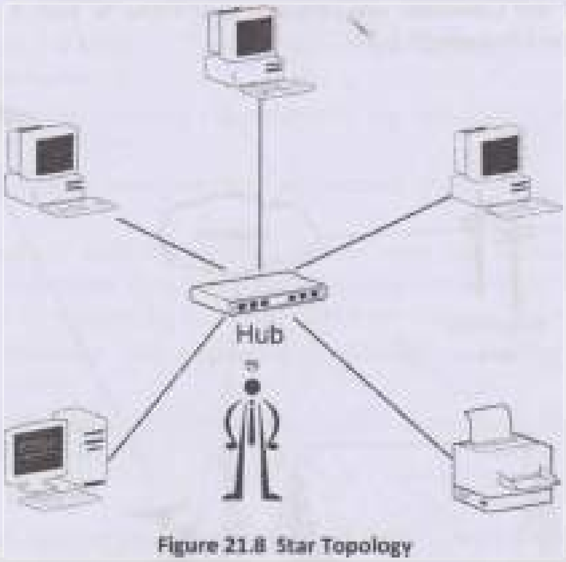


Figure 21.8 Star Topology

The star network topology is frequently used to connect one or more small computers or peripheral devices to a large host computer or CPU. Many organizations use the star network or a variation of it in a time-sharing system, in which several users are able to share a central processor. In a time-sharing setup, each terminal receives a fixed amount of the central CPU's time, called a time slice. If you are sitting at a terminal and cannot complete your task during the time slice, the computer come back to you to allow you to do so. Because the CPU operates much faster than terminals, you will probably not even notice that the CPU is away.

By establishing time-sharing, many people in a large organization can use a centralized computing facility. Time-sharing can also be purchased from an outside service, which is an economical way to operate for a small company that cannot afford its own large computer. Star network is frequently used in a LAN to connect several microcomputers to a central unit that works as a communications controller. If the user of one microcomputer wants to send a document or message to a user at another computer, the message is routed through the central communications controller. Another common use of the star network is as a LAN, to connect several microcomputers to a mainframe computer that allows access to an organization's database.

Access and control of star networks typically is maintained by a polling system. Polling means that the central computer or communications controller "polls" or asks each device in the network if it has a message to send and then allows each in turn to transmit data.

Advantages

- Easy to install and wire.
- No disruptions to the network when connecting or removing devices.
- Easy to detect faults and to remove parts.

Disadvantages

- Requires more cable length than a linear topology.
- If the hub or concentrator fails, nodes attached are disabled.
- More expensive than linear bus topologies because of the cost of the concentrators.

Ring Topology

The ring network is a local-area network (LAN) whose topology is a ring as shown in Figure 21.9. It can be as simple as a circle or point-to-point connections of computers at dispersed locations, with no central host computer or communications controller. That is, all of the nodes are connected in a closed loop. Messages travel around the ring, with each node reading those messages addressed to it. One of the advantages of ring networks is that they can span larger distances than other types of networks, such as bus networks, because each node regenerates messages as they pass through it.

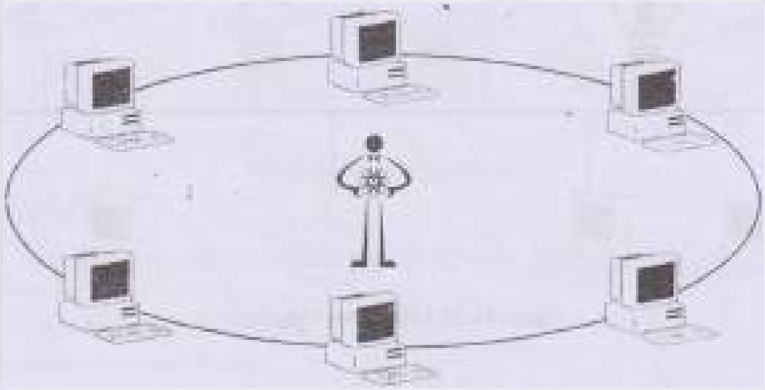


Figure 21.9 Ring Topology

Access and control of ring networks are typically maintained by a "token-passing" system. IBM's Token-ring network is thought by some observers to be a watershed event comparable to the development of the IBM PC itself, because the Token-ring network is designed to link all types of computers together, including not only personal computers but also possibly mini computers and mainframes.

A Token-ring network resembles a merry-go-round. To deliver a message, you would hand your addressed note to a rider (the token) on the merry-go-round, who would drop it off at the appropriate place.

Advantages

- Growth of system has minimal impact on performance.
- All stations have equal access.

Disadvantages

- Most expensive topology.
- Failure of one computer may impact others.
- Complex.

Linear Bus Topology

A linear bus topology consists of a main run of cable with a terminator at each end as shown in Figure 21.10. All nodes (file server, workstations, and peripherals) are connected to the linear cable. Ethernet and LocalTalk networks use a linear bus topology.

Bus networks are similar to ring networks except that the ends are not connected. All communications are carried on a common cable or bus and are available to each device on the network. Access and control of bus networks are typically maintained by a method called contention whereby if a line is unused, a terminal or device can transmit its message at will, but if two or more terminals initiate messages simultaneously, they must stop and transmit again at different intervals.

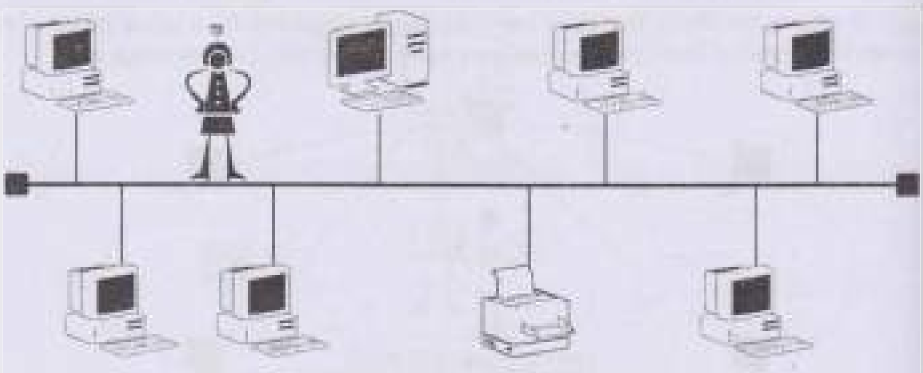


Figure 21.10 Linear Bus Topology

Advantages

- Easy to connect a computer or peripheral to a linear bus.
- Requires less cable length than a star topology.

Disadvantages

- Entire network shuts down if there is a break in the main cable.
- Terminators are required at both ends of the backbone cable.
- Difficult to identify the problem if the entire network shuts down.
- Not meant to be used as a stand-alone solution in a large building.

Tree Topology

A tree topology combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable as shown in Figure 21.11. Tree topologies allow for the expansion of an existing network, and enable organizations to configure a network to meet their needs.

Advantages

- Point-to-point wiring for individual segments.
- Supported by several hardware and software vendors.

Disadvantages

- Overall length of each segment is limited by the type of cabling used.
- If the backbone line breaks, the entire segment goes down.
- More difficult to configure and wire than other topologies.

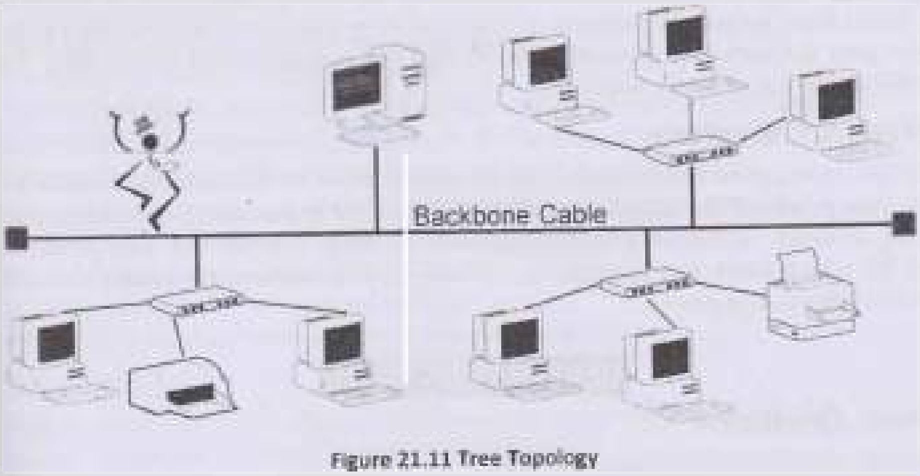


Figure 21.11 Tree Topology

NETWORK PROTOCOLS

A protocol is an agreed-upon format for transmitting data between two devices. The protocol determines the following:

- The type of error checking to be used.
- Data compression method, if any.
- How the sending device will indicate that it has finished sending a message.
- How the receiving device will indicate that it has received a message.

There are a variety of standard protocols from which programmers can choose. Each has its own particular advantages and disadvantages; for example, some are simpler than the others, some are more reliable, and some are faster. From a user's point of view, the only interesting aspect about protocols is that your computer or device must support the right ones if you want to communicate with other computers. The protocol can be implemented either in hardware or in software.

Some of the popular protocols are **TCP/IP** (Transmission Control Protocol/Internet Protocol), **SPX/IPX** (Sequenced Packet Exchange/Internetwork Packet Exchange), **NetBIOS** (Network Basic Input/Output System), **APPC** (Advanced Program-to-Program Communications), **DECnet**, **AppleTalk**, **WAP** (Wireless Application Protocol), etc.

NETWORK ARCHITECTURE

The term architecture can refer to either hardware or software, or a combination of hardware and software. The architecture of a system always defines its broad outlines, and may define precise mechanisms as well.

An open architecture allows the system to be connected easily to devices and programs made by other manufacturers. Open architectures use off-the-shelf components and conform to approved standards. A system with a closed architecture, on the other hand, is one whose design is proprietary, making it difficult to connect the system to other systems. As we have seen before, network architectures can be broadly classified as using either **peer-to-peer** or **client/server** architecture.

Peer-to-Peer Architecture

This is a type of network in which each workstation has equivalent capabilities and responsibilities. This differs from client/server architectures in which some workstations are dedicated to serving the others. Peer-to-peer networks are generally simpler and less expensive, but they usually do not offer the same performance under heavy loads.

Client/Server Architecture

This is a network architecture in which each computer or process on the network is either a client or a server. Servers are powerful computers or processors dedicated to managing disk drives (file servers), printers (print servers), or network traffic (network servers). Clients are less powerful PCs or workstations on which users run applications. Clients rely on servers for resources, such as files, devices, and even processing power.

REVIEW QUESTIONS

Short Answer Questions

01. What do you mean by telecommunications?
02. What do you mean by data communications?
03. What is a communications network?
04. What is a message switcher?
05. What do you mean by communication media? Give examples.
06. What is a twisted-pair wire and what is it used for?
07. What do you mean by telecommunications software?
08. Give the names of some communications satellites.
09. What are computer networks?
10. What do you mean by network topology?

11. What do you mean by network protocol?
12. What do you mean by network architecture?
13. What do you mean by token-ring network topology?
14. Give the names of some popular network protocols.
15. What are the different network architectures?

Descriptive Type Questions

01. What are the components of a network?
02. What are communications processors? Give examples.
03. What is a modem and what is it used for?
04. What are mulltiplexers and where is it used?
05. What are concentrators and what is it used for?
06. What are controllers and what are its uses?
07. Explain message switchers and its uses using a diagram.
08. What are front-end processors and what are they used for?
09. What are coaxial cables and what are they used for?
10. What are fiber optic cables and what are their advantages?
11. What are microwave systems?
12. What are communications satellites?
13. What are the different types of computer networks?
14. What is a network topology and what are the different types of network topologies?
15. What are network protocols?
16. What are the different types of network architectures?
17. What are the different types of networks?
18. Explain the term network topology. What are the different network topologies?
19. What are the advantages and disadvantages of star network topology?
20. What are the advantages and disadvantages of ring network topology?
21. What are the advantages and disadvantages of linear bus network topology?
22. What are the advantages and disadvantages of tree network topology?
23. What are the functions of a network protocol?
24. What do you mean by network architecture?
25. What do you mean by peer-to-peer network architecture?

Essay Questions

01. Explain the working of a communications network with a diagram.
02. Explain the functions of telecommunications software.
03. What do you mean by star network topology? Explain the star network topology with a diagram?
04. What do you mean by ring network topology? Explain the ring topology with a diagram?
05. What do you mean by linear bus network topology? Explain the linear bus topology with a diagram?
06. What do you mean by tree network topology? Explain the tree topology with a diagram?

Fill in the Blanks

01. A ________ is a group of two or more computer systems linked together

[illegible]

[illegible] computer systems and a variety of input/output terminals.

[illegible] that uses a network to transmit or receive data is a ________.

04. The devices, which support data transmission and reception between terminals and comput... called ________.
05. The word modem is a combined abbreviation of the two words ________ and ________.
06. ________ consists of high frequency radio waves that travel in straight lines through the air ... than through wires.
07. Communications satellites orbit ________ miles above the earth.
08. INTELSAT stands for ________.
09. The two main types of networks are ________ and ________.
10. ________ is the geometric arrangement of the computers in a network.
11. LAN stands for ________.
12. ________ is a computer network that spans a relatively large geographical area.
13. ________ topology is designed with each node (file server, workstations, and perip... connected directly to a central network hub or concentrator.
14. ________ topology consists of a main run of cable with a terminator at each end.
15. Ethernet and LocalTalk networks use a ________ topology.
16. ________ topology combines characteristics of linear bus and star topologies.
17. TCP/IP stands for ________.
18. SPX/IPX stands for ________.
19. NetBIOS stands for ________.
20. APPC stands for ________.

[**Answers:** (1) Network (2) Data communications (3) Terminal (4) Telecommunications proc... Modulation and Demodulation (6) Microwave transmission (7) 36,000 Km (8) Inte... Telecommunications Satellite Consortium (9)LANs and WANs (10) Network topology (11) Loca... Network (12) WAN (13) Star (14) Linear bus (15) Linear bus (16) Tree (17) Transmission C... Protocol/Internet Protocol (18) Sequenced Packet Exchange/Internetwork Packet Exchange ... Network Basic Input/Output System (20) Advanced Program-to-Program Communications]

True or False

01. Terminals include video display terminals and other end-user workstations.
02. Modems, multiplexers and front-end processors are examples of communications channels.
03. Modems come in several forms including small stand-alone units, plug-in circuit boa... microelectronic modem chips.
04. Modem distributes the messages coming from the CPU to the appropriate terminal.
05. A concentrator is essentially a smart multiplexer.
06. Twisted-pair wire is the oldest and still most common transmission line and consists ... wires twisted into pairs.
07. Coaxial cables use cables consisting of one or more hair-thin filaments of glass fiber w... protective jacket.
08. Since the microwaves cannot bend with the curvature of the earth, they are relayed via ...
09. Networks can be broadly classified as using either peer-to-peer or client/server archite...
10. One of the most popular protocols for LANs is called Ethernet.
11. WAN stands for Wide Angle Network.
12. Most Apple Macintosh networks are based on Apple's AppleTalk network system, wh... into Macintosh computers.
13. Token-ring network was invented by IBM.
14. Tree topologies do not allow for the expansion of an existing network.

15. WAP stands for Wireless Application Protocol.

[**Answers:** (1) True (2) False (3) True (4) False (5) True (6) True (7) False (8) True (9) False (10) True (11) False (12) True (13) True (14) False (15) True]

Multiple Choice

01. The components of a network are ___________.
    (1) Terminals, computers and software (2) Telecommunications processors (3) Telecommunications media (4) All of the above
02. Which of the following is a telecommunications processor?
    (1) Modem (2) Multiplexer (3) Concentrator (4) All of the above
03. Which of the following is a telecommunications media?
    (1) Modem (2) Multiplexer (3) Concentrator (4) Coaxial cable.
04. Which is the oldest and most common transmission line?
    (1) Twisted-pair wire (2) Coaxial cable (3) Fiber optic cable (4) None of the above
05. How many channels can a half-inch diameter fiber optic cable carry?
    (1) 500 (2) 5500 (3) 50000 (4) None of the above
06. Which of the following is the function of the telecommunications software?
    (1) Modulation (2) Demodulation (3) Access Control (4) None of the above
07. WAN stands for ______________.
    (1) Wireless Access Net (2) Wide Arm Network (3) Wide Area Network (4) None of the above
08. Which of the following is a network topology?
    (1) Star (2) Bus (3) Ring (4) All of the above
09. In which network the ends are not connected?
    (1) Bus (2) Star (3) Ring (4) None of the above
10. Which of the following is a network protocol?
    (1) TCP/IP (2) SPX/IPX (3) NetBios (4) All of the above

[Answers: (1) All of the above (2) All of the above (3) Coaxial cable (4) Twisted-pair wire (5) 50000 (6) Access control (7) Wide Area Network (8) All of the above (9) Bus (10) All of the above]

C H A P T E R 2 2

Communications Systems

TOPICS COVERED

- Introduction
- Radio
- Television
- Microwave systems
- Communications satellites
- Radar
- Fiber optics
- ISDN
- ADSL
- T1 and T3 line connection

Key Points

▲ Communication is the transmission of data fr... computer to another, one place to another or from one ... another.

▲ Satellites are an integral part of the ... communications system. The five major components ... are: Transponder, Antenna System, Power Package, C... Information System and Rocket Thruster System.

▲ Radar (Radio Detecting and Ranging) scans the ... space by means of high frequency radio waves, which ... out from a powerful transmitter and are reflected by ... which they encounter. The reflected beam is picked ... receiver and its strength and direction gives informa... size, distance, altitude, etc. of the object.

▲ Fiber optics can be described as a transmiss... employing a light-emitting source—turned on and off ... electrical impulses—whose emissions are sent thr... pipe to a light-sensitive receiver to convert the ch... intensities back into electrical impulses.

▲ ISDN is a high-speed, fully digital telephone ... is a technology for transmitting digital informat... bandwidth on existing phone lines to homes and ... and T3 lines are high speed Internet connections ... about 1.5 Mbps and 45 Mbps respectively.

INTRODUCTION

Communication is the transmission of data from one computer to another, one place to another or from one device to another. A communications device, therefore, is any machine that assists data transmission. For example, Radio, Television, Satellites, etc. are all communications devices.

RADIO

A radio receiver in its simplest form comprises of an input circuit for tuning into the freq... various transmitters to be received, a demodulation circuit for separating audio frequen... high-frequency carrier waves, a low-frequency amplifier stage, and a loud speaker. Th... elements (transistors) are supplied with the necessary operating voltages by a su... Corresponding to the frequency bands on which the various transmitters operate ... equipped to receive long waves (150-285 KHz), medium waves (up to 1605 KHz), short ... MHz), and ultra-short waves (up to 100 MHz). Long, medium and short wave reception ... a channel spacing of 9 KHz and with amplitude modulation (AM). The channel spac... short wave range is 300 KHz, and in this range frequency modulation (FM) is empl... here is usually better than in the other ranges, because high audio frequencies, which ... affect the sound pattern, can also be transmitted. Besides, atmospheric disturbances, ... amplitude-modulating effect, are of hardly any significance to this kind of reception.

The propagation conditions of the four radio wave ranges determine their ... application and the purposes for which they are used. Long and medium wave trans...

direct wave (which travels along the earth's surface) and an indirect wave. In general, only the direct wave is received (which has a range of up to some hundreds of miles); the indirect wave which is reflected back from the Heaviside layer (an electrically conducting layer about 55-85 miles above the earth's surface), makes much longer ranges possible. In the short wave range, only indirect waves are used. Ultra-short waves are propagated in a quasi-optical manner (waves travel in straight paths), so that they cannot travel beyond the optical horizon. To extend the range as much as possible, the transmitting antenna is installed at the top of a high mast or building.

TELEVISION

Television is the world's most powerful form of communication. Every day it reaches out to millions of people to entertain and inform them with 'real life' images of the world around them. Television is a system of sending and receiving pictures and sound by means of electronic signals transmitted through wires and optical fibers or by electromagnetic radiation. These signals are usually broadcast from a central television station to reception devices in television sets in homes or to relay stations used by cable television providers. The most common use of television is as a source of information and entertainment for viewers in their homes. Security personnel also use televisions to monitor buildings and facilities. Doctors can probe the interior of a human body with a microscopic television camera without conducting major surgery on the patient. Educators also use television to reach students throughout the world.

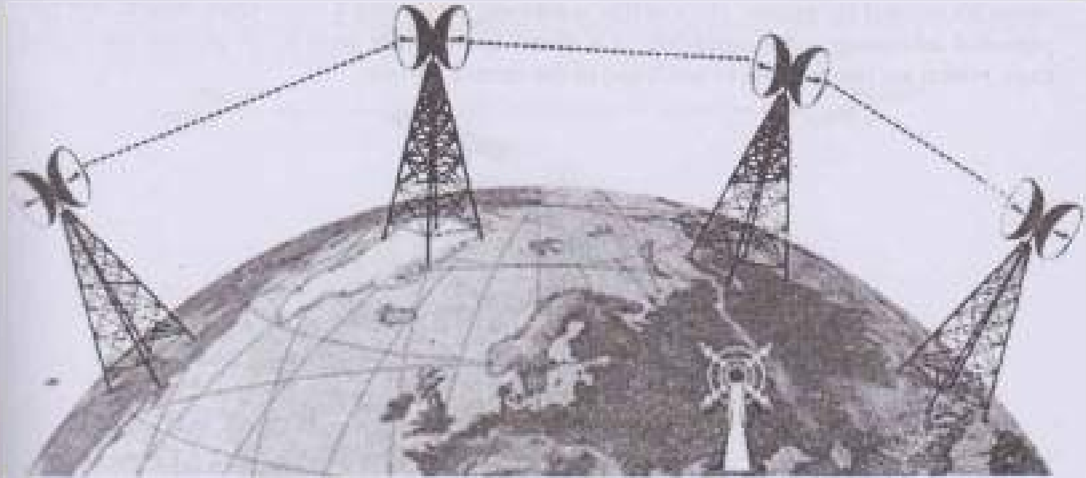


Figure 22.1 Microwave Transmission

The high-frequency waves radiated by transmitting antennas can travel only in a straight line, and [illegible] blocked by obstacles. For this reason, transmitting antennas must be placed on tall buildings or [illegible] Cable television was first developed in the late 1940s to serve areas that were blocked from [illegible] signals. The signal is picked up on a receiver and redistributed by cable. Viewers in most [illegible] now subscribe to cable television services that provide a wide variety of television programs [illegible] transmitted by cable to the viewer's television set. Network television stations use [illegible] relay stations to broadcast to affiliates far from the original source of the broadcast. Communications satellites also receive television signals from a ground station and relay them back to [illegible] areas. Satellite transmissions are used to efficiently distribute television and radio programs from one geographic location to another. In addition, direct-broadcast satellites deliver tele[illegible] programming directly to individual receivers through small home dishes.

MICROWAVE SYSTEMS

Microwave transmission consists of high-frequency waves (1000-3000 MHz) that travel in [illegible] lines through the air rather than through wires. A microwave system consists of towers [illegible] intervals of 25 to 30 miles on which dish-like antennas are mounted. Because the waves can[illegible] with the curvature of the earth, these towers must be within the line-of-sight from one anoth[illegible] one tower receives the signal, it amplifies the signal and sends it to the next tower. Communi[illegible] satellites in space, orbiting in the **Clarke orbit** are also used as microwave relay stations becau[illegible] rotate at the precise point and speed above the equator that makes them appear stationar[illegible] microwave transmitters on the ground. Microwaves systems have the capacity to carry large qu[illegible] of data – both digital and analog at high rates of speed. They are used for the transmission of [illegible] and telephonic signals.

COMMUNICATIONS SATELLITES

Satellites have now become an integral part of the worldwide communications system. Althou[illegible] range and long-distance communications took place much before the introduction of satellit[illegible] they had a lot of disadvantages. Point-to-point communications systems are very difficult in th[illegible] remote and isolated locations – locations, which are surrounded by oceans, mountains [illegible] obstacles created by nature. The satellite is nothing more than a radio-relay station. But they [illegible] potential advantage – the capability of a direct line-of-sight path to 98 percent (excluding [illegible] caps, which are inaccessible to satellites) of the earth's surface.

Figure 22.2 A Communications Satellite in Action

One of the most important events in the history of satellite communications took pla[illegible] COMSAT or Communications Satellite Corporation, launched four satellites within six [illegible] between 1965 and 1979. The first of these series was the 'Early Bird', which was launched i[illegible] was the first communications station to handle worldwide commercial telephone traffic from a fixed position in space. The next series, INTELSAT was a group of satellites that served 150 stations in 80 countries.

The communications satellites are placed in orbits called **equatorial geosynchronous orbit**. The satellite place in this orbit will appear stationary over a selected location on the earth's surface. So, communications satellites are placed in an orbit that is directly over the equator, moving in a west-to-east direction at an altitude of 22,282 miles above sea level and with a forward velocity of 6874 mph to complete one orbit in 24 hours. This orbit is called the **Clarke orbit**.

All of the ground equipment along with the transmission path and receiving antenna at the satellite are included in the up-link system. Basically this includes everything before the input terminals of the satellite receiver. The down-link is described in terms of satellite transmitter output power, down-link antenna gain and beam-width and the ground area that the transmitted signal will cover – the footprint. At the altitude of the Clarke orbit, one satellite could command a footprint area of 42.2% of the earth's surface. The beam-width from the satellite for such coverage is 17.2 degrees. Since such a satellite is not sufficient for global coverage, we need more than one (to be specific, three) satellite. These three satellites are placed 120 degrees apart in the Clarke orbit and would cover the earth's entire surface except for the polar caps. This makes it possible for one earth station to transmit to another station on the opposite side of the globe by sending data to its 'in-view' satellite, from which it is transmitted to its closest neighbor in the Clarke's orbit and from there back to the earth. The cross-link distance is 45,458 miles between the satellites, making the total 'earth-satellite-satellite-earth' distance 90,014 miles. A message would take about 0.5 seconds to travel this distance or almost one second if a return response is needed.

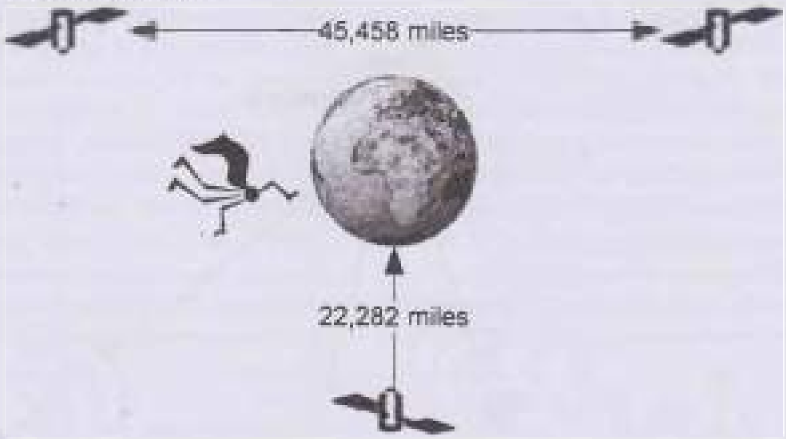


Figure 22.3 Cross-link Connections for Global Coverage

INTELSAT was the first to set up such a communications link, with satellites spaced over the Indian, Atlantic and Pacific Oceans above the equator. The five major components in a satellite are:

- The Transponder
- The Antenna System
- The Power Package
- The Control and Information System
- The Rocket Thruster System

The **transponder** is a high-frequency radio receiver, a frequency down-converter and a po amplifier, which is used to transmit the down-link signal. The **antenna system** contains the ant and the mechanisms to position them correctly. Once properly in place, they will generally fu trouble-free for the life of the satellite. The **power package** is the power supply to the satellite satellite must be powered either from a battery or a solar energy system. In the ca communications satellites in the Clarke orbit, a combination of battery power and solar energy is A solar cell system supplies the power to run the electronics and charge the batteries duri sunlight cycle and the battery furnishes the energy during the eclipse. The **control and inform system** and the **rocket thruster system** are called the **station keeping** system. The function station keeping system is to keep the satellite in the correct orbit with the antennas pointed in th direction desired.

RADAR

The name 'radar' is the acronym of Radio Detecting and Ranging. It denotes the method of sc the surrounding space by means of high frequency radio waves, which are sent out from a p transmitter and are reflected by any objects, which they encounter. The reflected beam is picked a receiver and its strength and direction gives information on the size, distance, altitude, etc object.

If for example, an observer in an aircraft wishes to survey by radar the terrain over wh flying, a rotating radar beam is directed downward from the aircraft. The beam scans a circular the form of a sector, which sweeps round and round. Depending on the nature of the reflecting the intensity of the reflected beam will vary as shown in Figure 22.4.

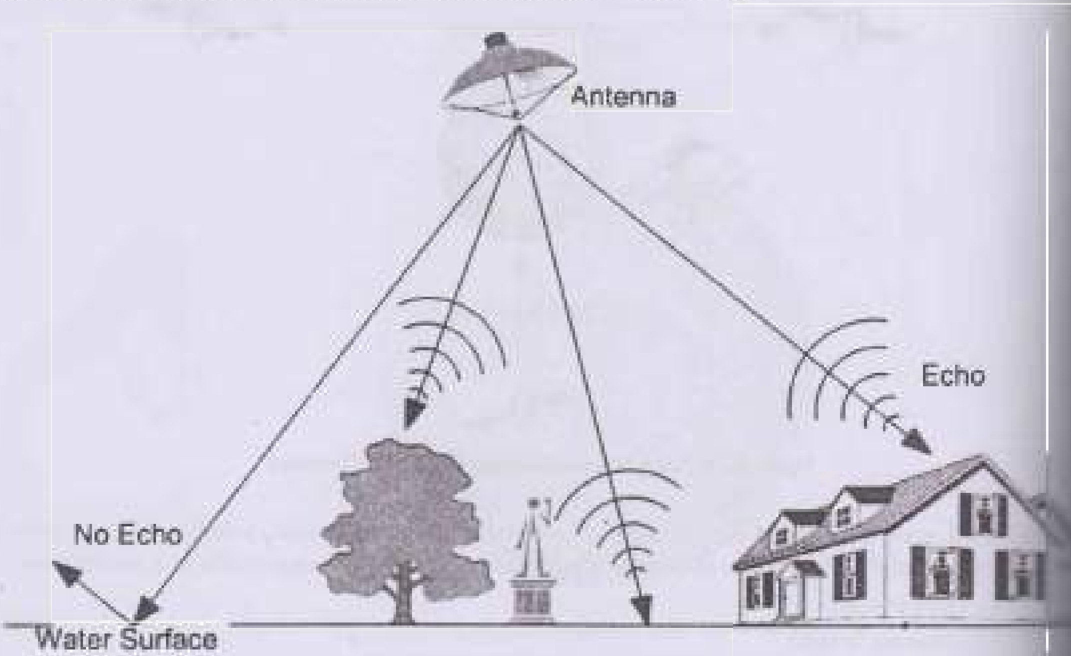


Figure 22.4 Working of a Radar

The transmission and reception of the high frequency waves are effected in the radar apparatus. Figure 22.5 shows a ground radar installation. The radar waves are generated in the transmitter, which is equipped with radio tubes of special design. The transmitting antenna usually also functions as the receiving antenna. This process is called **periodic changeover**. The receiver picks up the reflected beam and the corresponding electronic circuits are used to deflect an electron beam in a Cathode Ray Tube (CRT). The beam is so deflected that it scans the luminescent screen from the center to the edge while it rotates at the same speed as the antenna.

Figure 22.5 A Radar Installation

An echo picked up by the receiver strengthens the flow of electrons in the CRT, causing a point of light to appear on the screen and to remain visible by phosphorescent afterglow until fresh echoes are picked up on the next revolution of the scanning antenna. In this way the points of light build up a picture of the area scanned by the radar beam. The brightness of the display of the signal (the radar echo) on the luminescent screen of the CRT depends on the reflecting power of the object with regard to the high-frequency radio waves sent out by the radar transmitter. For this reason, a radar image generally looks quite different from an optical image, though as a rule they have the same outlines.

Most radar sets employ pulse radar. This is so called because the transmitter sends out short intense bursts or pulses of energy with a relatively long interval between the pulses. The receiver is active during this interval. When sufficient time has elapsed to permit the reception of echoes from the most distant objects of interest, the transmitter sends another short pulse and the cycle is repeated.

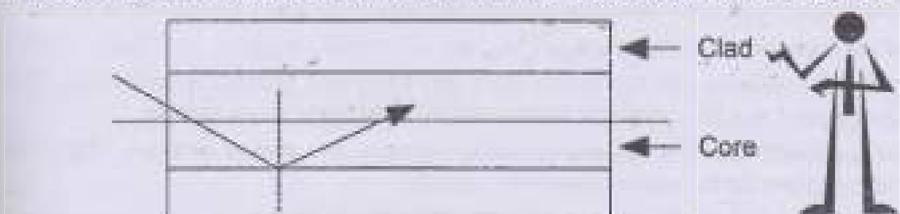


Figure 22.6 Fiber Optical Cable

FIBER OPTICS

Fiber optics can be described as a transmission system employing a light-emitting source—turned on and off rapidly by electrical impulses—whose emissions are sent through a glass pipe to a light-sensitive receiver to convert the changing light intensities back into electrical impulses. The 'core' of fiber optic cable is a very thin strand of highly refined cylindrical glass. The glass core of the cable may have a diameter as small as 4.5 μm (2/10,000 inch) or as large as 400 μm. A second layer of glass called the clad surrounds the core. The clad is fused directly to the core so that it is very difficult to see the boundary between the two with naked eyes.

The clad has a different optical density from the core material. Fiber optics is founded on the theory of reflection that results at the interface between two materials of different densities. They can conduct light pulses generated by lasers at transmission rates as high as 2 billion bits per second. This is about ten times greater than coaxial cables and 200 times better than twisted-pair wires.

Advantages and Disadvantages

Some of the **advantages** of fiber optic systems are:

- The main ingredient in glass is sand and there is an enormous supply of sand in the world compared to the supply of copper and aluminum.
- Photons of light, rather than an electrical current move through the optic fiber. Therefore there is no chance of a spark flash thereby making this system safer.
- Since the fiber system carries no electrical current, the energy transmitted through the fiber cannot radiate radio frequency interference, nor can it be contaminated by any external noise or radio frequency fields.
- It is nearly impossible to eavesdrop on fiber optic systems without being easily detected. Because of the absence of current flow through the fiber, intrusion into the system is also prevented. Confidential information cannot be routed to unwanted receivers, nor can false information be fed into the data steam.
- The transmission losses of fiber optic cables are much lower than that of the twisted-pair wires and coaxial cables.
- Fiber optic cables provide substantial size and weight reduction as well as increased [illegible] and greater carrying capacity. A half-inch diameter fiber optic cable can carry up to [illegible] channels, compared to about 5,500 channels for a standard coaxial cable.
- Glass is immune to corrosive and oxide degradation and will stand up well in hostile environments.
- The size of the core and clad of a single fiber conductor is much smaller than the diameter of the common copper wire and since fiber optic cables are not affected by and do not generate electromagnetic radiation; therefore, multiple fibers can be placed in the same cable.

Some **disadvantages** of the systems are:

- All fiber optic systems are limited to fixed point-to-point ground installations. They cannot leave the ground nor be associated with a mobile communications station.
- Popular light-emitting sources are restricted to very low power devices. There are higher power devices available, but they are very costly.
- The ways in which the light source can be modulated are limited.
- Because of low-power sources, the distance between repeater amplifiers must be relatively *short for high data rates demanded in some systems.*

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

ISDN is a high-speed, fully digital telephone service. Just as compact discs have made recorded music digital, ISDN upgrades today's analog telephone network to a digital system. ISDN can operate at speeds up to 128 kilobits/second, which is five or more times faster than today's analog modems. ISDN can dramatically speed up transfer of information over the Internet or over a remote LAN connection, especially rich media like graphics, audio, video or applications that normally run at LAN speeds.

ISDN stands for Integrated Services Digital Network – the name for digital telephone service that works over existing copper telephone wiring. There are several types of ISDN service, but the most appropriate type for individual computer users, and the type that this site focuses on is the ISDN Basic Rate Interface (BRI). Basic Rate ISDN divides the telephone line into 3 digital channels: 2 "B" channels and one "D" channel, each of which can be used simultaneously. The B channels are used to transmit data at the rate of 64 k or 56 k (depending on your telephone company). The D channel does the administrative work, such as setting up and tearing down the call and communicating with the telephone network. With two B channels, you can make two calls simultaneously. Most of the world's existing telephone networks are already digital. The only part that typically is not digital is the section that runs from the local exchange to your house or office. ISDN makes that final leg of the network digital. The original version of ISDN employs baseband transmission. Another version, called B-ISDN, uses broadband transmission and is able to support transmission rates of 1.5 Mbps. B-ISDN requires fiber optic cables and is not widely available.

ISDN brings the digital network to the individual user. Thus, the same twisted-pair copper telephone line that could traditionally carry only one voice, one computer or one fax "conversation" can now carry as many as three separate "conversations" at the same time, through the same line; ISDN makes this happen. How is this possible? The basic ISDN-to-user connection, called a Basic Rate Interface (BRI) contains three separate channels, or "pipes." Two of these channels (the B channels) carry user "conversations" from a telephone, a computer, a fax or almost any other device. The third channel (the D channel) carries call setup information for the network, but can also carry user data transmissions. This means that two separate "conversations", say a voice call and a computer transmission can take place at the same time through the same ISDN line. Simultaneously, a third "conversation", an e-mail message or a credit-card authorization, for example, could also take place through the same connection. The power of ISDN enables all three of these transmissions to happen at the same time, through the same copper twisted-pair telephone lines that once could handle only one conversation at a time.

ASYMMETRIC DIGITAL SUBSCRIBER LINE (ADSL)

ADSL is a technology for transmitting digital information at a high bandwidth on existing phone lines to homes and businesses. Unlike regular dialup phone service, ADSL provides continuously-available, "always on" connection. ADSL is asymmetric in that it uses most of the channel to transmit downstream to the user and only a small part to receive information from the user. ADSL simultaneously accommodates analog (voice) information on the same line. ADSL was specifically designed to exploit the one-way nature of most multimedia communications in which large amounts of information flow toward the user and only a small amount of interactive control information is returned. Because phone lines vary in quality and were not originally engineered with DSL in mind, it can generally only be used over short distances, typically less than 4 Km. ADSL supports data rates from 1.5 to 9 Mbps when receiving data (known as the downstream rate) and from 16 to 640 Kbps when sending data (known as the upstream rate).

T1 AND T3 LINE CONNECTION

A T1 Line produces a high speed Internet connection, operating at about 1.5 Mbps. Most T1 users small and medium sized companies whose employees use the Internet in large capacities. Many computers can be connected to a T1 network without affecting the speed or reliability of the connection. A T1 line works digitally to transmit information over the Internet and provide a high speed connection to computers in the network. It uses 23 channels with pulse code modulation signal to provide the speedy and reliable connection to the network.

T3 lines are incredibly fast Internet connections, operating at 45 Mbps. Most T3 lines are used by very large companies and universities with high traffic. Many computers can be connected to the Internet at the same time without the speed being affected with a T3 line. Additionally, T3 lines support the transmission of very large files over the Internet, such as videos and large databases. A T1 Line produces a high speed Internet connection, operating at about 1.5 million bits per second. Most T1 users are small and medium sized companies whose employees use the Internet in large capacities. Many computers can be connected to a T1 network without affecting the speed or reliability of the connection. Although the T1 line would be nice for home use because of its speed and ability to send and receive large files, it is rare that people have a working T1 line in their homes because of the unnecessary amount of bandwidth and high costs.

REVIEW QUESTIONS

Short Answer Questions

01. What do you mean by communication?
02. What do you mean by a communications device?
03. What you mean by the Clarke orbit?
04. What do you mean by COMSAT?
05. What do you mean by equatorial geosynchronous orbit?
06. What do you mean by fiber optics?

Descriptive Type Questions

01. What is a radio? Explain its working.
02. What is a television? Explain its working.
03. What are microwave systems? What are its advantages and limitations?
04. What are communications satellites? What are its advantages and limitations?
05. What is ADSL and how does it works?
06. What are T1 and T3 connections?

Essay Questions

01. How is global coverage achieved using communications satellites?
02. Explain the major components of a satellite.
03. Explain the working of radar using a diagram.
04. Explain the working of a fiber optic system using a diagram. What are the advantages and disadvantages of fiber optic systems?
05. Explain ISDN and the advantages and limitations of ISDN.

Fill in the Blanks

01. Medium waves have frequencies up to ________ KHz.
02. ________ layer is an electrically conducting layer about 55–85 miles above the earth's surface.

03. Microwave transmission consists of high-frequency waves in the range of ________ to ________ MHz.
04. COMSAT stands for ________.
05. ________ is a group of satellites that serves 150 stations in 80 countries.
06. The communications satellites are placed in orbits called ________.
07. The Clarke orbit is ________ mile above sea level.
08. ISDN stands for ________.

[Answers: (1) 1605 (2) Heaviside (3) 1000 to 3000 (4) Communications Satellite Corporation (5) INTELSAT (6) Clarke orbit (7) 22,282 (8) Integrated Services Digital Network]

True or False

01. Short waves have a frequency range of 150-285 KHz.
02. Reception is better when FM is employed.
03. AM stands for amplitude modulation.
04. A microwave system consists of towers located 100 miles apart.
05. Polar caps are accessible only to the communications satellites.
06. Early Bird was launched in 1965.
07. Communications satellites are placed in an orbit, which is 42,282 miles above sea level.
08. The 'core' of a fiber optic cable is a very thin strand of highly refined cylindrical glass.

[Answers: (1) True (2) True (3) True (4) False (5) False (6) True (7) False (8) True]

Multiple Choice

01. The frequency range of medium waves is________.
(1) 150-285Hz (2) Up to 1605 KHz (3) 150-285KHz (4) None of the above
02. FM stands for ________.
(1) Frequent Modification (2) Functional Modification (3) Frequency Modulation (4) None of the above
03. The distance between two microwave towers usually is________.
(1) 5-10 miles (2) 25-30 miles (3) 80-100 miles (4) None of the above
04. Which was the first satellite launched by COMSAT ________.
(1) Early Bird (2) Intelsat I (3) Molniya (4) ATS-6
05. Communications satellites are place in an orbit called ________.
(1) Clarke orbit (2) Asimov orbit (3) Newton orbit (4) None of the above
06. Which of the following is a component of a communications satellite?
(1) Transponder (2) Antenna system (3) Rocket thruster (4) All of the above
07. Radar stands for ________.
(1) Radio Detection and Reflection (2) Radio Deflection and Reflection (3) Radio Detection and Ranging (4) None of the above
08. In a fiber optic cable the core is surrounded by a second layer of glass called________.
(1) Yoke (2) Clad (3) Cap (4) Pipe

[Answers: (1) Up to 1605 Khz (2) Frequency Modulation (3) 25-30 miles (4) Early Bird (5) Clarke orbit (6) All of the above (7) Radio Detection and Ranging (8) Clad]

CHAPTER 23

Distributed Data Processing

TOPICS COVERED

- Introduction
- Distributing the processing and storage functions
- Advantages of distributed systems
- Disadvantages of distributed systems

> **Key Points**
>
> ▲ In distributed data processing systems, the com[illegible] storage devices, and even some computer professional[illegible] distributed to separate locations throughout the organizatio[illegible]
>
> ▲ Several computers each located at a different poi[illegible] nodes in the network may be used. The advanc[illegible] communication technology have made possible the integ[illegible] these computers located at different places.
>
> ▲ The main advantages of distributed computing are [illegible] control of local data, lower costs, modularity, better [illegible] times, ability to share data, greater reliability, direc[illegible] interaction, etc. Some of the disadvantages of distributed [illegible] are technical problems connecting dissimilar machines, [illegible] sophisticated communication systems, data integri[illegible] security problems and shortage of skilled professionals.

INTRODUCTION

Till recently most companies and organizations used centralized systems for their data processing needs. But as technology improved and data processing became more complex, the load on the centralized systems increased and a new way of data processing evolved--Distributed Data Processing (D[illegible] distributed processing for short.

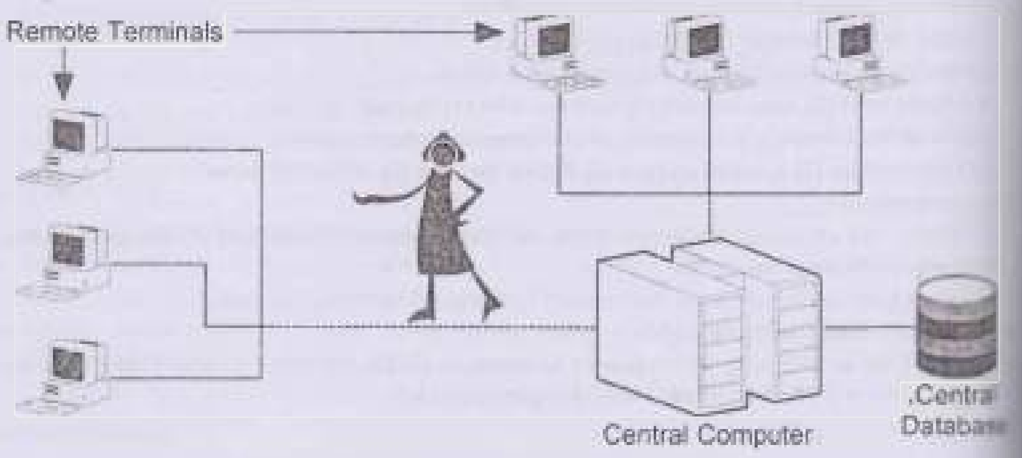


Figure 23.1 Centralized Data Processing System

In a centralized data processing system, the CPU, the storage devices, software and the professional data processing staff are located in one central facility. All the devices in the centralized system—including multiplexers, terminals and printers—converge on one central computer, even though the users may work at distant terminals. All processing and storage take place at the central location. But in distributed data processing systems, the computers, storage devices, and even some computer professionals are distributed to separate locations throughout the organization. Processing and storage may occur at several locations in the computer system called a network. Several computers each located at a different points or nodes in the network may be used. The advances in communication technology have made possible the integration of these computers located at different places. Most organizations can benefit from using distributed processing. Such a system can be more responsive to its users' needs, and it may cost less to develop and maintain than a centralized system.

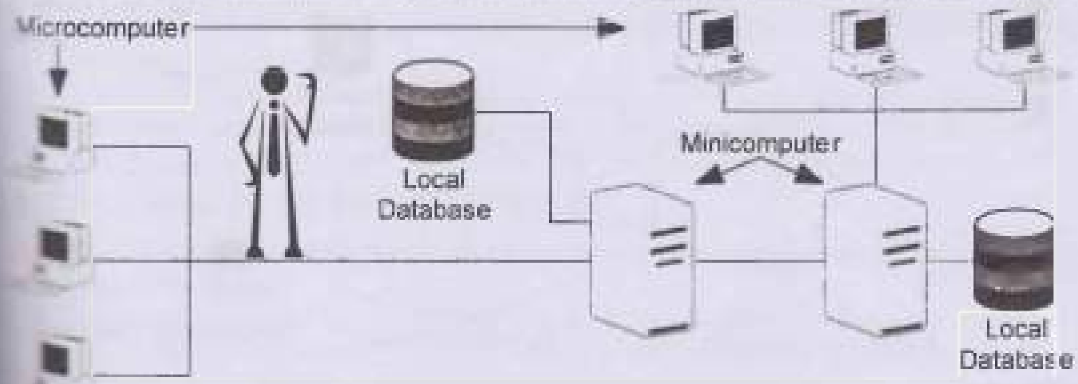


Figure 23.2 Distributed Data Processing System

DISTRIBUTING THE PROCESSING AND STORAGE FUNCTIONS

Although sharing the processing function distributes the computing load to computers away from the central computer, in most cases distributed data processing is chosen because storage too can be distributed. Furthermore, the data stored at different locations can be shared among the users. The following example shows how these characteristics of a distributed system can help an organization use its data resources more effectively. It shows how the distributed processing systems used in multi-branch banking are effective and efficient than a centralized system.

In the distributed multi-branch banking system, minicomputers are used at the branch banks and are responsible for the local processing of services such as savings and current accounts and loans. Each machine uses a copy of the same software for these functions. A mainframe at the central facility performs all of the consolidated accounting functions and is responsible for processing both transactions through the bank's network of Automated Teller Machines (ATMs) and credit card transactions.

Now, let us consider how the ATM application works. When a customer initiates a withdrawal transaction, the data associated with request are first sent to the central computer. Then the branch at which the customer's records are maintained must be determined and the request forwarded to the appropriate branch computer. The branch computer performs a search to verify the customer's account and determines whether the balance in the account is adequate. If there is enough money in the account, the depositor's record will be updated to reflect the withdrawal. Next, the data are returned to

the ATM, and the machine dispenses the cash and prints a receipt. All these events take place wit
span of a few seconds.

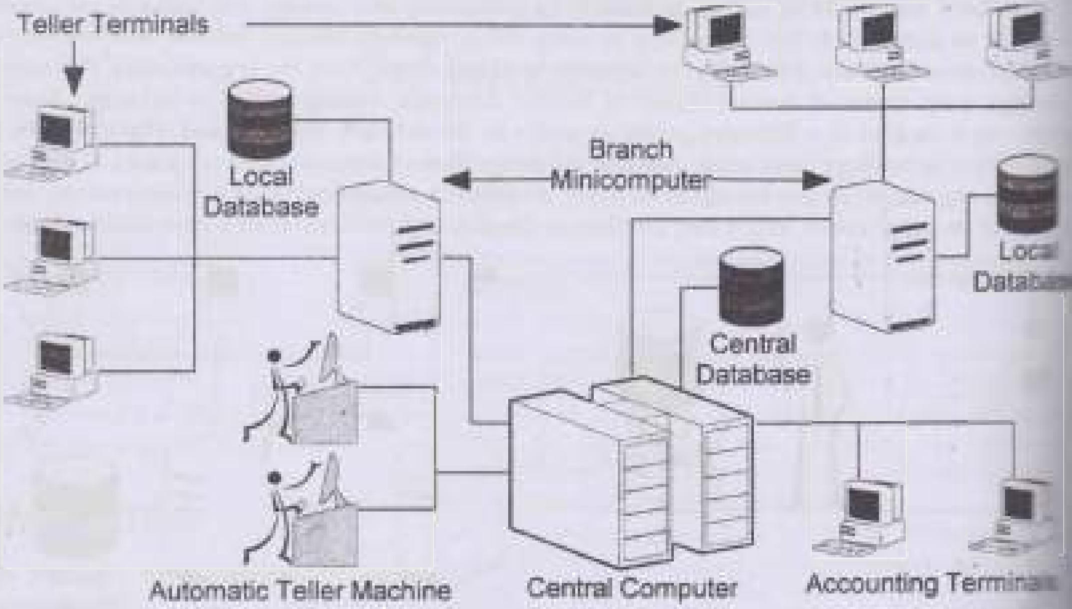


Figure 23.3 A Distributed Multi-branch Banking System

Most distributed systems are very complex. For example, in the above case the branch c
must perform as stand-alone machines while simultaneously interacting with other machin
network and share data as well.

ADVANTAGES OF DISTRIBUTED SYSTEMS

The **advantages** of distributed processing include:

- **Local control of local data** — The major benefit from a distributed data processing
  local control of local data. This means that the local organization can take more res
  for developing, scheduling, introducing, and managing applications. Above all
  perspective can keep the information system more focused on the local org
  objectives.
- **Lower cost** — Often the hardware in a distributed system is less expensive than
  centralized system. Several minicomputers or microcomputers cost less than one
  The maintenance costs of these machines are also less compared to the centraliz
  machines.
- **Modularity** — Distributed systems tend to be modular. As the demand for
  increases, most micros, minis and other supportive equipment such as second
  devices and printers can be added to the network. For example, in a local area net
  when a new microcomputer needs to be added it is simply plugged into the
  within minutes it is a functioning part of the existing network.
- **Better response times** — When only one centralized computer is used, the respo
  user's request can be delayed as more and more users make demands on the sy
  distributed system, local processing is done on local machines, and in many s

machines only occasionally need to call upon the resources of other machines in the system. As a result, there will not be much increase in the response time as more users are added to a distributed system.

- **Ability to share data** – Another advantage of a distributed system is its ability to share data across the nodes in a network. Without a network, it is difficult or impossible to share data. Of course, the floppy disk from one machine can be taken to another, and the data can be shared in this way; but it is much more convenient if the machines can share data through the electronic interface of a network.
- **Greater reliability** – Still another advantage of distributed systems is their reliability. If the centralized system breaks down, the whole operations of the organizations will to come to a halt. Networks, in general, are not subject to such catastrophes. If one computer in the network breaks down, the rest of the machines may not be affected depending on the network topology.
- **Direct user interaction** – Another advantage is that users directly interact with the information system in distributed processing. This means that users will not consider the computer an unapproachable, mysterious black box located behind closed doors.

DISADVANTAGES OF DISTRIBUTED SYSTEMS

Distributed networks have **disadvantages**, too, and these must be considered before a system is decentralized. They include:

- **Technical problems of connecting dissimilar machines** – Technical problems can sometimes be overwhelming for a distributed system. Additional layers of operating system software are needed to translate and coordinate the flow of data between machines. Sometimes a link between mainframes and microcomputers can be difficult to establish.
- **Need for sophisticated communication systems** – Distributed processing requires the development of a data communication system. These systems can be costly to develop and use. In addition, their maintenance can be a costly affair.
- **Data integrity and security problems** – Because data maintained by distributed systems can be accessed at many locations in the network, controlling the integrity of a database can be difficult.
- **Lack of professional support** – Finally, distributed computers are often placed in locations where little or no data processing support is available. Consequently, they will be run by non-professionals. Another aspect is that the communication systems also require highly trained personnel for their maintenance.

REVIEW QUESTIONS

Descriptive Type Questions

1. What is centralized data processing?
2. What is distributed data processing?
3. Explain how a distributed data processing system works.
4. What are the advantages of distributed data processing?
5. What are the disadvantages of distributed data processing?

Fill in the Blanks

1. There are two types of data processing systems: _________ and _________.

02. In _________ data processing system all processing is done at a central location.
03. In distributed processing, data processing and storage can occur at _________ locations.
04. The various components of a distributed processing system are connected by a _________.
05. The different points in a network are called _________.

[**Answers:** (1) Distributed and Centralized (2) Centralized (3) Different (4) Network (5) Nodes]

True or False

01. In centralized data processing systems, processing and storage take place at a central locat[ion].
02. In distributed processing several computers are used for processing and storage.
03. The components of a distributed system are connected together by a multiplexer.
04. Distributed processing systems are not modular.
05. With distributed data processing the response times are better.

[**Answers:** (1) True (2) True (3) False (3) False (5) True]

Multiple Choice

01. The two types of data processing systems are _________ and _________.
    (1) Distributed, Centralized (2) Centralized, Localized (3) Serial, Parallel (4) None of the ab[ove]
02. The components of a distributed system are connected by a _________.
    (1) Multiplexer (2) Communications controller (3) Network (4) Switcher
03. An advantage of distributed processing is _________.
    (1) Better response time (2) Modularity (3) Lower cost (4) All of the above
04. The different locations in a network are called _________.
    (1) Points (2) Nodes (3) Module (4) None of the above
05. Which of the following is not true about distributed processing?
    (1) Modular (2) Reliable (3) High maintenance costs (4) Slow response

[**Answers:** (1) Distributed, Centralized (2) Network (3) All of the above (4) Nodes (5) Slow resp[onse]]

C H A P T E R 2 4

Internet & World Wide Web

TOPICS COVERED

- Introduction
- What is special about the internet?
- Internet access
- Internet basics
- Internet protocols
- Internet addressing
- World Wide Web (WWW)
- Web pages and HTML
- Web browsers
- Searching the web
- Internet chat

Key Points

▲ The Internet is a global system of interconnected computer networks that interchange data by packet switching using the standardized Internet Protocol Suite (TCP/IP).

▲ The Internet carries various information resources and services, such as electronic mail, online chat, file transfer and file sharing, online gaming, and the inter-linked hypertext documents and other resources of the World Wide Web (WWW).

▲ Internet is the cheapest and fastest means to get, provide and compile information.

▲ An IP (Internet Protocol) address is an identifier for a particular machine on a particular network; it is part of a scheme to identify computers on the Internet.

▲ A domain name is a way to identify and locate computers connected to the Internet. Like the IP address no two computers can have the same domain name.

▲ The WWW is the graphical Internet service that provides a network of interactive documents and the software to access them. It is based on documents called pages that combine text, pictures, forms, sound, animation and hypertext links called hyperlinks

▲ A browser is a piece of software that acts as an interface between the user and the inner-workings of the Internet, specifically the WWW.

INTRODUCTION

The Internet is a global system of interconnected computer networks that interchange data by packet switching using the standardized Internet Protocol Suite (TCP/IP). It is a "network of networks" that consists of millions of private and public, academic, business, and government networks of local to global scope that are linked by copper wires, fiber-optic cables, wireless connections, and other technologies. The Internet carries various information resources and services, such as electronic mail, online chat, file transfer and file sharing, online gaming, and the inter-linked hypertext documents and other resources of the World Wide Web (WWW).

The terms Internet and World Wide Web are often used in everyday speech without much distinction. However, the Internet and the World Wide Web are not one and the same. The Internet is a global data communications system. It is a hardware and software infrastructure that provides connectivity between computers. In contrast, the Web is one of the services communicated via the Internet. It is a collection of interconnected documents and other resources, linked by hyperlinks and [illegible] Internet is the world's largest computer network scattered all over the world. It was created [illegible] years ago as a project for the U.S. Department of Defense. Its goal was to create a method for [illegible] separated computers to transfer data efficiently even in the event of a nuclear attack. From a handful of computer and users in the 1960s, today the Internet has grown to thousands of re networks that can connect millions of users. The number of Internet users has grown by 305.5% d the period 2000–2008. As of June 30, 2008, 1.463 billion people use the Internet according to In World Stats (http://www.internetworldstats.com/stats.htm). The region-wide breakup of Internet users is shown in Figure 24.1.

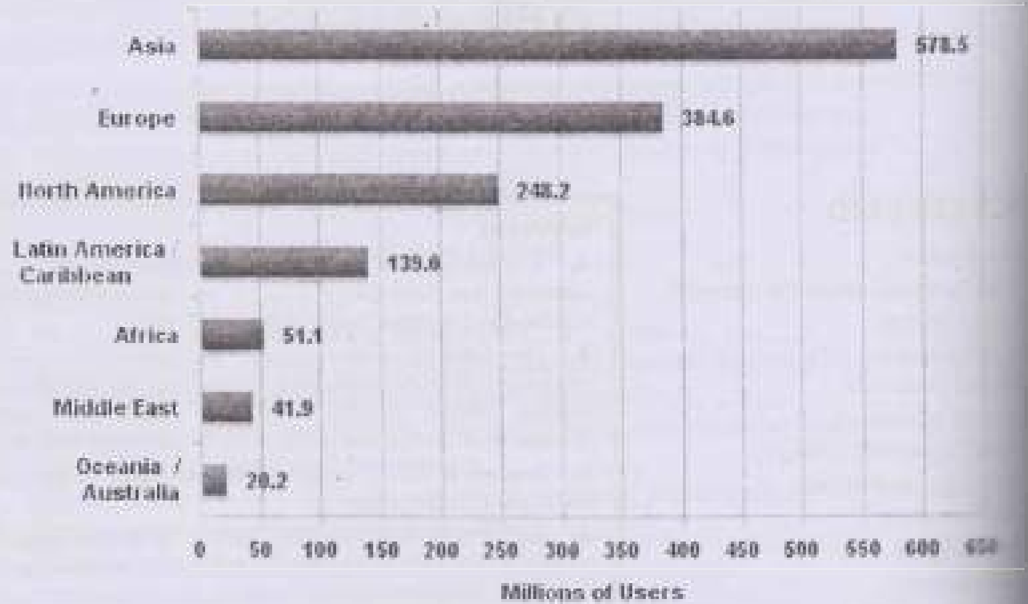


Figure 24.1 Internet Users in the World (http://www.internetworldstats.com/stats.htm)

Any single individual, company, or country does not own this global network. A networks, or "Internet," is a group of two or more networks that are:

▲ Interconnected physically
▲ Capable of communicating and sharing data with each other
▲ Able to act together as a single network.

Machines on one network can communicate with machines on other networks, and files, and other information back and forth. For this to work, the networks and machines of the Internet have to agree either to speak the same "language" when they are communic use an "interpreter." This "language" is software that enables the different types of separate networks to communicate and exchange information. To be used by differen machines and yet be understood by all of them, the software must follow a set of rules, or

The Internet, with a capital "I," is the network of networks, which either uses the TCP, or interacts with TCP/IP networks via gateways (the interpreters). The Internet networks as one, seamless network for its users. The Internet covers the globe and international networks as well as many smaller, local-area networks (LANs). The Internet to data, graphics, sound, software, text, and people through a variety of services communication and data exchange:

▲ Remote login (Telnet)
▲ File transfer (FTP)

- ▲ Electronic mail (E-Mail)
- ▲ News (Usenet or network news)
- ▲ Hypertext (WWW)

WHAT IS SPECIAL ABOUT THE INTERNET?

here are three obvious reasons. Internet is the cheapest and fastest means to get, provide and compile formation.

Getting Information on the Internet

e amount of information available through the Internet is staggering. To make all of it more easily ailable to users, programs such as the gopher were developed to help present material in some al fashion. The most recent and very successful attempt at presenting information over the ernet is the World Wide Web (WWW). You could get information about people, products, nizations, research data, electronic versions of the printed media, etc. from the Internet.

oviding Information on the Internet

of what you want to provide could be considered advertising. While that may sound somewhat ercial, it is the best and most inexpensive way to let people know who you are, what you are /have done, and how. For an organization or institution, setting up a home page is a good way the world know what its products and services are. In addition to advertising, the other critical ns that relate to provision of information are

- **Publishing**, including full text articles, reports, illustrated articles, abstracts, computer programs, and demonstrations.
- **Blogging**, which is a form of self-publishing. A blog (or Web log) is a website, usually maintained by an individual with regular entries of commentary, descriptions of events, or other material such as graphics or video.
- **Extension**, in which some of the delays associated with the printed media, may be reduced.
- **Teaching**, the possibilities here include both distance learning and assistance for students.

iling Information from the Internet

obviously a special case of "getting" information. The distinction is that it is possible to get information from the web. For instance, if you wanted to poll the readership for a or conduct a survey to detect the pulse of a selected community, the web provides you with platform and opportunity. Using forms, e-mail, etc., you can conduct surveys and get opinion across the world. There are hundreds of discussion groups and LISTSERVs, where one can tion and get it answered by hundreds of people who participate in these discussions.

NET ACCESS

nnect to the Internet in one of two basic ways, dialing into an Internet Service Provider's uter, or with a direct connection to an Internet Service Provider. The difference is mainly in d cost. In most cases you connect to your ISP using a telephone line and modem. This type is called the Dial-up connection. Sometimes you go in for a direct connection. We will types of connections in a little detail.

Connection

up account, you use your modem to convert computer bits and bytes into modulated that the phone lines can transmit. These signals are received by a modem at your ISP and demodulated into bits and bytes for their computer. "Modem" is short for "modul… demodulator." You usually connect to a local ISP and can surf or browse the Internet. Dial-up acc… either by way of SLIP (Serial Line Internet Protocol) or PPP (Point to Point Protocol). To establ… conventional dial-up connection to the Internet, you will need the following:

1. An account with an Internet Access Provider (In India, VSNL, Reliance, Airtel, etc are som… the Internet Access Providers). The account can be either TCP/IP or Shell.
2. A telephone connection.
3. A computer with serial port (for external modems) or an expansion slot (for internal mo…
4. A modem (external/internal).
5. A communication (or terminal emulation) software. SLIP/PPP (TCP/IP) account hol… require browser software (Internet Explorer, Firefox, Opera, etc.) and e-mail so… (Microsoft Outlook, Opera Mail, Eudora, Thunderbird, etc.). For Shell account hol… browser software (Lynx) and the E-mail software (Pine) are usually available with the … Access

The Figure 24.2 shows the components of a conventional dial-up connection:

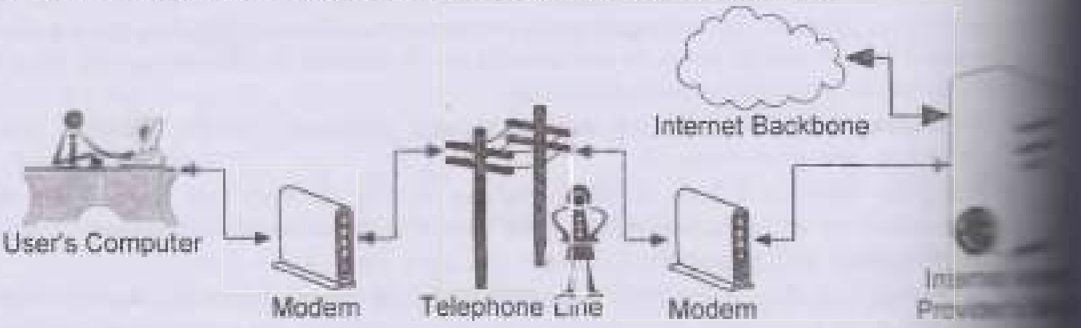


Figure 24.2 Components of a dial-up connection

Direct Connection

You can also get a direct connection to your ISP, where you have a fixed cable or a ded… line to the ISP. The most popular high speed Internet access these days is ADSL. Asy… Subscriber Line (ADSL) is a data communications technology that enables faster data … over copper telephone lines than a conventional voice band modem can provide. It … utilizing frequencies that are not used by a voice telephone call. A splitter—or micro… single telephone connection to be used for both ADSL service and voice calls at the same … phone lines vary in quality and were not originally engineered with DSL in mind, it can … be used over short distances, typically less than 4 Km.

Another type of dedicated connection is an ISDN (Integrated Services Digital Netw… is a higher-speed version of the standard phone line, but actually requires two phone … handle more than 56,600 bps. ISDN lines scale upward, meaning you can transparentl… to get faster speeds with a single ISDN connection, up to about 1.28 million bps. With … and growing popularity of ADSL broadband technology with static IPs, the use of … But ISDN still plays a very big role as a backup network for point-to-point leased li… low cost reliable data network for governmental agencies and organizations such as … financial institutions.

You can also get a dedicated line called a T1 or T3. A T1 ('Tee-one') line can handle 1.5 Mbps. A T3 line can handle 30 times that speed (45 Mbps). If you have a dedicated line, you do not use a modem to connect your computer to the Internet, but instead a router. If you have a network in the office and several people need to access the Internet simultaneously, consider ADSL or T1 connection. When a user connects to the Internet, the router automatically handles the connection. Even multiple tasks at the same time are possible and you need not have a modem or telephone line for each computer and user.

INTERNET BASICS

For most people who are new to the Internet, the first experience is quite overwhelming. Faced with the wide range of features and options and the scope, magnitude and amount of information and other resources, newbies spend a lot of time simply finding their bearings. However as one gets the feel of the Internet, it becomes clear that Internet is similar to any other medium of information and/or communication.

Once you know the information that you want to find, how to find it, where to find it and how to access it, the Internet becomes an extremely powerful resource—irrespective of whether you are using it for work, education, entertainment or just for the fun of exploring. Once you know how to send and receive electronic mail, subscribe to mailing lists, join and participate in discussion groups and Internet chats, your power to communicate with people anywhere in the world will increase dramatically. The beauty of Internet is that all these power and resources are available at a very minimal cost. So Internet literacy is a must for every individual who wants to succeed in this information age.

What Should I Do?

Before you can decide how you want to use the Internet, you should get an idea about what you can do and what is there in the cyberspace. For beginners, the best way to get inducted into the cyber world is to start browsing the Internet using one of the powerful web browsers like Internet Explorer (Microsoft Corporation) or Firefox (Mozilla Foundation), Opera (Opera Software ASA), Chrome (Google), Safari (Apple Corporation), etc.

Web browsers are mainly used to access pages of the World Wide Web. By clicking on the hypertext links on a page it is possible to jump from one Internet site to another, regardless of its location. Hypertext links are usually highlighted or different colored text, images or icons. You can check for hypertext links by moving the mouse over the area; if the mouse pointer changes its shape to that of a hand [ ] then it is a hypertext link. This jumping from one site to another using the hypertext links is called 'net surfing' or 'web browsing'.

But today's web browsers can do much more than browsing. You can download files, play games, send and receive mails and even chat with others. In other words, the modern day web browsers are very versatile and they allow you to do almost all the activities that are possible on the Internet. Given below is a list of activities that you could do with a web browser:

- Visit websites
- Send and receive electronic mail
- Read and post articles in newsgroups
- Download files to your PC
- Chat with other users on-line
- Play games with others on-line

- ▲ Access on-line multimedia including radio and video broadcasts
- ▲ Search the Internet for information

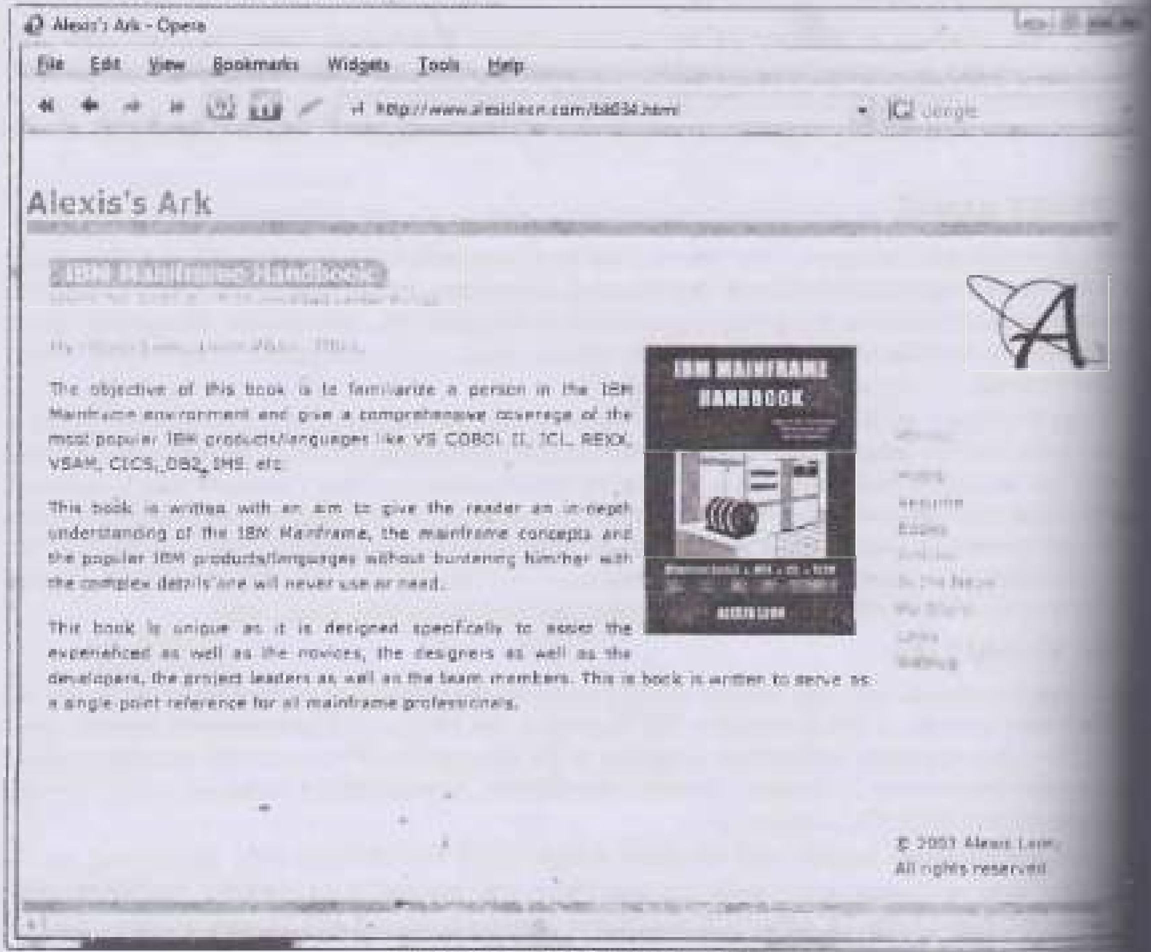


Figure 24.3 Web Browser in Action

- ▲ Subscribe to electronic newsletters, e-zines, RSS feeds, etc.
- ▲ Join contests
- ▲ Contribute articles, and other materials
- ▲ Do on-line shopping
- ▲ Post your resumes on the Internet
- ▲ Create your own websites
- ▲ Create an e-mail ID and account for you
- ▲ Use the e-mail reminder service
- ▲ Find a person's details
- ▲ Send flowers or gifts to others.

The above list is by no means a complete and comprehensive one. There are a lot of other things that you can do on the Internet.

INTERNET PROTOCOLS

We will examine the various Internet protocols used. The most commonly used protocols are:

- Transmission Control Protocol/Internet Protocol (TCP/IP)
- File Transfer Protocol (FTP)
- Hyper Text Transfer Protocol (HTTP)
- Telnet
- Gopher
- Wide Area Information Service (WAIS)

Transmission Control Protocol / Internet Protocol (TCP/IP)

TCP/IP stands for Transmission Control Protocol/Internet Protocol. TCP/IP is actually a collection of protocols, or rules, that govern the way data travels from one machine to another across networks. The Internet is based on TCP/IP. TCP/IP has two major components—TCP and IP. The IP component does the following:

- Envelopes and addresses the data
- Enables the network to read the envelope and forward the data to its destination
- Defines how much data can fit in a single "envelope" (a packet).

The relationship between data, IP, and networks is often compared to the relationship between a letter, its addressed envelope, and the postal system as shown in the Figure 24.4. The top portion of the figure shows the data being packaged and addressed. The addressed and packaged data is sent over the network to its destination. The TCP component does the following:

- Breaks data up into packets that the network can handle efficiently
- Verifies whether all the packets have arrived at their destination
- "Reassembles" the data.

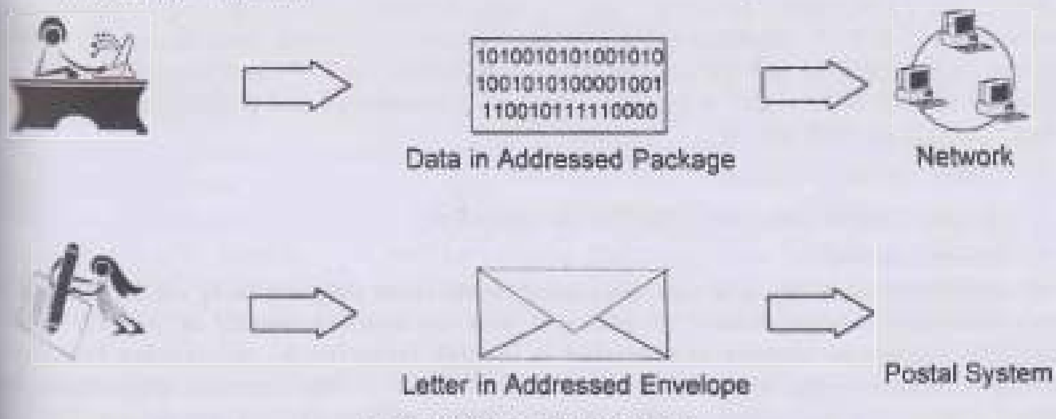


Figure 24.4 IP vs. Postal System

TCP/IP can be compared to moving across the country. You pack your belongings in boxes and put your new address on them. The moving company picks them up, makes a list of the boxes, and ships them across the country along the most efficient route—this may mean putting your dishes and your bedroom furniture on different trucks. Your belongings arrive at your new address. You ... your list to make sure that everything you shipped has arrived (in good shape), then you unpack ... boxes and "reassemble" your house.

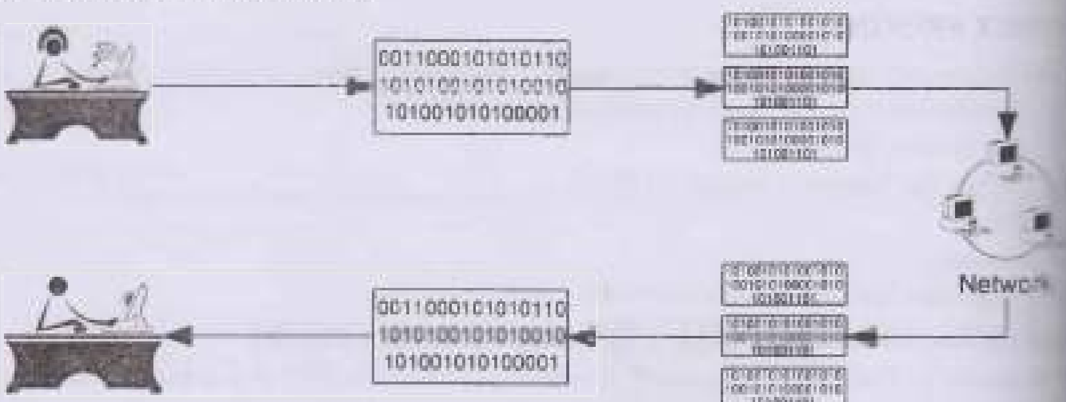


Figure 24.5 TCP/IP

File Transfer Protocol (FTP)

FTP stands for File Transfer Protocol, and is part of the TCP/IP protocol suite. It is the protocol ... of rules, which enables files to be transferred between computers. FTP is a powerful tool which ... files to be transferred from "computer A" to "computer B", or vice versa.

Figure 24.6 File Transfer Protocol

FTP works on the client/server principle. A client program enables the user to interact ... server in order to access information and services on the server computer. Files that can be ... are stored on computers called FTP servers. To access these files, an FTP client program is used. ... an interface that allows the user to locate the file(s) to be transferred and initiate the transfer ... The basic steps to use FTP are:

1. Connect to the FTP server
2. Navigate the file structure to find the file you want
3. Transfer the file.

The specifics of each step will vary, depending on the client program being used and the ... Internet connection. Anonymous FTP allows a user to access a wealth of publicly ... information. No special account or password is needed. However, an anonymous FTP ... sometimes ask users to login with the name "anonymous" and use their electronic mail address ... password. There are a wide variety of files that are publicly available through anonymous FTP

- **Shareware** – software that you can try for free for a limited period and if you ... product you will have to buy it.
- **Freeware** – completely free software, for example fonts, clipart and games.

- **Upgrades and Patches** — upgrades to current software and "fixes" for software problems.
- **Documents** — examples include research papers, articles and Internet documentation.

Files on FTP servers are often compressed. Compression decreases file size. This enables more files to be stored on the server and makes file transfer times shorter. In order to use a compressed file it needs to be decompressed using appropriate software. It is a good idea to have current virus checking software on the computer before files are transferred to it.

Hypertext Transfer Protocol (HTTP)

HTTP is short for Hypertext Transfer Protocol. It is the set of rules, or protocol that governs the transfer of hypertext between two or more computers. The World Wide Web encompasses the universe of information that is available via HTTP.

Hypertext is text that is specially coded using a standard system called Hypertext Markup Language (HTML). The HTML codes are used to create links. These links can be textual or graphic, and when clicked on, can "link" the user to another resource such as other HTML documents, text files, graphics, animation and sound. HTTP is based on the client/server principle. HTTP allows "computer A" (the client) to establish a connection with "computer B" (the server) and make a request. The server accepts the connection initiated by the client and sends back a response. An HTTP request identifies the resource that the client is interested in and tells the server what "action" to take on the resource.

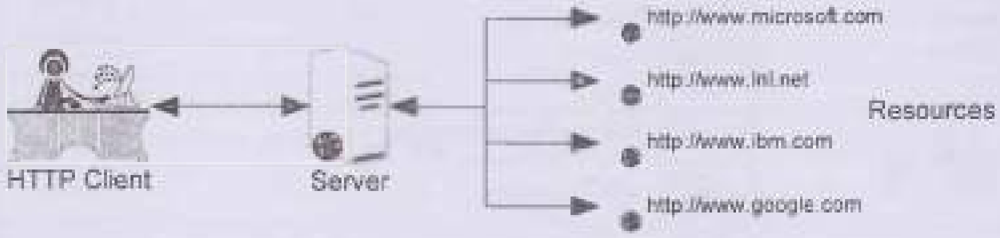


Figure 24.7 HTTP

When a user selects a hypertext link, the client program on their computer uses HTTP to contact the server, identify a resource, and ask the server to respond with an action. The server accepts the request, and then uses HTTP to respond to or perform the action. Usually hypertext links will be blue in color and will be underlined (this is the normal convention, which is not always followed). When you move the mouse pointer over a hypertext link the pointer changes its shape to that of a hand. In the case of text based browsers, the hypertext links will be highlighted and you can navigate between them using the keyboard.

In Figure 24.8 an index of sample web pages are given as hypertext links. When you click on one link, say, 'Pages with graphics', you will be taken to that page. Thus, when you select any of the hypertext links, you are identifying a particular resource, and asking the server to send it back to your computer in a format that your computer can display or store. HTTP also provides access to other Internet protocols like File Transfer Protocol (FTP), Simple Mail Transfer Protocol (SMTP), Network News Transfer Protocol (NNTP), WAIS, Gopher, Telnet, etc.

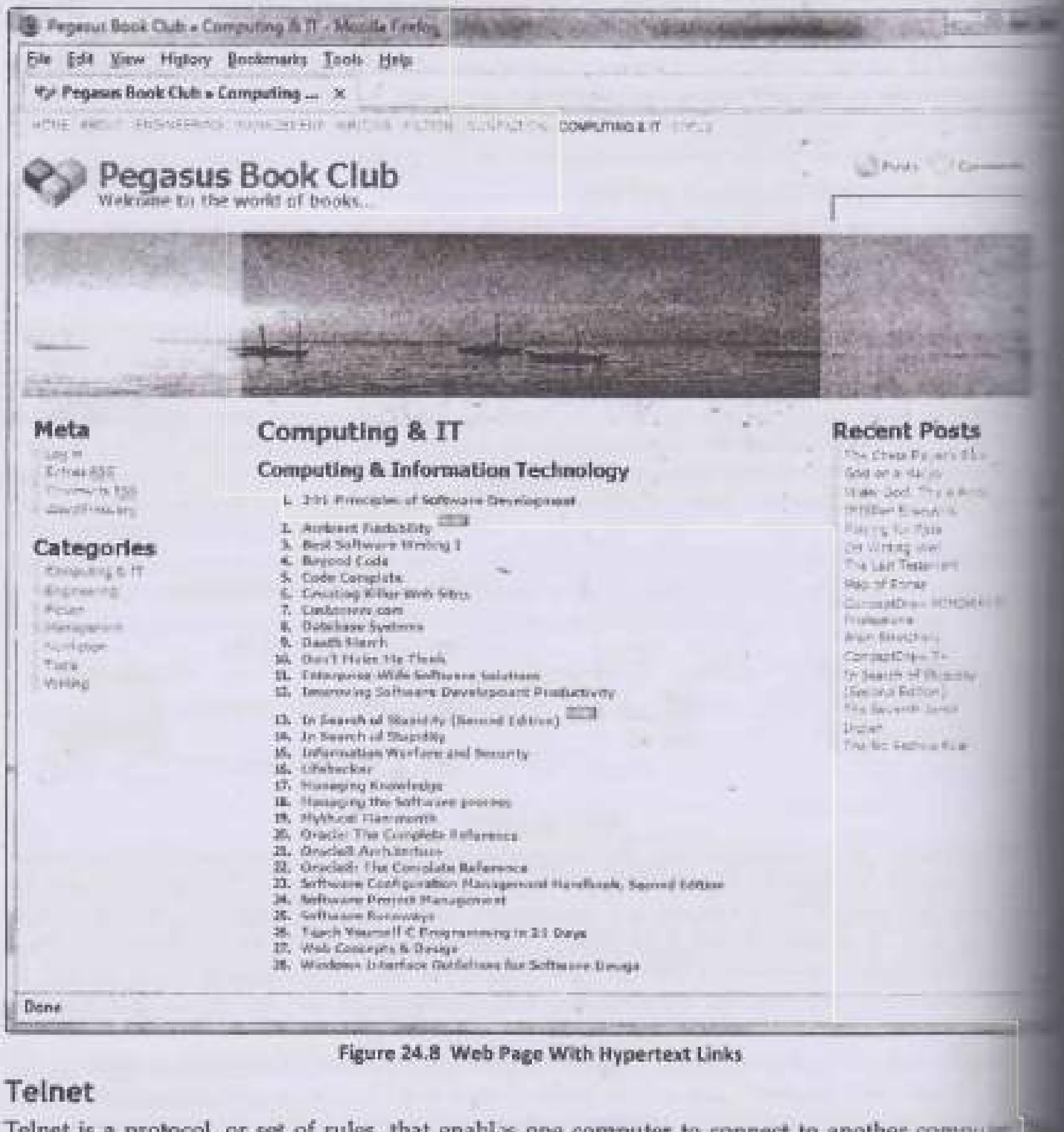


Figure 24.8 Web Page With Hypertext Links

Telnet

Telnet is a protocol, or set of rules, that enables one computer to connect to another compu... process is also referred to as remote login. The user's computer, which initiates the conne... referred to as the local computer, and the machine being connected to, which accepts the conne... referred to as the remote, or host, computer. The remote computer can be physically located in ... room, the next town, or in another country. Once connected, the user's computer emulates the ... computer. When the user types in commands, they are executed on the remote computer. The ... monitor displays what is taking place on the remote computer during the telnet session.

The procedure for connecting to a remote computer will depend on how your Internet acc... up. Once a connection to a remote computer is made, instructions or menus may appear. Som...

machines may require a user to have an account on the machine, and may prompt users for a username and password.

Figure 24.9 Telnet

Many resources, such as library catalogs, are available via telnet without an account and password. Telnet also operates on the client/server principle. The local computer uses a telnet client program to establish the connection and display data on the local computer's monitor. The remote, or host, computer uses a telnet server program to accept the connection and send responses to requests for information back to the local computer. Telnet allows the user to access Internet resources on other computers around the world. A variety of resources are available through telnet. For example: Library catalogs, Databases, other Internet tools such as FTP, Gopher, and the World Wide Web, etc.

During the mid-2000s, the Telnet protocol was superseded for remote login, but telnet clients are still used, often when diagnosing problems, to manually "talk" to other services without specialized client software. For example, it is sometimes used in debugging network services such as an SMTP, IRC, HTTP, FTP or POP3 server, by serving as a simple way to send commands to the server and examine the responses. Thus, other software such as **netcat** or **socat** on Unix or **PuTTY** on Windows are finding greater favor with some system administrators for testing purposes, as they can be called with arguments not to send any terminal control handshaking data.

Gopher

Gopher is a protocol designed to search, retrieve, and display documents from remote sites on the Internet. In addition to document display, document retrieval, it is possible to initiate on-line transactions with other systems via Gopher. It accomplishes this using the client/server model of users running "client" software on their local machines that provide an interface that interacts with remote "servers" or computers that have information of interest.

Gopher was created as a piece of software to utilize some of the services that were becoming available on the Internet. It was designed to work with a variety of different Internet stand alone services. The integration of many services into Gopher has made the Internet an easier medium to navigate. Gopher can work with the following Internet tools, or systems like WAIS, FTP, HTTP, etc.

The World Wide Web was in its infancy in 1991, and Gopher services quickly became established. By the late 1990s, Gopher had ceased expanding. Several factors contributed to Gopher's stagnation:

* Gopher Client functionality was quickly duplicated by early Web browsers, such as Mosaic. Furthermore, the user friendliness of the World Wide Web, with its integration of text and graphics, made Gopher less appealing.
* Gopher has an inflexible structure when compared to the free-form HTML of the Web. With Gopher, every document has a defined format and type, and the typical user must navigate through a single server-defined menu system to get to a particular document.

As of 2008, there are approximately 125 gopher servers indexed by Veronica-2 (a search engine system for the Gopher protocol). Many of them are owned by universities in various parts of the world. Most of them are neglected and rarely updated except for the ones run by enthusiasts of [illegible] protocol. A handful of new servers are set up every year by hobbyists.

It was suggested that the bandwidth-sparing simple interface of Gopher would be a good [illegible] for mobile phones and Personal digital assistants (PDAs), but so far, Wireless Markup [illegible] (WML)/Wireless Application Protocol (WAP), DoCoMo i-mode, XHTML Basic or other [illegible] HTML and XML, have proved more popular.

WAIS

WAIS (pronounced "wayz") stands for Wide Area Information Service. WAIS is an Internet [illegible] that is based on the Z39.50 standard. The Z39.50 standard describes a protocol, or set of [illegible] computer-to-computer information retrieval. WAIS also works on the client/server principle. A [illegible] client program enables the user's computer to contact a WAIS server, submit a search [illegible] receive a response to that query. WAIS has the capability of simultaneously searching in [illegible] one database. After the search phrase has been typed into the client interface, the user can then [illegible] which databases should be used to complete the search. Depending on the WAIS client [illegible] used, this may be a matter of using a mouse to select database names displayed on a [illegible] typing in the database names using the keyboard. To understand how WAIS works to [illegible] search, it is important to know that the database itself is not being searched for the [illegible] phrase. Rather, an index for the database is searched. The index is created by people, and [illegible] all, or as many, of the words in all the items contained in the database. Once the search [illegible] executed, all items containing the words appearing in the search phrase will be returned to [illegible] provided that the words in the search phrase appear in the indexes of the selected databases. [illegible] of the abundance of content and search engines now available on the Web, few if any [illegible] remain in operation.

INTERNET ADDRESSING

In general, Internet addressing is a systematic way to identify people, computers and [illegible] resources. On the Internet, the term "address" is used loosely. Address can mean many [illegible] things from an electronic mail address to a URL.

IP Address

If you want to connect to another computer, send an e-mail message, or transfer files [illegible] another computer, you first need to know where the other computer is—you need the [illegible] "address." An IP (Internet Protocol) address is an identifier for a particular machine on [illegible] network; it is part of a scheme to identify computers on the Internet. IP addresses are also [illegible] as IP numbers and Internet addresses. An IP address consists of four sections separated [illegible] Each section contains a number ranging from 0 to 255. Example: 202.54.1.6. These [illegible] represent both the machine itself, or host, and the network that the host is on. The [illegible] the IP address is allocated to Internet Service Providers (ISPs) by the InterNIC, under [illegible] Internet Assigned Numbers Authority (IANA). ISPs then assign the host portion of the [illegible] the machines on the networks that they operate. The IP addresses have the following [illegible] common:

- IP addresses are unique.
- No two machines can have the same IP number.
- IP addresses are also global and standardized.

- All machines connected to the Internet agree to use the same scheme for establishing an address.

omain Names

domain name is a way to identify and locate computers connected to the Internet. No two nizations can have the same domain name. A domain name always contains two or more ponents separated by periods, called "dots" . Some examples of domain names are: *microsoft.com*, *t*, *ibm.com*, *nasa.gov*, *utexas.edu*, *tcs.co.in*, etc. The last portion of the domain name is the top-level ain name and describes the type of organization holding that name. The major categories for top- domain names are:

- **aero** - air-transport industry
- **biz** - business
- **coop** - cooperatives
- **com** - commercial entities
- **edu** - educational institutions
- **gov** - United States Federal Government entities
- **info** - information
- **int** - international organizations
- **mil** - United States military
- **mobi** - mobile devices
- **museum** - museums
- **name** - individuals, by name
- **net** - organizations directly involved in Internet operations
- **org** - organizations that do not fit into any other category, such as non-profit groups
- **pro** - professions
- **tel** - Internet communication services
- **travel** - travel and tourism industry related sites
- **Country codes** - a two-letter abbreviation for a particular country. For example, "in" for India, "uk" for United Kingdom or "fr" for France, etc.

domain name corresponds to numeric IP (Internet Protocol) addresses. An IP address takes of 4 numbers, each one between 0 and 255, separated by periods.

Internet uses the numeric IP address to send data. For instance, you may be connecting to a ide Web server with the domain name "*www.microsoft.com*", but as far as the network is d, you are connecting to the Web server with the IP address associated with that domain The Domain Name System (DNS) completes the task of matching domain names to IP Domain names, and their corresponding IP addresses, must be unique. The domain name is a collection of databases that contain information about domain names and their ing IP addresses. Domain name system servers are computers that translate domain names sses. This system allows Internet users to deal with the more intuitive domain names, having to remember a series of numbers.

- Contacts a web server and sends a request for information.
- Receives the information and then displays it on the user's computer.

A browser can be graphical or text-based and can make the Internet easier to use and m intuitive. A text-based browser shows the user only the textual matter. A graphical browser allow user to see more of what the WWW has to offer such as graphics, photographs and multimedia graphical browser allows the user to view images on their computer, "point-and-click" with a m to select hypertext links, and uses drop-down menus and toolbar buttons to navigate and a resources on the Internet. To illustrate, Figure 24.11 shows a part of an Internet Explorer s showing a page from the website of L & L Consultancy Services Pvt. Ltd. (*http://www.lnl.net*).

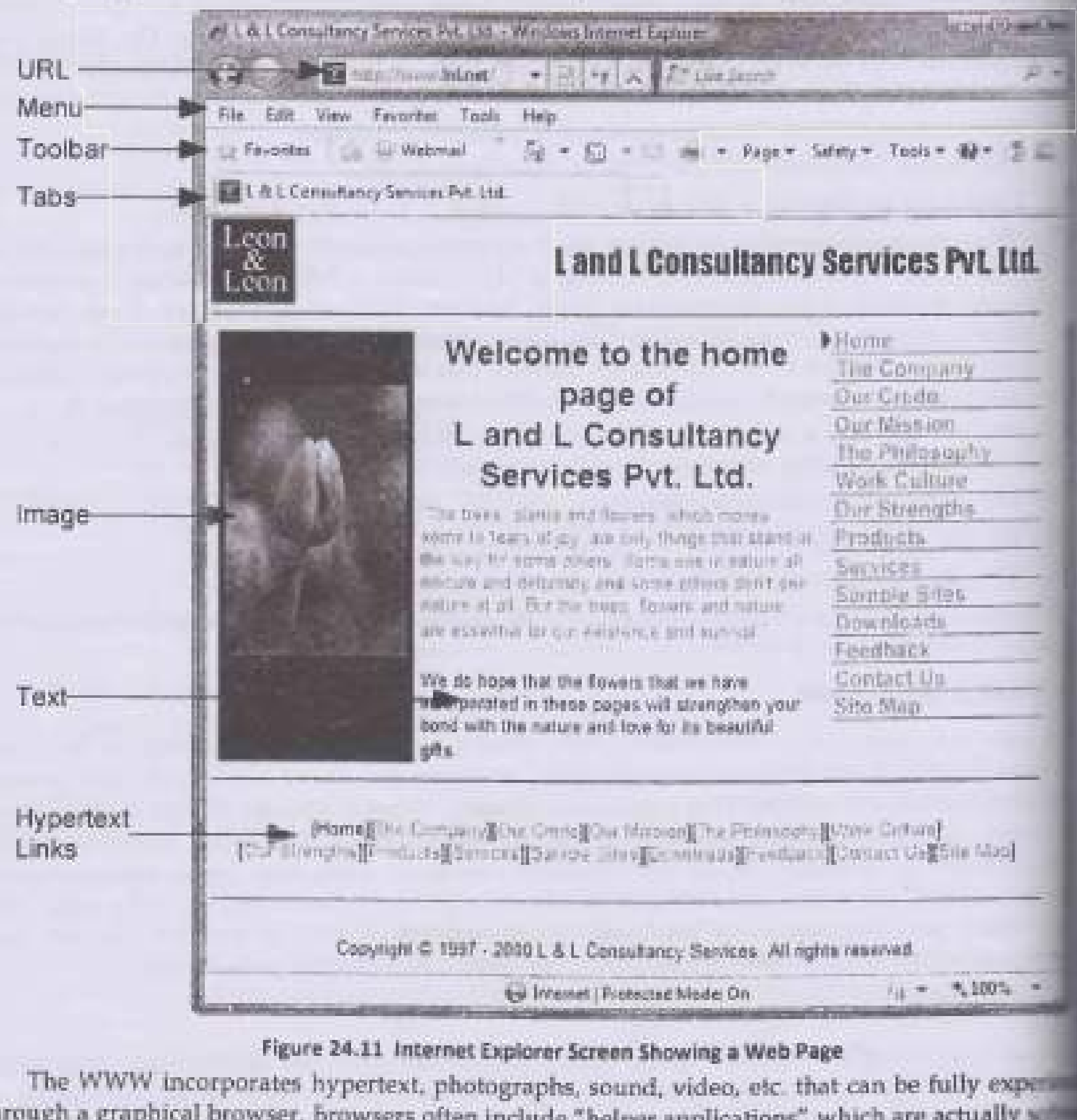


Figure 24.11 Internet Explorer Screen Showing a Web Page

The WWW incorporates hypertext, photographs, sound, video, etc. that can be fully expe through a graphical browser. Browsers often include "helper applications" which are actually so programs that are needed to display images, hear sounds or run animation sequences. The b automatically invokes these helper applications when a user selects a link to a resource that requires them.

A text-based browser allows a user to see only text. Graphic elements are not displayed and hypertext links are accessed by using the keyboard. Lynx is an example of a text-based browser and the Figure 24.12 shows a portion of a Lynx screen. Notice the absence of pictures and other graphics and multimedia elements.

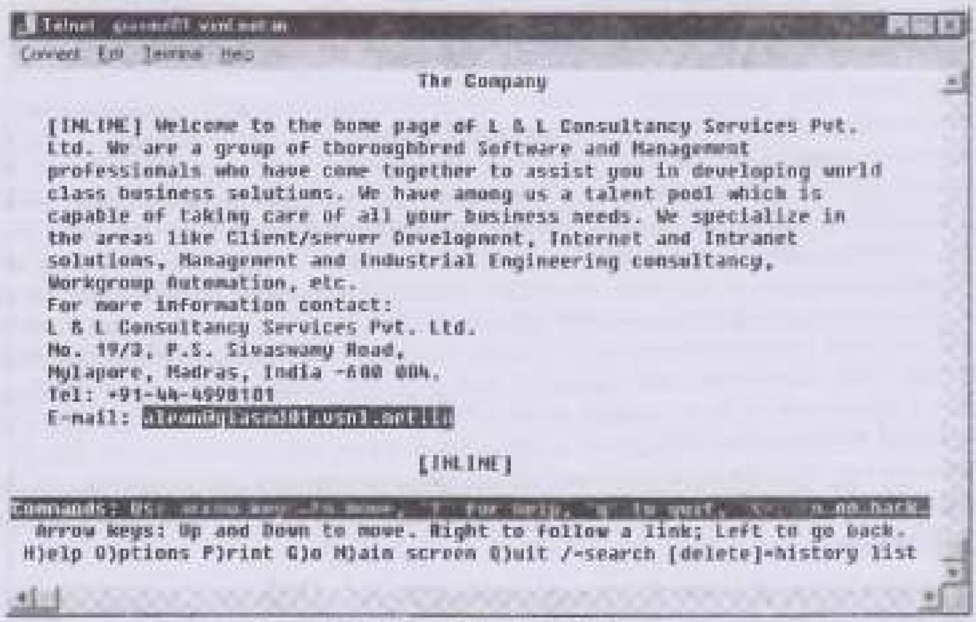


Figure 24.12 Lynx--A Text-based Browser

Browsing in Lynx consists of highlighting the chosen link using cursor keys, or having all links on a page numbered and entering the chosen link's number. Current versions support SSL and many HTML features. Tables are linearized (scrunched together one cell after another without tabular structure), while frames are identified by name and can be explored as if they were separate pages. Lynx cannot inherently display various types of non-text content on the web, such as images and video, but it can launch external programs to handle it, like an image viewer or video player.

Because of its text-to-speech-friendly interface, Lynx was once popular with visually-impaired users, but better screen readers have reduced the appeal of this application. Lynx is also used to check the usability of websites in older browsers. It is still included in a number of Linux distributions, and is particularly useful for reading documentation when only a text-based environment is available. Despite its text-only nature and age, it can still be used to effectively browse much of the modern web, including performing interactive tasks like editing Wikipedia. The speed benefits of text-only browsing are most apparent when using low bandwidth internet connections, or older computer hardware that may be slow to render image-heavy content.

There are many different types of browsers and all of them perform the same basic functions (transferring hypertext) but many have specific features that are unique. Examples of some common browsers are Internet Explorer (Microsoft Corporation) or Firefox (Mozilla Foundation), Opera (Opera Software ASA), Chrome (Google), Safari (Apple Corporation), etc.

Web Browsing

Internet browsing or 'net surfing', as it is often called, is the process of visiting different websi the Internet hosted by various companies, organizations, educational institutions, maga individuals, etc. The Internet contains a wealth of information that can help your business. with a good Internet browser, you can easily get around to the myriad of sites, gathering comp information, conducting market research, reading publications, and staying in touch with happening at your business associations.

SEARCHING THE WEB

The World Wide Web has emerged as a viable and legitimate way to publish information. Exp is starting to suggest that certain kinds of information can be found more effectively on the Web can be found using print sources. Until recently, surfing was a typical approach for information on the Web. Surfing is unstructured and serendipitous browsing. Starting particular Web page, the approach is to follow links from page to page, make educated guesses the way, hoping sooner or later to arrive at the desired piece of information. Surfing is bro without tools. A number of new tools have been developed that enable information published Web to be searched and discovered more effectively. This chapter focuses on some of the tools available for finding information on the Web using two interdependent approaches: browsing subject trees and hierarchies (web indexes), and keyword searching using search engines. increasingly important for Internet users to know when it is appropriate to turn to these tools, efficiently and effectively use them, how to select the best tool and approach for the task at hand in general, how to integrate these tools and approaches into everyday work. There are two main of search tools: web indexes and search engines. We will now explore more details about these

Web Directory

A web directory or link directory is a directory on the World Wide Web. It specializes in lin other websites and categorizing those links. A web directory is not a search engine and d display lists of web pages based on keywords; instead, it lists websites by category and subc The categorization is usually based on the whole website rather than one page or a set of key and sites are often limited to inclusion in only a few categories. Web directories often allow site to directly submit their site for inclusion, and have editors review submissions for fitness. Some popular web indexes are:

- AboutUs.org (www.aboutus.org)
- Best of the Web (www.botw.org)
- The WWW Virtual Library (www.vlib.org)
- Yahoo! Directory (dir.yahoo.com)

Search Engines

A web search engine is an interactive tool to help people locate information available via the Wide Web. Web search engines are actually databases that contain references to thou resources. Users interact with the database, submitting questions that "ask" the database if it resources that match a specific criterion. There are many search engines available on the web. search engine provides an interface between the user and the underlying database. The presents the user with a place to type in a search string, which may be a word, a phrase, a some other criterion, and a way to submit the request.

The web search engine runs the search string against the database, returns a list of resources that match the criteria, and displays the results for the user. Many web search engines use "fill-out" forms as an interface, and support complex queries. Many also include instructions and tips to search the database more effectively. Because web search engines can use hypertext, users are able to link directly to resources listed in the result display. Some of the most popular search engines are:

- Google (www.google.com)
- Ask.com (www.ask.com)
- Live Search (www.live.com)
- AltaVista (www.altavista.com)
- Yahoo! Search (search.yahoo.com)

Meta-search Engines

A web meta-searcher is a tool that helps users to locate information available via the World Wide Web. Web meta-searchers provide a single interface that enables users to search many different search engines, indexes, and databases simultaneously. There are a number of web meta-searchers available. Because the content of search engines, indexes, and databases will vary, the same query typed into several search engines is likely to produce different results. When searching a topic, users often want to see results from various sources.

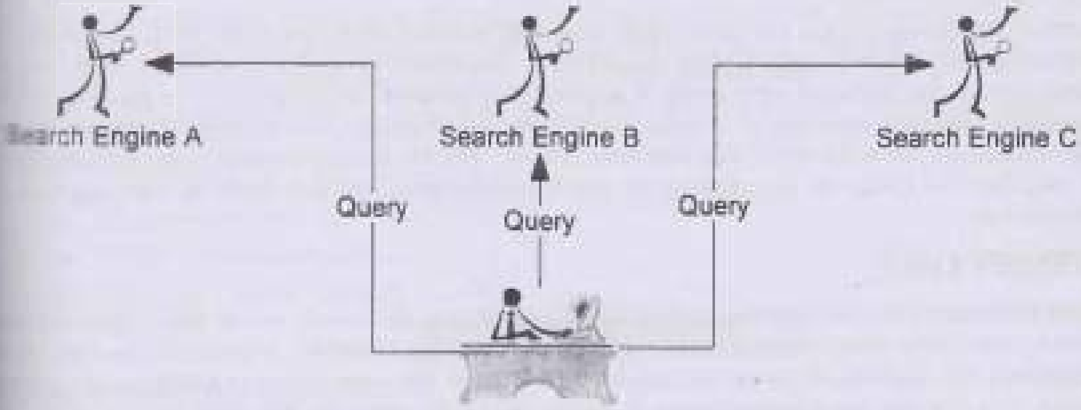


Figure 24.13 A Query being sent to Several Search Engines

One way to compare the results of several search engines is to type and retype a query into individual search engines one at a time. However, this can be very time consuming. A meta-searcher helps to make this task more efficient by providing a central location where the query is typed in once, and results can be obtained from multiple search engines as shown in Figure 24.14.

Meta-searchers differ from other search engines and indexes in the following:

- Single search engines and directories provide a collection or database of resources that can be queried.
- Meta-searchers do not provide a database. They provide a service that sends a single query to multiple databases.

Examples of web meta-searchers include:

- Dogpile (www.dogpile.com)
- Vivisimo (www.vivisimo.com)

- Kartoo (www.kartoo.com)
- Mamma (www.mamma.com)
- Clusty (www.clusty.com)

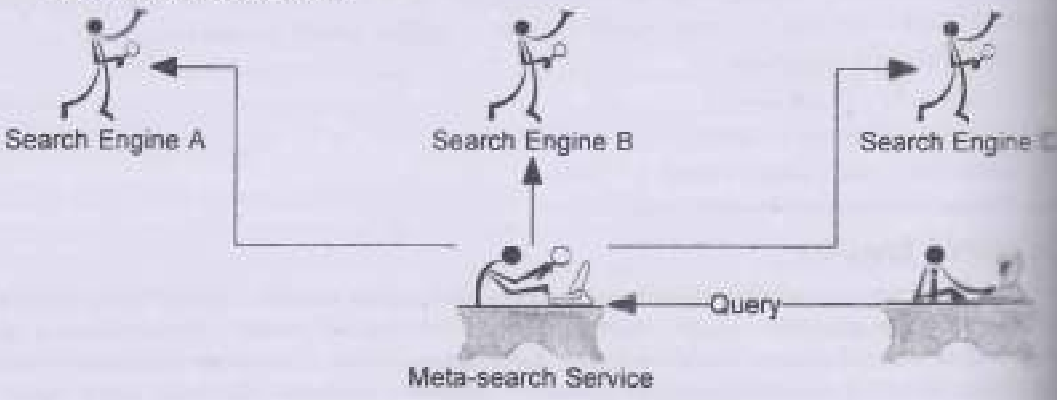


Figure 24.14 Working of a Meta-Search Engine

Making Your Search

To use a search engine or a directory, open your web browser and type in the URL. The conducting a search will vary slightly according to the search engine or web index used. simply type in the keyword, or a series of keywords or phrases, which are used to generate documents matching your query. In other words, the search engine or web index will bring pages containing the keyword(s) that you have entered. The list usually contains a short desc the site, the site URL, etc. By clicking on the hypertext link, you can jump to the page interested in.

INTERNET CHAT

Internet chat lets you communicate with people from all over the world, in real time. There are ways to chat with other Internet users. You can use a large number of sites on the web, customized chat facilities of the on-line service providers, or you can connect to telnet services to chat. You can also use client software to access one of the networks that host Internet Relay (IRC).

Internet Relay Chat (IRC)

IRC is a multi-user chat system that allows many people to communicate simultaneously Internet, in real time. It was developed by Jarkko Oikarinen (Finland) in 1988. IRC conversati place on channels and you chat with other people by typing messages at the keyboard. The place on channels. Channels are the virtual locations on IRC networks where users meet to talk another. The larger networks have thousands of channels and you have to join one of them can talk with other people. It is even possible to have conversations on several channels at time. Some channels will be topic specific, but others are less rigid and will be having a Channels have different modes. Most channels are public, but you can talk on a private or channel, where it is possible to restrict access, for example, to 'invite only'.

An operator runs every channel. You become the operator if you are the first person to existing channel that has become empty, or if you create a new channel. A person who already status can make you an operator. Channel operators have special powers in IRC; they can set the channel mode and control who is allowed on it. To take part in IRC you need to run a client program on your computer while connected to the Internet. IRC is organized in networks. Each network consists of a series of servers that constantly relay chat back and forth among themselves. You access IRC by connecting to a specific server and this automatically gives you access to the entire network.

As mentioned above you need a client program to run an IRC session. If your ISP has not provided you with an IRC client program, you can download any one of the client programs that are available on the web. Some of the IRC programs and the site from where they could be downloaded are given below:

- mIRC (www.mirc.com)
- Miranda IM (www.miranda-im.org)
- XChat (www.xchat.org)

Chatting on Web

There are many live chat sites on the web. There are hundreds of sites devoted exclusively to chat and many sites offer chat areas as an additional feature. Some sites provide links to hundreds of chat servers. The seasoned IRC user may find the web-based chat rather slow and cumbersome compared with a session run from an IRC client. Many web chat sites do not show new messages automatically and often you need to scroll through several screens to pick up the thread of a conversation, making it a very difficult task. On the positive side, web-based chats are usually more colorful than the IRC. On some sites you can include images, sounds with your messages. Some of the places on the web where you chat on-line are given below. In most of the sites the service is free, but you should register before you can start chatting.

- Yahoo! Messenger (messenger.yahoo.com)
- Rediff Chat (www.rediff.com/chat)
- TalkCity (www.talkcity.com)
- Oneindia (chat.oneindia.in)

REVIEW QUESTIONS

Descriptive Type Questions

1. What is the Internet?
2. How does the Internet work?
3. What is the difference between a dial-up connection and a direct connection?
4. List some of the activities that you can do on the Internet.
5. What are the different protocols available on the Internet?
6. What is TCP/IP and how does it work?
7. What is HTTP and how does it work?
8. What is FTP and how does it work?
9. What is anonymous FTP?
10. How are addresses defined on the Internet?
11. What is a URL?
12. What is a domain name and how is it different from an IP address?
13. What is the difference between Gopher and WIAS?
14. What is Telnet?
15. Why is a web browser such as Internet Explorer or Lynx necessary for the Internet?

16. Describe the World Wide Web. How is it different from the Internet?
17. What is a browser and how does it work?
18. What is the difference between Firefox and Lynx?
19. What are hypertext links and where are they used?
20. What are helper applications and why are they important?
21. What is HTML and what is its importance?
22. What are web directories? Give examples.
23. What are search engines? Give examples.
24. What are meta-search engines and how are they different from normal search engines?
25. What is IRC and how does it work?

Fill in the Blanks

01. __________ is the world's largest computer network, the network of networks, scattered all ove world.
02. __________ are used to access pages of the World Wide Web.
03. When you connect to your ISP using a telephone line and modem, that type of connection is the __________.
04. TCP/IP stands for __________.
05. HTTP is short for __________ and it is the set of rules, or protocol, that governs the trans __________ between two or more computers.
06. Hypertext is text that is specially coded using a standard system called __________.
07. __________ is a protocol, or set of rules, that enables one computer to connect to another com and this process is also referred to as __________.
08. __________ is a protocol designed to search, retrieve, and display documents from remote the Internet.
09. WAIS stands for __________.
10. The __________ completes the task of matching domain names to IP addresses.
11. A __________ identifies a particular Internet resource like a Web page, a Gopher server, catalog, an image, or a text file.
12. A __________ is a single unit of information, often called a document that is available via the Wide Web (WWW).
13. HTML stands for __________.
14. A __________ is a piece of software that acts as an interface between the user and the workings of the Internet, specifically the World Wide Web.
15. __________ is the process of visiting different websites on the Internet hosted by the companies, organizations, educational institutions, magazines, individuals, etc.
16. There are two main types of search tools: __________ and __________.
17. __________ provides a single interface that enables users to search many different search indexes, and databases simultaneously.
18. __________ lets you communicate with people from all over the world, in real time.
19. IRC was developed by __________ in 1988.
20. __________ are the virtual locations on IRC networks where users meet to talk to one another.

[Answers: (1) Internet (2) Web browsers (3) Dial-up connection (4) Transmission Protocol/Internet Protocol (5) Hypertex Transfer Protocol, Hypertext (6) HTML (7) Telnet, Gopher (9) Wide Area Information Service (10) Domain Name System (11) URL (12) Web Hypertext Markup Language (14) Browser (15) Web surfing (16) Web directories, Search Meta-search engines (18) Internet chat (19) Jarkko Oikarinen (20) Channels]

True or False

01. Any single individual, company, or country does not own the global network – Internet.
02. The Internet offers access to data, graphics, sound, software, text, and people through a variety of services and tools for communication and data exchange.
03. Direct connection is either by way of SLIP or PPP.
04. A T-1 line can handle 1,280 Kilobytes per second and a T-3 line can handle ten times that speed.
05. Internet Explorer and Firefox are two powerful text based browsers.
06. TCP/IP is actually a collection of protocols, or rules, that govern the way data travels from one machine to another across networks.
07. FTP is a protocol, which allows files to be transferred between two computers.
08. HTTP does not provide access to other Internet protocols like FTP, SMTP, NNTP, WAIS, etc.
09. Once connected via Telnet, the user's computer emulates the remote computer.
10. As of 2008, there are approximately 125 gopher servers indexed by Veronica-2
11. WAIS is an Internet search tool that is based on the Z49.50 standard.
12. Domain names are unique.
13. The '.com' extension in a domain name indicates that the name belongs to an educational institution.
14. Two machines can have the same IP address.
15. WWW cannot incorporate multimedia.
16. HTML defines several aspects of a web page including heading levels, bold, italics, images, paragraph breaks and hypertext links to other resources.
17. Lynx is a graphical browser.
18. AltaVista is a meta-search engine.
19. IRC is a multi-user chat system that allows many people to communicate simultaneously across the Internet, in real time.
20. Channel operators have special powers in IRC; they can set the channel mode and control who is allowed on it.

[Answers: (1) True (2) True (3) False (4) False (5) False (6) True (7) True (8) False (9) True (10) True (11) True (12) True (13) False (14) False (15) False (16) True (17) False (18) False (19) True (20) True]

C H A P T E R 2 5

Overview of Electronic Mail

TOPICS COVERED

- Introduction
- How e-mail works?
- Why use e-mail?
- E-mail – names and addresses
- Mailing basics
- How private is the e-mail?
- E-mail ethics
- Spamming
- Advantages and disadvantages
- Tips for effective e-mail use
- Smileys (emoticons)

Key Points

- E-mail is an electronic message sent from one computer to another. You can send or receive personal and business-related messages with attachments like pictures or other documents.
- An e-mail address identifies a person and the computer for purposes of exchanging electronic mail messages.
- E-mail messages are a lot like letters. Simplicity, directness and brevity will make people read your messages. Our e-mail says a lot about our values, our attention to detail, and the reputation of the organization we represent. Like any form of communication, there are certain manners that you should follow when using the e-mail.

INTRODUCTION

It can take days to send a mail across the country and weeks to go around the world. That is why nowadays, it is referred to as the 'snail mail'. To save time and money, we use the electronic mail. It is fast, easy to use and cheaper than the post office. So what is an e-mail? In its simplest form, e-mail is an electronic message sent from one computer to another. You can send or receive personal and business-related messages with attachments like pictures or other documents.

Just as a letter or document makes stops at different postal stations along its way, an e-mail is passed from one computer to another as it travels along the network. Each computer reads the e-mail address and routes it to another computer until it eventually reaches its destination. It is then stored in an electronic mailbox. With the Internet, this whole process usually takes just a few minutes, allowing you to communicate quickly and easily with millions of people around the world anytime of the day or night, for the cost of a local phone call.

You can send e-mails to practically anyone with an e-mail address, anywhere in the world. Until recently, e-mail on the Internet was good only for short notes. You could not send attachments or formatted documents or graphics. With the advent of MIME, which stands for Multipurpose Internet Mail Extension, and other types of encoding schemes, like UUencode, not only can you send messages electronically, but you can also send formatted documents, photos, sound files, and video files as attachments.

In the past few years, e-mail has evolved from an alternative means of communication to a way of doing business. Simply put, e-mail is everywhere. According to a Radicati Group (www.radicati.com) study in August 2008, there are about 1.3 billion e-mail users worldwide.

The advantages of e-mail are obvious. As many people are discovering, however, it has potential pitfalls. From the user's standpoint, the onslaught of messages from colleagues and clients, families and friends, and Internet mailing lists can quickly become unmanageable. And there is no guarantee that messages will arrive safely or look exactly the way the sender intended it to be. As a messaging platform, the Internet is undergoing some growing pains. But e-mail is here to stay and will continue to mature.

HOW E-MAIL WORKS?

The working of the electronic mail is quite simple and we will explain it with the help of the figure 25.1. The first thing you have to do is to type in your message, key-in the recipient's e-mail address and press the send button of your e-mail program. Once you have addressed and sent the e-mail, it gets encoded by a modem and is sent down the phone line as an analog signal [A].

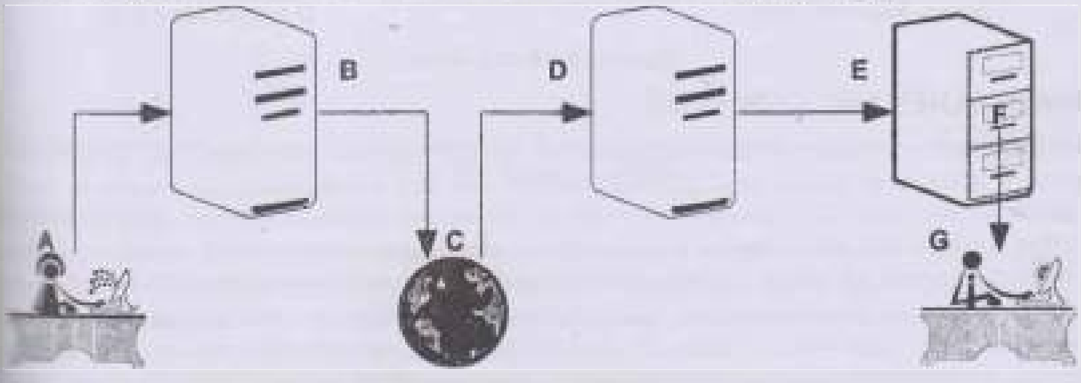


Figure 25.1 How E-mail Works?

The e-mail message arrives at your service provider's server. If it recognizes the e-mail address as valid, the mail will be sent [B]. The mail is sent via the Internet [C]. It will be received by the recipient's provider [D] and is sent to the provider's mail server [E] where it will be delivered to the recipient's mail box [F] and it will remain there until the recipient next connects to the Internet. Finally, the recipient's modem and computer decode the data, and he or she can read your e-mail message [G].

It is very important that you type-in the recipient's address correctly. As with the normal postal delivery system, the address should be correct for the message to be delivered. If the computer trying to deliver your message does not recognize the mailing address, it will automatically send you a message informing that the mail could not be delivered.

WHY USE E-MAIL?

E-mail is everywhere! Once you start looking you will discover that most individuals and businesses have an electronic address together with the more 'old-fashioned' telephone and fax numbers. An electronic mail message might be just a few lines of text asking a friend a favor or it can be a large business proposal. It is much more convenient and economical to send a message or document by e-mail than by the conventional mail (also called snail mail) or fax. E-mail is also delivered much faster than the conventional mail. There are e-mail programs, which can manage all your electronic messages for you. With an Internet account, you can send e-mail from within many applications such as word processing programs and web browsers. Many browsers have the e-mail feature integrated into it.

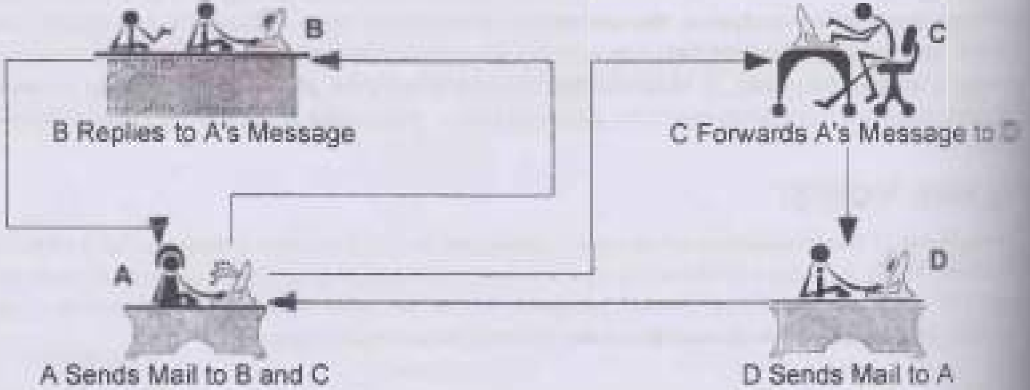


Figure 25.2 E-mail in Action

E-MAIL—NAMES AND ADDRESSES

Electronic mail, or e-mail, allows information to be sent between computers and people ... Internet. It is the most widely used Internet resource. Just as a written letter can be sent to ... recipients, an electronic mail message can be sent to one or more e-mail addresses. An e-mail ... identifies a person and the computer for purposes of exchanging electronic mail messages. The ... structure of an e-mail address is: *username@host.subdomain.second-level-domain.first-level-...*

Many names on the Internet are case sensitive, so take time to type the name exactly ... examples of valid e-mail IDs are *ramkumar@giasmd01.vsnl.net.in* and *ram@gmail.com*. E-mail ... read from left to right. For example, "*ram@gmail.com*" is read as "*ram at gmail dot com*", where ... the name of the person sending or receiving the message; this is referred to as the username. ... part of the domain name of the organization, and "*com*" is also part of the domain name and ... that "gmail" is a commercial organization.

MAILING BASICS

We have seen how the e-mail works. In this section, we will learn how to compose, ... forward a mail. We will also see how to make use of the different features available with ... programs. To compose an e-mail message, click on the '*Compose new message*' button on the ... You will get an empty mail form, which will have the following parts as shown in the Figure ...

- ▲ **To** — Enter the e-mail address of the person(s) to whom the message is sent.
- ▲ **Cc** — Enter the e-mail address of the person(s) to whom the copy of the message is ...
- ▲ **Subject** — Enter a brief description as to what the message is about.
- ▲ **Body** — Enter the actual message here.

Some mail programs allow the facility to send blind copies; if this feature is available ... recipients of the mail will not know that you have sent a blind copy to another person. ... mail programs have the following features: address book, signature feature, and attachments ... Now we will see how to make use of these features.

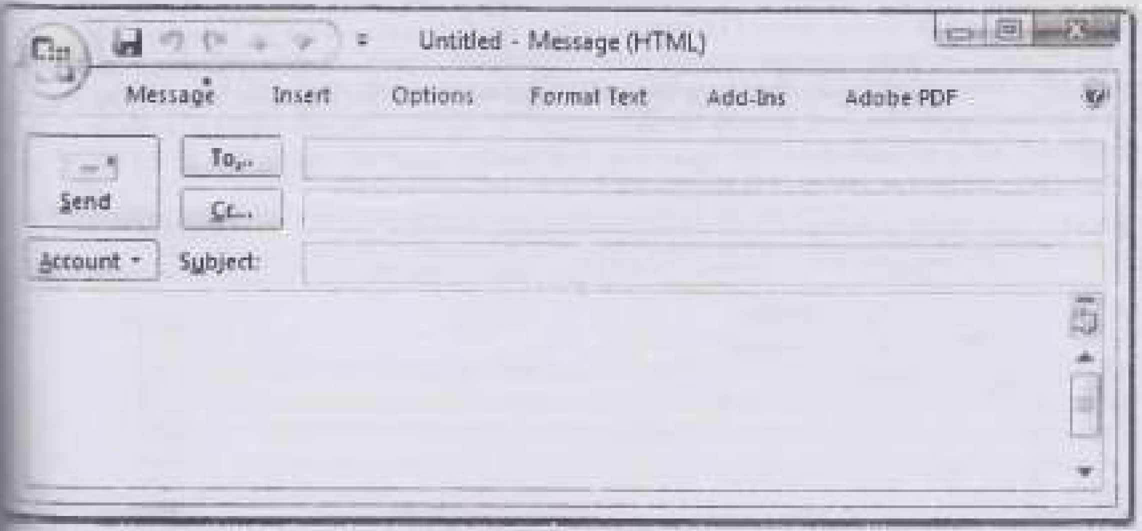


Figure 25.3 Empty E-mail Form

...dress Book

... address book is a place where you can store information about the people with whom you ...espond. The advantage of having a person's details in the address book is that you do not have to ... those details each and every time you send a message. You just have to select the person's ... and the e-mail ID will automatically get inserted.

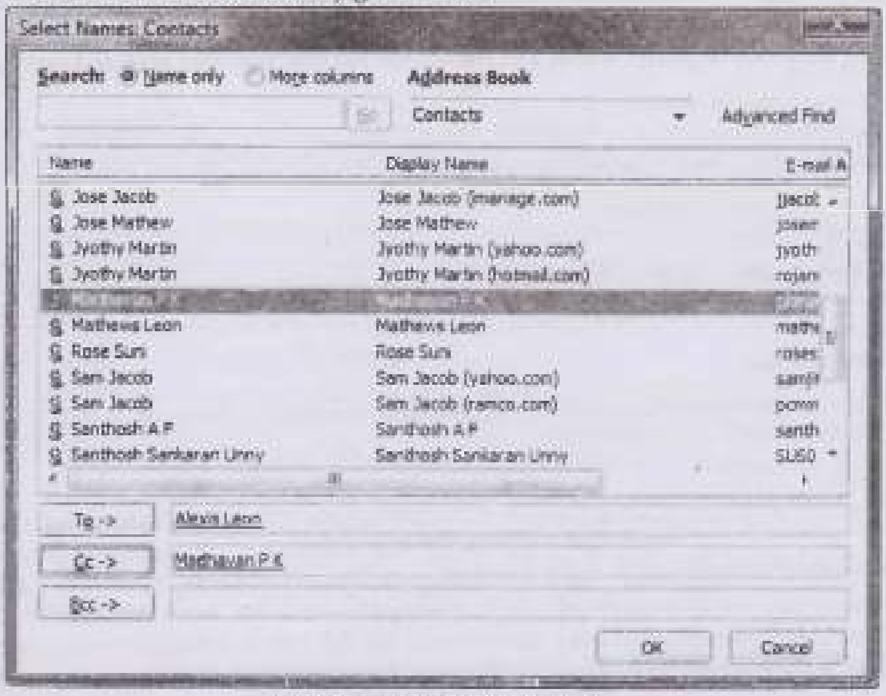


Figure 25.4 Use of Address Book

You can add new addresses to it, you can create groups (so that when you want to send a mail to all the members of the group, instead of adding each person's ID,you need only to select the group), you can modify the details, you can delete a person's name from the book. If a person has more than one e-mail ID then you can set one among them as the default ID. When you want to insert the e-mail ID of a person, press the small icon by the side of the 'To' or 'Cc' columns and the contents of the address book will pop-up as shown in Figure 25.4. You can the select the names and it will appear in the respective columns as shown in the Figure 25.5.

Figure 25.5 Inserting Names from the Address Book to a Mail

File Attachments

One major drawback of e-mail is that you cannot send formatted text. For example, if I want to send a word document, which contains pictures, bulleted lists, etc., and if I do a cut and paste, all the formatting, all the pictures, etc. will be lost. You will get only the text. The solution is to send the file as an attachment to the mail. You can attach any file to a mail. It is a good idea to compress the file you are attaching using utilities like pkzip, which will reduce the file size and save time and money during transmission.

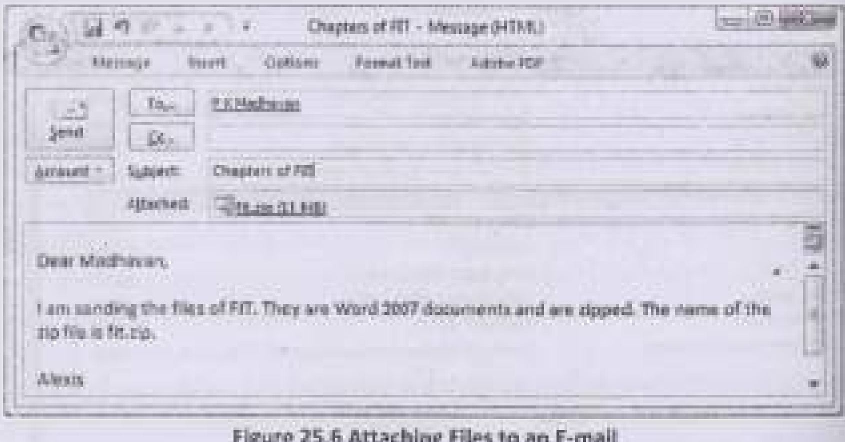


Figure 25.6 Attaching Files to an E-mail

You can attach the file you want to send by clicking on the icon with the picture of a paperclip (Figure 25.6). A dialog box will appear asking you to specify the name and location of the file you want to attach. Once you have given the necessary information, the file will be attached to the mail. A mail with an attachment will have a paper clip icon by the side of it indicating that it has an attachment.

Signature

Are you tired of typing in your name and address at the end of each message that you send. Then you can make use of the signature option provided. You can store the information that you want to attach at the end of the messages as your signature. Then you can configure your system in such a way that all the out-going messages will have your signature at the end of the message. If you do not want to have your signature on all messages, you can uncheck the option.

When you need to include the signature to a message, click on the signature icon (the icon with the picture of a pen on it) and the signature will be appended to the message. The signature can be anything from your name and address, to your URL or contact information.

Setting Priority

You can set priority to a mail message that you are sending. The usual values are 'Low', 'Normal' and 'High'. When you set the priority of a mail as high, you are indicating that the message requires immediate attention. High priority messages will be marked in red to indicate that it needs immediate attention. It is not a good practice to set the priority of all the messages as 'High'. Use this option only when required. The default priority is 'Normal'.

Replying and Forwarding E-Mail Messages

Just like you send and receive letters, you can send and receive electronic mails too. But e-mail programs give you many more options. You can reply to the author by pressing a button. You need not type in the address or the subject becouse the programs are intelligent enough to automatically put the electronic address of the person whose mail you are replying to, prefix the subject with '*RE:*' to indicate that it is a reply. The programs will also include the original mail (if you set that option) as part of the reply, which is a great help in identifying the mail, especially when a person receives hundreds of mails a day.

You have two options for replying to a mail: '*Reply*' and '*Reply to All*'. The difference between the two is that, in the first case, the reply mail will be sent only to the person who had sent the mail to you. In the second case, your reply will be sent to all the persons, to whom the copies of the original mail were sent. If the mail was sent to you only, then using '*Reply*' or '*Reply to All*' does not make any difference at all.

For example, if you want to reply to a mail that you had received, you must highlight the mail by clicking on it and then, press the reply button. The '*To*' address, the '*Subject*' (with RE:) and the original message will automatically appear. You just have to type in the reply and send the mail. Notice that the original message is marked with a '>' sign. Some programs allow you to use other symbols instead of '>'. But the '>'symbol is the most commonly used one.

Another task that you can accomplish with considerable ease while using the electronic mail is forwarding a message that you have received. The difference between replying and forwarding is that you reply to the person who had sent the mail, but you can forward a message to anybody you like. Most e-mail programs will let you add any message you want.

The message that is being forwarded will be indented with '>'symbol as in the case of replying. You will have to enter the e-mail ID of the person(s) to whom the message is being forwarded. Most e-mail programs will prefix the subject of the forwarded message with '*FW:*'.

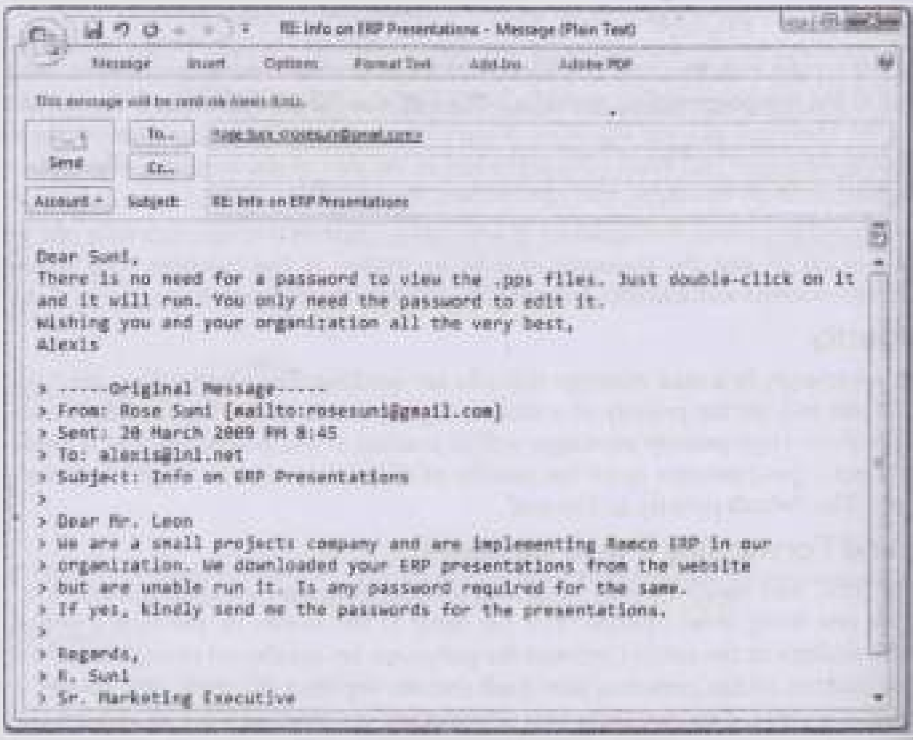


Figure 25.7 Replying to an E-mail

Customizing your Mail Program

You can customize the way you send the mail. You can decide whether to send the mail in Te[illegible] or in HTML format. Most mail programs are capable of reading the mail in HTML [illegible] advantage of using HTML format is that you can add color and other formatting like b[illegible] bulleted or numbered lists, etc. The disadvantage is that old mail programs are not capable [illegible] the mail in the HTML format. So if the person who receives the mail does not have a prog[illegible] not capable of reading the mail in HTML format, then he will get a lot of HTML tags, [illegible] quite annoying.

You can use the spellchecking feature of the e-mail programs so that spelling [illegible] avoided. Some programs will allow you to set the option in such a way that spellchecking [illegible] all outgoing messages. If your mail program has this feature, then do enable it, for it is a [illegible] feature, because it will prevent any mail from being sent without a spellcheck. We have n[illegible] to compose a mail, reply and forward a mail, customize your mail program, add the sign[illegible] file, etc. Now you can explore on your own and find out what additional features your [illegible] has.

HOW PRIVATE IS THE E-MAIL?

E-mail is less private than the conventional mail since its contents could be read by any[illegible] access to the recipient's computer. It is also possible to interrupt an e-mail on its way, [illegible] send it as if it were untouched. Therefore, it is wise to be cautious about sending sensitive [illegible] e-mail unless you have some way of protecting the contents like encryption.

E-MAIL ETHICS

E-mail messages are a lot like letters. Simplicity, directness, and brevity will make people read your messages. Our e-mail says a lot about our values, our attention to detail, and the reputation of the organization we represent. Like any form of communication, there are certain manners that you should follow when using the e-mail. Here are some guidelines, which will help you in getting the most out of your electronic mailing system.

- Let your messages have a personal touch. Write it the way you would say it—use everyday language. Vary your sentence lengths.
- Be friendly, and use humor to break up the tension of what you have to say.
- Be succinct and considerate of the recipient's time and on-line charges, especially with services that charge by the hour or by the size of messages. E-mail messages work best if they are short and to the point.
- Know your recipient. Different people have different ideas of what is acceptable. Find out and respect each person's wishes.
- Avoid sarcasm, unless you are sure it will work, and think very carefully before using e-mail to express anger. With e-mail, once sent, is gone.
- Be careful about your use of irony or even some forms of humor, which can be misinterpreted. Unlike face-to-face meetings or phone conversations, there are no visual or oral clues to provide a sense of what is going on.
- Be brief. This not only saves bandwidth but also cuts down on eyestrain.
- Make the subject line precise.
- Do not copy the full text of a long message into your response. Copy only the parts you need to refer to.
- Do not assume that everybody likes emoticons (emotional icons). Some people find them annoying.
- Look sharp. Good writing is 90 percent clarity, and half of clarity is appearance. No one likes facing a long unbroken block of text characters. Put a blank line between paragraphs to help you organize your thinking. If you have six points to make, number them as such and indent each one.
- Use your technology. A memory-resident spellchecker or thesaurus will help you avoid the embarrassment of a misspelled word or a word used incorrectly.
- Compose your messages off-line. A regular word processor is much more powerful than the text editors used on most e-mail systems.
- Read the message before sending it, you will be amazed by the number of mistakes that has crept in.
- Most e-mail programs these days let you insert what is called a signature at the bottom of the message. This can be anything from a clever quote to some additional information about you, like your title and company name or other e-mail addresses you have.
- Configure your e-mail client to check all your accounts in one shot.
- If security is not a concern, configure your e-mail client to remember passwords.
- Get a free-mail account for personal e-mail or mailing lists.
- If you are sending large files as attachments, use some compression utility like *pkzip*, before sending them.

- Do not send copies of e-mail to people unless they need to be copied. In addition to clu… up their mailboxes, it can place them in an awkward position, making them feel as … have to do something with the information. It can also be intimidating to the main recip…
- Stay on the topic if you are posting to a public bulletin board, forum or news group. M… focused on a specific topic, and messages that stray too far from the topic can be annoy…
- Briefly describe who you are if the recipient does not already know.
- Be aware that e-mail can be archived and, under certain circumstances, may not be … On-line services and public e-mail providers usually protect the confidentiality … subscribers' e-mail, but some companies consider employee e-mail sent over the … network to be company property and subject to scrutiny.
- Avoid "Urgent" or "Priority" unless it really is.
- Avoid using all capital letters. IT IS THE EQUIVALENT OF SHOUTING! Also, it is … read.
- You should check your mail regularly. Unlike a fax or normal mail, an e-mail message … cases is not automatically delivered to your desk. You have to log on to check your mail.

SPAMMING

Sometimes having an e-mail account can be very frustrating. People will fill your mailbo… advertisement, forwarded messages, product details, business offers, and all sorts of unwa… Separating the messages you really want from the hundreds of unwanted mails is a daunt… This process called spamming, makes many people really hate e-mail. But you are not power… fight against unsolicited e-mail. Many of the e-mail clients we review include **special filters** … to block spam. For instance, Microsoft Outlook 2007 has a Junk E-mail folder to which susp… mails are moved. If your e-mail client does not have a spam filter, you can use its filtering … create one. A few third-party products can also help. Some of the spam filter products are:

- SpamEater Pro (*www.spameaterpro.com*)
- CA Anti-Spam (*www.quirb.com*)
- SPAMfighter Pro (*www.spamfighter.com*)
- Choice-mail One (*www.digiportal.com*)
- Spam Buster (*www.contactplus.com*)

A couple of tricks can also help.

- When the sender of unsolicited e-mail offers to remove you from a list, do not fall … just confirms that your e-mail account is active, and you may actually receive more spam.
- Send a message to your ISP or on-line service telling it that you received unsolicited … provide the originating address. In most cases, the return addresses are phony, … service provider may be able to take action to stop the spam.

E-MAIL—ADVANTAGES AND DISADVANTAGES

It is difficult sometimes to comprehend all the benefits and values of electronic-commun… technology. There is now 24-hour access a day from anywhere in the world to endless amou… and information. Global communication is easier. The technology also has opened the door … types of professionals to work at home, because they can still tap into corporate informa… work can now be done anywhere a computer can be plugged in.

But there is a dark side to the technology. First, it has created an information overload. People are swamped by junk mails and finding what is relevant and need to be read from the hundreds of mails that one receives can become a daunting task. Second, the very existence of electronic communication has perpetuated the myth that it will lead to better communication. But that not true, if you are not a good communicator without electronic technology, you will not become one just because you use the technology. Technology improves our ability to communicate, extends the reach of our communications, and reduces long-distance communications timelines, but it is the individual using the technology that makes the communications better or worse. Another disadvantage of the e-mail is that it can become a distraction and can prevent people from doing any productive work.

TIPS FOR EFFECTIVE E-MAIL USE

To work more productively and to prevent e-mail interruptions, you can do the following:

- If the mail is automatically delivered to your mailbox, shut off the computer beep that alerts you when you have an incoming message.
- If your mail does not come to your inbox and you have to check for your mail by connecting to the mail server, then do it during non-peak hours, when you will get connected immediately.
- Compose your messages off-line. This will save on-line time and you will get a chance to review the mail.
- Organize the mails in different folders, so that it can be tracked easily and efficiently.
- Keep the e-mail IDs of all the people with whom you correspond in the address book, so that each time you do not have to key it in. This will reduce the chances of error and will save time.
- Tell your friends and colleagues what type of documents you would want to receive and what you would not.
- And remember; do not let technology wipe out oral communication!!!!

SMILEYS (EMOTICONS)

When we talk to people face to-face, our body language, the tone of our voice and our facial expressions impart great meaning to what we say. On-line, you can personalize your messages by using smileys or emoticons (on-line emotions). You create smileys by typing characters from your keyboard. You would be amazed at the range of emotions these little characters can express. Some of the very popular ones are given below:

:-) Happy	:-)) Very Happy	:-(Sad
:-((Very Sad	;-) Wink	:-* Kiss
:-o Surprised	:-@ Screaming	:-I Indifferent
:-e Disappointed	:-|| Angry	>:-< Mad
%-) Confused	:-D Laughing	:'-(Crying

In addition to smileys, here are a few common abbreviations you can use:

AFAIK - As Far As I Know	AFK - Away From Keyboard
BCNU - Be Seeing You	BRB - Be Right Back
BFN - Bye For Now	BTW - By The Way
CUL/CUL8R - See You Later	FAQ - Frequently Asked Question
G - Grin	HTH - Hope This Helps

IJWTK - I Just Want To Know
IMO - In My Opinion
LOL - Laughing Out Loud
OIC - Oh I See
ROTFL - Rolling on the Floor Laughing
TIA - Thanks In Advance
IJWTS - I Just Want To Say
IMHO - In My Humble Opinion
OAO - Over and Out
OTOH - On The Other Hand
RUOK? - Are You OK?
THX - Thanks

REVIEW QUESTIONS

Descriptive Type Questions

01. What is an e-mail?
02. How does an e-mail work?
03. Why use an e-mail?
04. How private is your e-mail?
05. What is the structure of an e-mail address?
06. How will you compose, reply and forward an e-mail message?
07. What are the advantages of using address book, signature and file attachment facility?
08. What are emoticons and why and where are they used?
09. What is spamming and how can you avoid it?
10. Explain the basic e-mail ethics.

Fill in the Blanks

01. __________ is an electronic message sent from one computer to another.
02. MIME stands for __________.
03. One way of protecting the contents of e-mail is __________.
04. __________ identifies a person and the computer for purposes of exchanging elec... messages.
05. __________ is a place where you can store the information about the people with ... correspond.
06. You can store the information that you want to attach at the end of the messag... __________.
07. :-) stands for __________.
08. TIA stands for __________.

[Answers: (1) E-mail (2) Multipurpose Internet Mail Extension (3) Encryption (4) E-mail ... Address book (6) Signature (7) Happy (8) Thanks in Advance]

True or False

01. E-mail is an electronic message sent from one computer to another.
02. MIME stands for Multipurpose Internet Mail Exploration.
03. It is not possible to send formatted documents, photos, sound files, and video files as ... through e-mail.
04. It is possible to interrupt the e-mail on its way, read them and then send it as if it is unt...
05. You can set priority to a mail message that you are sending.
06. Most mail programs are capable of reading the mail in HTML format.
07. Using all capital letters in e-mail is the equivalent of shouting and is considered bad ma...
08. You can personalize your e-mail messages by using smileys or emoticons.

[Answers: (1) True (2) True (3) False (4) True (5) True (6) True (7) True (8) True]

CHAPTER 26

Introduction to Intranets

TOPICS COVERED

* Introduction
* Characteristics of intranet
* Advantages of intranets
* Business benefits of intranets
* Drawbacks of intranets
* Why does an organization need intranet?
* Intranet vs. Groupware
* Intranet vs. E-mail
* Intranet vs. Client/server systems
* Extranet
* Intranets, extranets, and e-commerce

Key Points

▲ Intranet is a network connecting an affiliated set of clients using standard Internet protocols, esp. TCP/IP and HTTP or as an IP-based network of nodes behind a firewall, or behind several firewalls connected by secure, possibly virtual, networks.

▲ Intranets are only logically "internal" to an organization. Physically they can span the globe, as long as access is limited to a defined community of interest.

▲ The main characteristics of intranet are openness, ease of use, low cost, flexibility, scalability, and ability to accommodate new technology.

▲ An extranet is a business-to-business intranet that allows limited, controlled, secure access between a company's intranet and designated, authenticated users from remote locations. It is an intranet that allows controlled access by authenticated parties.

INTRODUCTION

Internet is a communication network, which bridges all the small computer networks worldwide as a whole. Intranet is based upon Internet technology, in particular WWW, to build Information Systems within organization or enterprise to accomplish standardization and automation. Fundamentally, it means network computing environments, which let the users share the information through the Internet and web browsers. Ultimately, it allows a certain organization to build a Groupware within the web environment at low cost on top of existing network infrastructure. By doing this, closed organization network would be interconnected with existing worldwide Internet, which results in diverse information that strengthens competitive advantages of the organization. Basically, it runs on top of TCP/IP and HTTP and filters out any illegal access through firewall.

The Internet connects people, organizations and information sources by using common protocols to link computers on a public and open-to-all basis, where as an Intranet uses the same common protocols for internal company or group purposes. Instead of adopting a common proprietary standard for its communications, information storage and presentation, etc., the company (or any group of people or companies) decides to use Internet standards and methods.

An Intranet can be defined, as a network connecting an affiliated set of clients using standard Internet protocols, esp. TCP/IP and HTTP or as an IP-based network of nodes behind a firewall, or behind several firewalls connected by secure, possibly virtual, networks. In general, a web is an unstructured client/server network that uses HTTP as its transaction protocol. The World Wide Web comprises all HTTP nodes on the public Internet. An internal web comprises all HTTP nodes on a private network, such as an organization's LAN or WAN. If the organization is a corporation, the internal web is also a corporate web. If a corporate web connects two or more trading partners, it is often referred to as a business-to-business web, or an extranet. Note that internal webs—also kn intranets—are only logically "internal" to an organization. Physically they can span the globe, a as access is limited to a defined community of interest.

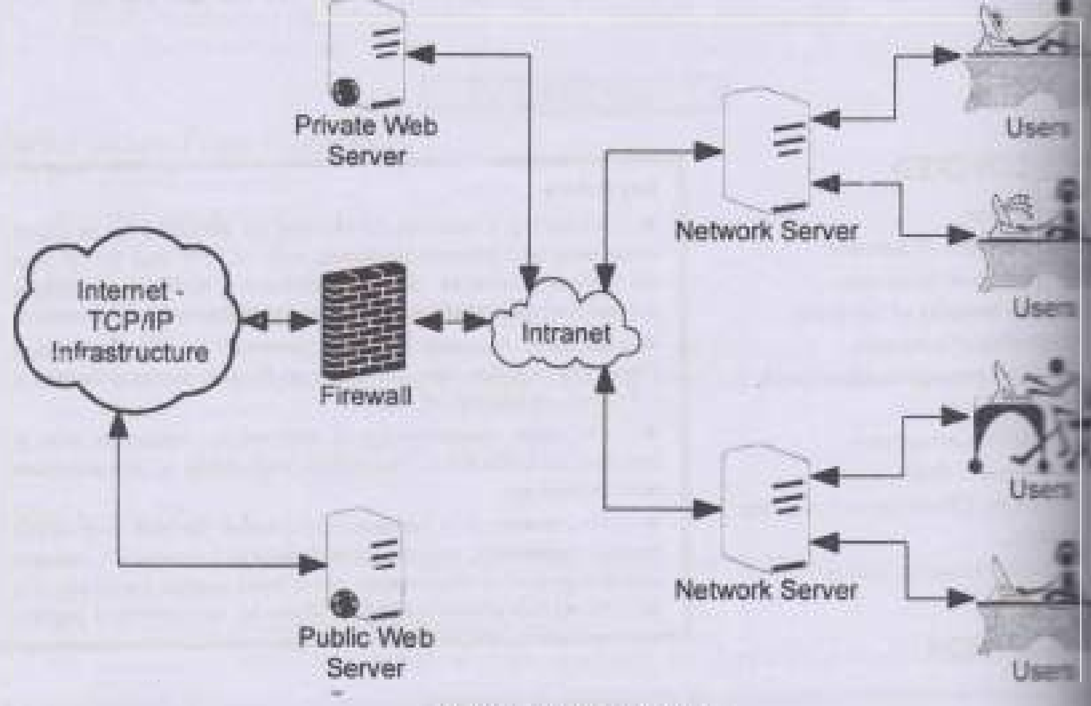


Figure 26.1 Intranet in Action

An intranet can be as big as a community of interest. Scale is an important factor implementation, but it has no bearing on the logical association of clients that make up an intra example, a workgroup with one web server, a company with several hundred web servers, professional organization with ten thousand web servers can each be considered an intranet. nothing constrains these webs to be "inside" or bounded in any physical sense, size is signific a network design perspective. Intranet Design Magazine refers to expansive private webs, intranets or extranets to connote that WAN economics and technologies apply.

CHARACTERISTICS OF INTRANET

Intranet inherits all the merits of Internet:

- ▲ Openness — Open architecture based on Internet.
- ▲ Ease of use — World Wide Web facilitates it.
- ▲ Low cost — Low network cost, license fee, client program installation expense.
- ▲ Flexibility — All of the solutions available for customizing.
- ▲ Scalability — Easy to scale up and down.
- ▲ Innovation — Easy to accommodate new technology.

ADVANTAGES OF INTRANETS

Some of the advantages of intranets are:

- Compared with Client/Server architectures, it costs much less to build initial systems, which results in maximum efficiency and flexibility.
- It is based on Internet protocols, which expands accessibility worldwide.
- It is possible to link with enterprise homepage to facilitate marketing and business operations, and furthermore, it automates building a MIS (Management Information Systems) such as Decision Making Systems.
- Consistent graphical user interface of web browsers eliminates separate tutorial session.
- It handles multimedia data effortlessly.
- HTML documents facilitate higher level of document exchanging scheme.
- Ready to access the information worldwide.
- Intuitive graphical user interface for everyday average skilled users.
- Fully support open standards and architecture for flexible expandability.
- Low administration and maintenance costs.
- Platform-independent system configuration features.

BUSINESS BENEFITS OF INTRANETS

There are lots of business benefits, including:

- People use and get accustomed to the same kinds of approaches and systems for internal company/group, working externally with other groups/companies/individuals, and private use for work or leisure purposes. This reduces the learning curve.
- The company/group and its people have access to the very wide and rapidly increasing range of applications, products and services flowing from the worldwide acceptance of Internet methods, and the very attractive prices that result from intense competition among suppliers – as well as a lot of free or very low cost applications and information.
- The skills needed to develop, maintain and enhance applications are converging, and companies will be able to obtain technical skills from a wider pool.
- Intranet approach makes employees and jobs more flexible and mobile, since applications and information are readily shared regardless of geography and time zones, and people share a common platform of learning.
- A common approach to internal information and published information enables significant savings; for example, in design and print of publications, customers and staff can access the same data at the same time.

DRAWBACKS OF INTRANETS

[illegible] approach to information systems has its limitations. In the case of Intranets, the constraints include:

- **Performance limitations** – Some applications that have been well optimized for conventional and proprietary systems create a heavy system workload when migrating them to an Internet platform or merging them with Intranet presentation; this problem will reduce with enhanced Internet technologies and continuing improvements in hardware price-performance.

- **Presentational issues** — Some people whose experience is rooted in paper presentat[illegible] web pages (for example) to look like printed equivalents, and burden the systems [illegible] users with unnecessary and sometimes tedious "graphics", which often get in the wa[illegible] information rather than making it more accessible and attractive. This is really a [illegible] curve matter; at some stage the users' real needs tend to come to the fore.
- **The "me too" syndrome** — The Internet world spawns innovations on a daily or [illegible] hourly basis. It is very difficult when a novelty first appears to know whether it is a [illegible] advancement or a passing fad, but some systems people can't resist the urge to use the [illegible] capabilities. There is also a tendency for suppliers to promote new application [illegible] will only optimize with next generation technologies, and that can cripple the two [illegible] four-year old systems that most people use at any particular time.

WHY DOES AN ORGANIZATION NEED INTRANET?

Whether the target market of an organization is corporate conglomerates or the home comp[illegible] the goal is to reach more customers, more effectively and efficiently, and to provide them [illegible] service. Daily, more consumers look to the web for new sources, and more businesses look [illegible] internal web, or Intranet, to process their clients' needs in a more cost-effective and efficient [illegible]

To remain competitive, all organizations need to keep pace with technological adv[illegible] organizations, which use intranets to electronically transmit documents internally, pay [illegible] investment in the technology within six to twelve weeks, according to a study com[illegible] Netscape.

Benefits to Employees and Organizations

Some of the benefits of the intranets to the employees and organizations are:

- Employees can access information they need, when they need it.
- One determines as to who can have access to what data, and to what extent.
- Transactions can be followed electronically.
- Databases can be updated dynamically — as the transaction occurs.
- Communication can take place instantaneously — anywhere in the world.
- Employees can work remotely, and remote employees can be hired for their expertise.
- You can access other businesses for ordering, sourcing, contracting, and so on.

INTRANET VS. GROUPWARE

Groupware, a term coined by marketers around 1995 to mean "software that facilitates grou[illegible] never emerged as a well-defined software category. Today, the term is used less and tend[illegible] narrowly identified with three products: Lotus Notes, Microsoft Exchange and Novell Gr[illegible] Groupware functionality is roughly synonymous with collaborative computing, and emb[illegible] following:

- Document sharing
- Collaborative authoring
- Versioning
- Messaging
- Secure access
- Search/retrieval

- Discussion forums
- Database integration

Intranet technology is well suited to many of these tasks, having matured in areas where it was initially weak, such as security and integrated search. The major groupware products have shifted from their early proprietary roots to internet-based architectures. For instance, Microsoft Exchange 5.5 supports POP3 and IMAP4 Internet mail, NNTP-based newsgroups, and LDAP directory services.

INTRANET VS. E-MAIL

Email is networking's killer application and the foundation of Internet messaging. Intranets inherit Simple Mail Transport Protocol (SMTP, RFC-822) from the TCP/IP suite. In addition to SMTP (which enables plain text messaging), intranets use Multipurpose Internet Mail Extensions (MIME, RFC-2045) to carry diverse content. In fact, the MIME content types are the web's content types—adding a new format such as streaming audio amounts to defining a new MIME type. Because intranets have established Internet mail as the de facto messaging standard, they are replacing proprietary mail systems such as Lotus VIM and Microsoft MAPI in much the same way as they have other proprietary network protocols.

INTRANET VS. CLIENT/SERVER SYSTEMS

Intranets follow a multi-tier application architecture with roughly the following correspondence:

- Browser = Client.
- Web server and Application servers = Business logic tiers.
- CGI, proprietary server API, JDBC driver or Message Queuing = Middleware.
- Component Transaction Server = Transaction Manager
- Database servers = Back-end data stores.

EXTRANET

An extranet is a business-to-business intranet that allows limited, controlled, secure access between a company's intranet and designated, authenticated users from remote locations. It is an intranet that allows controlled access by authenticated parties. A brief list of examples could include:

- Allowing suppliers access to relevant inventory levels
- Allowing clients to review their account records
- Allowing students to update address information in real time

As with Intranet, access is granted only where you establish that it is required. User access is controlled by the latest in security technologies, protecting sensitive material from intrusion.

INTRANETS, EXTRANETS AND E-COMMERCE

What is the relationship between intranets, extranets and e-commerce? The answer has three parts. First, intranets, extranets and e-commerce have in common the use of Internet (predominantly web) protocols to connect business users. Second, intranets are more localized and can therefore move data faster than more distributed extranets. (Bandwidth limitations also apply to e-commerce.) Third, the amount of control that network managers can exert over users is different for the three technologies.

On an **Intranet**, administrators can narrowly prescribe access and policy for a fixed group of users. For example, a company could specify Red Hat Linux as its standard desktop operating system, and

Opera as its standard browser and mail client. The company could then write intranet [illegible] applications that leverage the uniform computing environment, over which it exercises strong [illegible]

On a business-to-business **Extranet**, system architects at each of the participating compa[illegible] collaborate to ensure a common interface and consistent semantics (data meanings). [illegible] company cannot reasonably enforce standards on its trading partners, extranet application [illegible] must take into account a wider range of technologies than is the case for intranets. For exa[illegible] company participating in an extranet might be using Microsoft Internet Explorer, another Fi[illegible] another Opera. In order to collaborate via extranet, the applications have to perform adequat[illegible] represented platforms.

The same is true, even more, for **e-commerce**, in which the trading partners may be [illegible] unknown to one another. This is the case when you walk into a supermarket: the common [illegible] communication is based on the need to transact business, and not necessarily on a long-[illegible] relationship. Thus, e-commerce applications often support a level of security and tra[illegible] integrity (for instance, non-repudiation of orders) not present in intranet or extranet applica[illegible]

REVIEW QUESTIONS

Descriptive Type Questions

01. What is an intranet and how is it different from the Internet?
02. What is an extranet?
03. What are the characteristics of the intranet?
04. What are the advantages of intranet and what are its drawbacks?
05. What are the business benefits of the intranet?
06. Why does an organization need an intranet?
07. What is the relationship between intranets, extranets and e-commerce?
08. How is intranet different from groupware and e-mail?

Fill in the Blanks

01. WWW stands for ____________.
02. TCP/IP stands for ____________.
03. HTTP stands for ____________.
04. WAN is the abbreviation of ____________.
05. LAN stands for ____________.

[Answers: (1) World Wide Web (2) Transmission Control Protocol/Internet Protocol (3) [illegible] Transfer Protocol (4) Wide Area Network (5) Local Area Network]

True or False

01. Using an intranet, it is possible to link with enterprise homepage to facilitate mark[illegible] business operations.
02. Employees and jobs can become more flexible and mobile using the intranet approach.
03. Large organizations, which use intranets to electronically transmit documents internall[illegible] their investment in the technology within six to twelve weeks.
04. Lotus Notes, Microsoft Exchange and Novell GroupWise are groupware products.
05. MIME is the abbreviation of Multipurpose Internet Mail Extension.

[Answers: (1) True (2) True (3) True (4) True (5) True]

CHAPTER 27

Introduction to E-commerce and E-business

TOPICS COVERED

- Introduction
- Technological advancements
- E-commerce defined
- E-commerce
- E-commerce and e-business

> **Key Points**
>
> ▲ E-commerce can be broadly classified as the set of business activities involving consumers, service providers, manufacturers and intermediaries, who use computer networks such as the Internet for conducting their business transactions.
>
> ▲ E-commerce is generally associated with the buying and selling of information, products and services via computer networks. Today, e-commerce is a business reality and is rapidly growing and has become an integral part of the business environment.
>
> ▲ The primary goal of e-commerce is to bring the organizations closer to their actual customers, thus providing the customers the products and services much faster and at lesser cost than possible by the traditional busihess models.
>
> ▲ E-business, in addition to encompassing e-commerce, includes both front- and back-office applications that form the engine for modern business. E-business is not just about e-commerce transactions; it is about redefining old business models, with the aid of technology, to maximize customer value. E-business is the overall strategy and e-commerce is an extremely important facet of e-business.
>
> ▲ E-business involves not setting up the company website and being able to accept credit card payments or being able to sell the products or services on-line. It involves fundamental restructuring and streamlining of the business using technology.

INTRODUCTION

Electronic commerce or E-commerce can be broadly classified as the set of business activities involving consumers, service providers, manufacturers and intermediaries, who use computer networks such as the Internet for conducting their business transactions.

The primary goal of e-commerce is to bring the organizations closer to their actual customers, thus providing the customers the products and services much faster and at lesser cost than possible by the traditional business models. The other goals [illegible] reduction in product and [illegible] cost (by eliminating unnecessary intermediaries and unwanted procedures), improve customer [illegible] time (by making use of technological developments to improve communications and [illegible] processes), improve the quality of the products and services and improve customer satisfaction. Thus implementing e-commerce has become a business necessity, as companies that fail to take advantage of this technology will soon find themselves out of business.

TECHNOLOGICAL ADVANCEMENTS

Continuing increases in the computational power of computers and the capacity of networks to carry data have put us on the doorstep of a new era in distributed computer processing. Teraflop computers (Tera or one trillion floating point operations per second) and gigabit networks will enable computers to access remote information and provide services that will—for many applications—diminish the importance of distance to virtual insignificance. These advances in distributed computing will revolutionize the way we acquire information, interact with our colleagues, and carry out business and social activities.

Already researchers have benchmarked processors at 20-gigaflops. Experimental networks have achieved data rates in excess of several gigabits per second. Scientists are also designing machines using massively parallel processors (MPPs), which they believe will be able to operate at the rate of a teraflop or more in the very near future. Some network researchers believe that future optical networks will be capable of achieving data rates as high as a terabit per second. Along with these technological advances, many economists believe that the economic success will hinge on the ability to innovate, design, and manufacture—areas for which increased computing power is essential. They believe that the future will see the linking together or convergence of the four major e-commerce drivers—computers, networks, information, and people.

Computers will provide the raw computational power necessary to support new and powerful software applications; high-speed networks will support convenient user-to-user communications and allow access to information throughout the network. In the future environment, commerce will be carried out in a way that is markedly different from the way it had been carried out in the past. Many of our business transactions will be carried out without human intervention. Many of our educational endeavors (such as distance learning, interactive classrooms, digital libraries, web-based teaching, etc.) and social interactions (on-line shopping, video conferencing, chat sessions, e-mail, etc.) will take place without leaving our homes. This new manner of carrying out commerce is called electronic commerce or e-commerce.

E-COMMERCE DEFINED

Electronic commerce integrates communications, data management, and security services, to allow business applications within different organizations to automatically interchange information. Communications services transfer the information from the originator to the recipient. Data management services define the interchange format of the information. Security services authenticate the source of information, verify the integrity of the information received by the recipient, prevent disclosure of the information to unauthorized users, and verify that the intended recipient received the information. Electronic commerce applies and integrates these infrastructure services to support business and commercial applications including financial transactions such as electronic bidding, ordering and payments, and exchange of digital product specifications and design data.

E-commerce is a multidisciplinary field that includes; technical areas such as networking and telecommunications, security and storage and retrieval of multimedia information, business areas such as procurement, purchasing, production, marketing, billing and payment, and supply chain management. It also includes legal aspects like information privacy, intellectual property, taxation, contractual obligations, etc. It includes financial aspects like EDI transactions, credit card payments and credit card processing, etc.

Commerce is usually thought of in a business context to mean an exchange of goods or commodities, especially on a large scale. Webster's dictionary defines 'commerce' as an interchange goods or commodities between different countries (foreign commerce) or between different parts of the same country (domestic commerce). Goods are not conveyed without being accompanied by a variety of information. A typical commerce activity may include a purchase order and invoice. It may require updating accounting and inventory records, and it may require manipulating and modifying administrative information. Commerce, though, is not limited to business activities, also applies to social exchanges, such as exchanges of ideas or opinions. Commerce, therefore, can be considered as an exchange of goods or information in carrying out social or business activities. For some commerce activities, it is the exchange, or conveyance, of information itself that is the end objective. Examples of these types of activities include mail or phone exchanges, that may or may not be, directly related to a business transaction. Thus, information—as the object of a commerce activity or accompanying a commerce activity—has been an integral part of conducting commerce traditionally.

Information is also an integral part of electronic commerce, but electronic and traditional commerce each deal with information differently. Conveying information has traditionally been done through paper exchanges, direct personal contact, or through the phone or postal systems. In electronic commerce, information may be conveyed via a communications network, or other electronic media. The way information is processed in electronic commerce also differs from the way it has been processed traditionally. Traditionally, information accompanying a business transaction had to be acted upon by the individuals involved in the transaction. In electronic commerce, information processing is automated, reducing or eliminating the need for human intervention and the use of paper. Thus, conducting commerce electronically differs from conducting commerce traditionally; in the way information is exchanged and processed. It is this change, in the way which information is processed and exchanged, that distinguishes electronic from traditional commerce. E-commerce is thus the commerce transacted using automated processing procedures integrated with automated procedures for the interchange of information.

This integration in the processing and exchange of information can be achieved through integrating a set of services. This set is made up of communications, data management, and security services. By integrating these services with the business application, electronic commerce can make these services transparently available to the user. Through this integration and automation, conducting commerce is made more efficient, convenient, and accurate.

A number of activities, including mail exchanges, electronic funds transfer, remote access to business systems, and automatic monitoring of store inventory levels, automated production planning and Just-in-Time (JIT) manufacturing, automatic purchase order processing and fulfillment, web-based customer support, etc., can be used in electronic commerce. It is the expansion of these activities, along with their incorporation into the process of conducting commerce electronically, that is, one of the main objectives of electronic commerce. Ultimately, one would like to see these activities become as common as the use of the telephone today.

E-COMMERCE

E-commerce is generally associated with the buying and selling of information, products and services via computer networks. Today e-commerce is a business reality and is rapidly growing and has become an integral part of the business environment. We have seen an introduction to e-commerce, its benefits and the factors driving its growth. Back in 1994, when companies started putting up commercial websites, those websites were primarily meant for advertising and providing marketing information. Doing e-commerce was not a goal of the organizations at that time.

In 1994, there were less than 1000 organizations worldwide having a commercial website. In 1996, ... selling products and services over the Internet, reaching new customers and ensuring the loyalty of the customers using the Internet, creating new ways of transacting business over the Internet, etc. were not even in the wildest dreams of the companies having a web presence. Today these and more are possible and the number of commercial websites has grown to more than million. Companies are realizing that the web is having a profound impact on how they conduct business. With its open-platform-based technology and ubiquitous reach, the Internet is allowing companies to open up new distribution channels, forge communities of buyers and sellers, revenues and increase profits. In ways unimaginable just a few years ago, corporations are Internet technology to set up e-commerce business and successfully conduct trade over the Internet. Let us look into some examples:

- **Dell Computers** (*www.dell.com*) sold products worth $61.13 billion in 2008 and these provide 30 percent higher profit margins than those purchased by its non-online customers.
- Launched as a website in July 1995, **Amazon.com Inc.**, with two employees in Seattle, grew fast that, its revenue in 1999 was more than $600 million in 1998 and ousted the two book majors Barnes & Noble and Borders Books & Music from their top slots. In 2007, the revenue was $14.84 billion. Now the popularity of Amazon.com is so huge that made someone "*Now Amazon is first a bookstore and only then the river!*"
- **Wine.com** (*www.wine.com*), formerly **Virtual Vineyards**, was created in 1994 by Robert and Peter Granoff as one of the first web-based businesses attracts customers from around world, handles its marketing, sales, and financial transactions over the Internet, with suppliers and distributors on several continents, and exists only in cyberspace.
- In India, it takes only a few minutes to choose a flight or plan a vacation at Make My **Trip.Com** (*www.makemytrip.com*), an integrated on-line travel transaction site, whereas hours to do the same thing using a travel agent.
- **FedEx** (*www.fedex.com*) and **DHL Worldwide Express** (*www.dhl.com*) allows its customers only to track their packages on-line but also allows them to schedule pickups, create and so on.
- **Tata McGraw-Hill Publishing Company Ltd.** (*www.tatamcgrawhill.com*) opened its and is now selling books worldwide, accepting book proposals, offering special through the site.
- **South Indian Bank** (*www.southindianbank.com*) started its Internet banking service enables the customers to do banking transaction over the Internet.
- **Rediff on the Net** (*www.rediff.com*) which started as a new an on-line news service a back, is now a full-fledged web portal offering goods ranging from books, music apparel, toys, electronic goods to musical instruments.
- **Indiaplazza** (*www.indiaplaza.in*), formerly **Fabmall**, which opened a music and book with its '*Browse, Shop and Have a Great Time*' slogan and offered the music and book convenient way to do their on-line shopping has now become the largest online mall and sells a variety of items like books, music, movies, electronic goods, apparel, and so on.

These are only some of the well-known success stories. There are hundreds of organizations—both foreign and Indian—which conduct their business transactions over the The pervasive nature of Internet and WWW on the business is shown in Figure 27.1. The the suppliers and the organizations are all connected using this new digital medium.

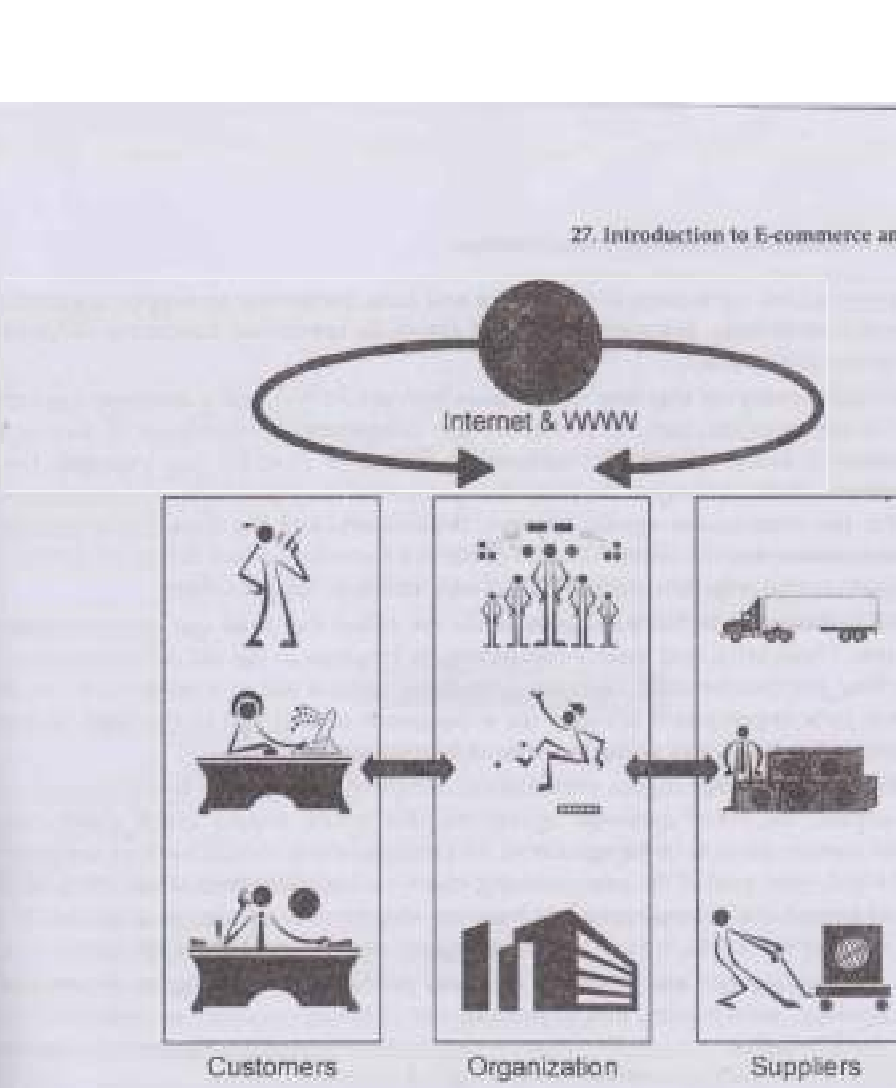


Figure 27.1 Internet as a Medium that Connects Customers, Suppliers and the Organization

As the Figure 27.1 clearly shows, no organization can ignore Internet and survive. **But doing ...ness on the Internet and doing business the Internet way are very different.** When you accept ...ments through the Internet, advertise your products on the web, and send e-mails to potential ...omers, you are doing business over the Internet. When you accept payments over the Internet or ... other electronic media (like EDI or EFT), we call it e-commerce; but doing e-commerce is not the ... of doing business electronically.

In this Internet age, e-commerce is just the beginning. When you accept payments electronically, ... reach you or your bank at '*Internet speed*' – the speed that you cannot expect in the traditional ... transactions. So when you are getting your payments at '*Internet speed*' you should be ready ... business at the same speed. When you optimize your business operations, streamline your ... chain to meet the challenges of the digital economy, automate your business processes, achieve ...ation integration and acquire business intelligence, when your organization can take proactive ... within seconds, react to changes in customer demands and swings in market trends quickly, ... you can say that you are **doing business the Internet way**. Then you call your business E-...

...MMERCE AND E-BUSINESS

...ing to Kalakota and Robinson, "Few concepts have revolutionized businesses more profoundly ... e-commerce. New economy, new tools, new rules. Simply put the streamlining of interactions, products, and payments from customers to companies and from companies to suppliers is caus... earthquake in many boardrooms. Managers are being forced to reexamine traditional defini... value as we enter a new millennium."

E-commerce is here to stay. In this new millennium Internet, WWW and e-commerce are the... industry drivers. No company can survive in this brutally competitive environment, if they ig... commerce. E-commerce, more specifically, business-to-consumer (B-to-C) has changed the... companies do business. It has changed the way the consumers buy products and services. It... changed the life for the commission agents, brokers, dealmakers, and the likes. It has brought... consumers – the end users – and the manufacturers or service providers closer than ever before. It... created new distribution channels, new customers and new business opportunities.

The companies that operate in the traditional mode are called the '*Brick and mortar compa...* the Internet parlance. These brick and mortar companies do business in the old fashioned way. The... do not use the web or Internet for their business operations, at least not in a major way. So, the... question is whether your organization is ready for e-commerce or is it still in the brick and... mode. Is your organization capable of doing business at *Internet speed*?

In order to do business in this digital marketplace, adopting e-commerce is not enough... have mentioned earlier, the entire business operations – the entire supply chain (right from... suppliers to the end users) – have to be reengineered. The reengineering should be done keeping... mind that the end result – the goal of the reengineering effort – is to do business at *Internet speed*... an organization has geared itself, transformed its business structures and cultures and is ready... business in today's connected world, we call that organization an e-business (e-biz for short).

E-business is the convergence and fusion of business process, enterprise applications, ... infrastructure, technology, information, and organizational structure (people) necessary to ... high performance business. It is not possible for an organization to execute e-commerce tra... efficiently and effectively without first transforming to the e-business model.

What is the difference between e-commerce and e-business? E-commerce is buying and ... using an electronic medium. It is accepting credit card payments over the net, doing ... transactions using the Internet, selling commodities or information using the WWW and so on.

According to Kalakota and Robinson, "E-business, in addition to encompassing e-com... includes both front- and back-office applications that form the engine for modern business. E-b... is not just about e-commerce transactions; it's about redefining old business models, with the ... technology, to maximize customer value. **E-business is the overall strategy and e-commerce ... extremely important facet of e-business.**"

Thus, e-business involves not setting up the company website and being able to accept cre... payments or being able to sell the products or services on-line. It involves fundamental restr... and streamlining of the business using technology. Yes, we are talking about Enterprise ... Planning (ERP) systems, Supply Chain Management, Customer Relationship Management (... Data Warehousing, Data Marts, Data Mining, On-line Analytical Processing (OLAP), Geog... Information Systems (GIS), etc. to name a few.

To transform a traditional organization to do e-business involves use of technology to the ... Technological advancements are making things better, bigger and bolder. Businesses are cap... doing things that were unimaginable a few years back. For example, now an organization can ... purchase order and notify the customer within seconds after the customer has confirmed the ... customers can do the order cancellation without involving anybody from the company, the cu... can the track the order status and the status of the shipment on-line over the Internet. These ...

took days just a few years back and involved interaction with the customer service staff. Now people can make on-line payments over a Secure Socket Layer (SSL) and be reasonably sure that the information will not be tampered with or end up in the hands of wrong people. They can download and transfer digital cash to their friends or pay for the good they have bought. It is technology and innovation and new business processes that are making these things possible. So today's organizations – the e-businesses – should make technology an ally and should constantly innovate and continuously improve to stay in business and be competitive.

According to Patricia Seybold, "*...you cannot do business on the Internet in a vacuum. Instead, Internet commerce needs to be part of the boarder electronic business strategy – a strategy that embraces all the ways that you let your customers do business with you electronically: by Touch-tone phone, by fax, by e-mail, by kiosk, via handhelds, and via the Web.*"

REVIEW QUESTIONS

Short Answer Questions

1. What are the activities that come under e-commerce?
2. What is the primary goal of e-commerce?
3. What do you mean by doing business at the Internet speed?

Descriptive Type Questions

1. What are the goals of e-commerce?
2. Give some examples of e-commerce activities.
3. Define e-commerce.
4. Information is an integral part of e-commerce. Explain
5. What do you mean by e-business?
6. What is the role of technology in e-business?

Essay Questions

1. How advancements in technology have helped e-commerce?
2. Give some real world examples of successful e-commerce ventures.
3. Explain doing business on the Internet using a diagram.
4. How e-business is different from e-commerce?

Fill in the Blanks

1. The four major e-commerce drivers are _____, _____, _____ and _____.
2. _______ integrates communications, data management, and security services, to allow business applications within different organizations to automatically interchange information.
3. _______ can be considered to be an exchange of goods or information in carrying out social or business activities.
4. _______ is generally associated with the buying and selling of information, products and services via computer networks.
5. _______ is the convergence and fusion of business process, enterprise applications, business infrastructure, technology, information, and organizational structure (people) necessary to create a high performance business.

[Answers: (1) Computers, networks, information, and people (2) E-commerce (3) Commerce (4) E-commerce (5) E-business]

True or False

01. The primary goal of e-commerce is to bring the organizations closer to their actual customers.
02. Teraflop computers and gigabit networks will enable computers to access remote information and provide services that will diminish the importance of distance to virtual insignificance.
03. Information is also an integral part of electronic commerce and electronic and traditional commerce each deal with information in the same way.
04. E-business is the overall strategy and e-commerce is an extremely important facet of e-business.
05. It is not possible for an organization to execute e-commerce transactions efficiently and effectively without first transforming to the e-busniess model.

[Answers: (1) True (2) True (3) False (4) True (5) True]

C H A P T E R 2 8

Introduction to Web Design

TOPICS COVERED

- Introduction
- Web design
- Creating a website
- Web hosting
- Website promotion

Key Points

▲ The web has grown very fast. In fact, the web has grown substantially faster than the Internet at large, as measured by number of hosts. Netcraft's latest Web survey found 185,497,213 websites in January 2009. According to Internet World Stats, the number of people who use the web is 1,463,632,361 as on June 30, 2008.

▲ In today's competitive world, if you want to survive, thrive and compete, then you no longer can ignore the web. Your marketing strategy, may it be personal or organizational, should include plans for creating your presence on the web.

▲ Small companies in particular should care about their web presence strategy, because for the first time, small businesses have a real and accessible way to level the playing field with larger competitors.

▲ Web page design requires conceptualizing, planning, modeling, and executing electronic media content and its delivery via the Internet using technologies suitable for rendering and presentation by web browsers or other web-based graphical user interfaces.

▲ Once you have your website up and running, you should let the world know such a site exists. Or in other words, you will have to market your website or announce your web presence.

INTRODUCTION

You have a company, which has products to sell and services to offer. You are a professional, an expert in your field, you want to share your expertise with others, and you want to earn professional recognition. You are hunting for a job and you want to market yourself. You are an educational institution and you want to let people know about your courses and other training facilities. You are a consultant and you want to advertise your services. You are an employer and you want to attract the best talent available. Is it possible for all the above mentioned people and organizations to find an inexpensive, yet highly visible medium which cuts across the language and geographical barriers, which is up 24 hours a day 365 days a year. The answer is yes, the Internet or the World Wide Web (or simply web or WWW) provides an ideal medium for all these people to create their presence.

The web has grown very fast. In fact, the web has grown substantially faster than the Internet at large, as measured by number of hosts. Netcraft's (www.netcraft.com) latest Web survey found 185,497,213 websites in January 2009. If you consider the fact that in June 1993, there were only 130 website, you will be amazed by the growth, which has been nothing but phenomenal. If the Web maintains this growth rate, it will reach 200 million sites by 2010. But the 200 million sites still will not represent full penetration as the world has more than 200 million companies, non-profit organizations, governmental agencies and eventually they all will have website as well as many individuals. So the number of websites will continue to increase as it has been in the past. No other medium has this big

CREATING A WEBSITE

There is a lot of difference between just establishing connectivity and gaining competence. As Internet connectivity soars all over the world, it becomes ever more challenging just to attract attention on the web. With well over 100 million websites vying for visitors, commercial ventures without a clear strategy will be lost in the crowd. In this chapter, we will be discussing how to create the web presence, what resources that you will be requiring, how to go about creating your website, etc. We will not be discussing the web design concepts or the strategies and techniques to make your website stand out, which is a topic that is beyond the scope of this book.

If you want to set up a website—whether it is your personal site or your company's—there are many options. The charges can range from zero upwards. If you are an individual or a non-profit organization there are many Internet Service Providers (ISPs) who offer you the necessary infrastructure free of cost. You can create a simple one-page site to a full-fledged site. We will see more about these ISPs later in this chapter. One thing with these free services is that, you should know how to create your own pages, which means that you should have knowledge of HTML or its more sophisticated cousins like Java, CGI, PHP, Pearl, etc. Although some of these free ISPs have automated facilities which will allow even a layman to create simple sites, but if you want to create sites with reasonable pedigree then you need to know at least one of the many web authoring languages.

If you do not believe in going in for these free web hosting services or you are a commercial organization, then you need to have place where you can put up your site. The place where you physically store the pages that make up your site is called a server, more precisely a web server. The server will have all your web pages, graphics, and other programs that is needed to host your site. It goes without saying that your server needs to be connected permanently to the Internet.

Once you have the server and Internet connection, you need an address or URL, so that others can connect to your site, or for you to tell others that you have put up a site at such and such a place, you need to have this address or URL. We have seen what an IP address and domain name is. As we have seen there are two kinds of domain names country-specific ('in' for India 'sg' for Singapore) or global ('com' for commercial, 'edu' for educational, etc.). You will have to register with the appropriate authority—the domain name registrar—to get the domain name. A domain name registrar is a company, accredited by the Internet Corporation for Assigned Names and Numbers (ICANN) or by a national ccTLD (Country code Top-Level Domain) authority, to register Internet domain names. The complete list of these registrars—both international and country specific—could be obtained from the website of DomainNameRegistrars.com (*www.domainnameregistrars.com*).

Now that you have the Internet connection, the web server and the domain name, the next step is designing your site. The site will have pages, images, and other programs. If you are planning to design and develop the web pages by yourself, you can add an HTML editor to your shopping list. With the HTML editors you do not have to remember the HTML tags, you just have to type-in the text, place the graphics, format the text and graphics, and the HTML editor will do the job of putting the HTML tags. Some of the HTML editors are Adobe Dreamweaver, Microsoft Expression Web, CoffeeCup HTML Editor, etc. If you want to have feedback forms, access counters, shopping carts, search engines, etc., in your page, then HTML alone is not enough. You will need CGI (Common Gateway Interface) on your web server and the programming languages and tools to implement the CGI programs, like PHP, JavaScript, Ruby, Perl, Python, and Tcl, etc. You can also seek the help of a professional consultant or agency, which specializes in web design and development. But the charges can vary depending on the complexity of the page, scope of the work (whether it is development alone, or whether it is design and development, whether image are supplied by you, whether the text is in soft copy, etc.) and reputation and competence of the consultant/agency.

WEB HOSTING

Once you have designed and developed your website, then next question is "Where will I put up my web server?" Actually you have many options. The easiest way is to get the services of an Internet Service Provider (ISP). An ISP is a company that provides access to the Internet. Their customers can be businesses, individuals or organizations. In this option you will rent a specified amount of disk space on the server of the ISP as well as a shared or dedicated bandwidth on his Internet connection. The ISPs will configure their machine (virtual hosting) so that their computer will respond to your domain name. The users will not know whether your site is hosted on your on server on an ISP's machine. The ISP will be handling hundreds of clients like you and will have many websites on their computer. Most ISP's will give you a URL, which will be an extension of their domain name. For example, suppose you have taken the service of an ISP whose domain name is 'www.isp.com' and your company name is, say, 'xyz'. Then the ISP will assign you a URL, which will be something like 'www.isp.com/xyz' and for which you will not have to pay anything extra. But if you want a domain name like 'www.xyz.com' then the only way is to register your domain name (if it is available) with a domain name registrar. The web hosting charges and features offered will vary depending on the ISP. So do some research (on the web) well and ask for testimonials before you choose a hosting company for your website. Choose the ISP, which has a reputation in the business and which has a good technical support team. Also, choose one that offers all the features you want like databases, e-mail accounts, domain parking, webmail, etc.

Now we will see some of the free web presence providers. As mentioned earlier there are a lot of companies who will host your home page free of cost. But this facility is, in most cases, available only for individuals and non-profit organizations. There are free web presence providers who offer a host of facilities free, for which you have to spend a fortune otherwise. Many of these providers will give you FTP access to your site (a must if you want to update the files from your PC), CGI access (a must if you want to have site counters and feedback forms), free e-mail accounts, and other facilities. The amount of disk space will vary depending on the provider, but most of them will give disk space as high as 50–100 MB per individual/organization, which is more than enough to host a reasonably large site. In fact, most individual home pages will require less than 1 MB of space. Most these providers will have facilities like wizards and templates which will allow even novices who do not know anything about the HTML or web authoring to host their sites. For experts, the provider will give the disk space and FTP and in most cases CGI access, so that one can do the design and development and then upload the files to the providers server.

In most cases, the service provider will have a technical support team. So in case of any problem, you can contact the technical support team or the webmaster of the site. Almost all the free web presence providers will put advertisements and banners in your page; that is where their revenue comes, which enable them to provide you the free service. But there are a few providers who do not put the advertisements, so if you are very particular that your site should not have any advertisements then you can choose a provider who does not put banners in your site. Many providers will delete the site if it is inactive or does not have any hits for a specified period of time (usually 2 to 3 months). Also most providers will not allow pornographic or illegal material or links to it and there will be additional restrictions depending on the provider. So it is a good idea to read the 'rules and regulations', FAQ and support guide before you sign up. Given below are some of the most popular free web presence providers:

- ▲ Awardspace (www.awardspace.com)
- ▲ Atspace (www.atspace.com)
- ▲ 50Webs (www.50webs.com)
- ▲ Yahoo! Geocities (geocities.yahoo.com/home)
- ▲ ZeroCatch (www.0catch.com)

WEBSITE PROMOTION

Once you have your website up and running, you should let the world know that such a site exists. In other words, you will have to market your website or announce your web presence. To successfully market your website you need to run an on-going campaign, just as you would for a product or service. We have identified the major areas that you should concentrate during the ad campaign. All of them may not apply to your website, and the emphasis on each area may vary according to your situation. They include:

1. Announcing your website with Internet search engines and directories
2. Issuing a press release
3. Announcing in newsgroups
4. Participating in e-mail lists
5. Obtaining links from other websites
6. Purchasing ad banners on other websites
7. Running on-site events
8. Issuing an e-newsletter
9. Conducting a direct e-marketing campaign
10. Using your letterheads, brochures, annual reports, visiting cards, etc

- ▲ **Announcing Your website with Internet Search Engines and Directories** – The objective here is to get your website listed in the Internet's equivalent of the yellow pages. This is probably the most cost effective way of reaching potential visitors who otherwise may not be aware of your company. Once listed, people who search on these directories can find your site. There are several "tricky" things you can do to try to get your URL listed higher or more times on a search engine results page. We are listing these alternatives, but are in no way recommending them as these website promotion methods may be viewed as "cheating" by some members of the Internet community. In fact, some of the search engines are starting to penalize people who use these tricks. The reason why we list these tricks is to help you understand why some sites always show up multiple times or always at the top.
  1. Placing mass amounts of hidden keywords <!publishing company, publishing company,...> at the bottom of your document. Search engines calculate keywords by how many times they appear on a page. It is important to be aware that search engines may penalize you for excessively repeating keywords. At present, InfoSeek and Lycos are two examples and others may adopt similar policies in the future.
  2. Changing your name to '**A1 Enterprises**' or '**!Rob's Restaurant**' in order to appear at the top. Our suggestion is that you pick something descriptive instead. You might appear at the top by changing your name, but will be skipped over because the new one does not evoke a professional or trustworthy company image.

3. Changing your <TITLE> regularly so when robots revisit your site to refresh their information, they will interpret the new title to mean the existence of a new site. The result being your page will be listed more than once in a search.

There are hundreds of sites where you can announce your site. Each typically falls into one of six categories:

1. Search engines
2. Announcement sites
3. General directories
4. Geographic sites
5. Specific-interest sites
6. Selective sites.

Always announce your site the day it is published as it will take from a day to several weeks for the search engines to include it in their databases. It is best to not announce before your site is published, however, as potential customers who click to a site still under construction are unlikely to return. As your website changes and grows you may want to announce additional web pages to the search engines. For example, if you create a new section of your site for a new product, you may want to announce the main page of that section.

- **Issuing a Press Release** — A press release allows you to reach prospects through publications that cover your topic of interest. A release needs to be coordinated with the launch of your site (or it is not news) and may be distributed by e-mail, newswire, fax or mail. The four keys to a successful press release are:
  1. Having newsworthy content
  2. Targeting interested editors
  3. Matching distribution method with editor preference
  4. Properly formatting the release for each method of distribution.
- **Announcing in Newsgroups** — A newsgroup is an electronic bulletin board where people with shared interests can communicate. There are thousands of newsgroups on the Internet with millions of daily participants. Done right and with care, posting to a newsgroup can generate tremendous, almost instant, word-of-mouth. If you want to post, target only those newsgroups that cover topics associated with your product. First, determine if the newsgroup accepts postings. If it does, monitor the postings and participant response. When you post, provide useful advice or information, not an advertisement for your product. Be specific and keep it short. You can end with a mention that your site has useful information on the topic you are posting. If possible, become a known participant by posting frequently with both advice and questions. And do not forget to include your signature on every e-mail or posting. If you have an announcement, be sure to post it to the "announcement newsgroups" which are designed for announcements. Finally, if there is sufficient interest, you may even want to create your own newsgroup.
- **Participating in E-mail Lists** — An e-mail list is much like a newsgroup. The key difference is that messages go directly to a participant's e-mail box rather than the participant going to the newsgroup to read the postings. For that reason, posting to an e-mail list requires even more caution than a newsgroup. Otherwise, newsgroups rules apply.
- **Obtaining Links From Other websites** — There are two types of links:
  1. One-way links to your website

2. Two-way links where you provide a return link to the other website.

Getting a link simply requires finding sites that have a reason for pointing to you, then ask for the link. If a site acts as a resource for information that resides on your site, the owner of the site will probably want to point to you. If you can't get them to point to your main page, then ask for a link to your page that contains the specific information. Seek out partners for trading links including vendors, suppliers and providers of complimentary products.

- **Purchasing Ad Banners on Other websites** – As more links appear on any given page, advertising increasingly becomes a way to stand out from your competitor. You can sponsor another site through barter or direct payment. In either case, you can find appropriate sites to sponsor yourself or have another company find them for you. Join LinkExchange for Internet advertising.
- **Running On-Site Events** – Running events on your site is an excellent way to encourage repeat traffic. You'll want to begin running events once traffic from your site launch begins to fade. Examples include contests, games, on-line interviews, chat sessions and broadcasts.
- **Issuing an E-Newsletter** – You can ask site visitors to sign up for a newsletter and distribute it by e-mail. An e-newsletter allows you to keep visitors up-to-date on site changes and new offerings. It also serves as a channel for delivering valuable information related to your products that can help convert prospects into customers.
- **Conducting a Direct e-Marketing Campaign** – Direct e-marketing on the Internet is in its formative stages. You can send your message in e-mail or HTML format; solicited or unsolicited. We do not recommend using unsolicited e-mail as the receiver bears the cost.
- **Using your letterheads, brochures, annual reports, visiting cards, etc** – This is another inexpensive, but a very effective way of advertising your site. Each time an employee gives his/her card to somebody, you are getting free advertisement. Same is the case with annual reports and brochures. Because the web is dynamic in nature people will want to visit your site for the latest information that might not be available in the brochures or product catalogues.

So now you know how to create and announce your web presence. If you want to thrive and succeed in today's competitive world you need to establish your presence on the web. Small companies in particular should care about their web presence strategy, because for the first time, small businesses have a real and accessible way to level the playing field with larger competitors. You can communicate more efficiently through e-mail and newsgroups. You can access more information through research online. Your online presence can look as polished and professional as that of a Fortune 50 company. Also, the Internet is a low-cost technology that is accessible to even the smallest micro-business. And, it has become easier to use and more relevant to business needs. So there is virtually no reason not to take advantage of this powerful tool!

REVIEW QUESTIONS

Descriptive Type Questions

01. Why it is said that the Internet or the World Wide Web provides an ideal medium for all people to create their presence?
02. If you want to thrive and succeed in today's competitive world you need to establish your presence on the web. Explain
03. Explain the growing popularity of WWW and its usage?

04. What are the advantages of WWW over the other media?
05. What do you mean by web design?
06. What is the intent of web design?
07. Why do you need a browser plug-in?
08. What are static web pages?
09. How are dynamic web pages different from static pages?
10. How can content be changed on the client side?
11. How is dynamic content compiled on the server?
12. What are the basic aspects of design?
13. What are the different categories of sites where one can announce one's site?
14. What is a newsgroup?
15. What is an e-mail list?

Essay Questions

01. Describe how a web site is created?
02. What do you mean by web hosting? Explain the various alternatives available.
03. Explain the promotion strategies for a website.

Fill in the Blanks

01. GUI stands for ______.
02. GIF, JPEG and PNG are formats for ________.
03. Flash, QuickTime and Java run-time environment are examples of ______.
04. Typically web pages are classified as _______ and _______.
05. The first page of a website is known as the ______ or ______.
06. ISP stands for ________.

[Answers: (1) Graphical User Interface (2) Bit-mapped images (3) Browser plug-ins (4) Static, Dynamic (5) Home, Index (6) Internet Service Provider]

True or False

01. There were 185,497,213 websites in January 2009.
02. If the web maintains this growth rate, it will reach 200 million sites by 2010.
03. The number of people who use the web is 1,463,632,361 as on June 30, 2008.
04. With connectivity in over 100 countries, international communication is a fundamental facet of the web.
05. Plug-ins cannot be embedded in web pages, using HTML or XHTML tags.
06. A website typically consists of text and images.

[Answers: (1) True (2) True (3) True (4) True (5) False (6) True]

CHAPTER 29

Overview of Web Technologies

TOPICS COVERED

- Introduction
- HTML
- XHTML
- XML
- CSS
- JavaScript
- PHP
- Databases on the Web

Key Points

▲ The intent of web design is to create a website (a [illegible] of electronic files residing on one or more web servers [illegible] presents content (including interactive features or interfaces [illegible] the end user in the form of web pages upon request. [illegible] elements as text, forms, and bit-mapped images (gif, jpg, [illegible] can be placed on the page using HTML, XHTML, or XML [illegible]

▲ This chapter gives an overview of the various [illegible] development tools like HTML, XHTML, XML, CSS, Java[illegible] PHP, etc.

INTRODUCTION

We have seen that the intent of web design is to create a website, (a collection of electronic [illegible] residing on one or more web servers) that presents content (including interactive features or inter[illegible] to the end-user in the form of web pages upon request. Such elements as text, forms, and bit-[illegible] images (gif, jpg, png) can be placed on the page using HTML, XHTML, or XML tags. Displaying [illegible] complex media (vector graphics, animations, videos, and sounds) usually requires browsers [illegible] incorporate optional plug-ins, such as Flash, QuickTime, and Java run-time environment. Other [illegible] ins are embedded in web pages, using HTML or XHTML tags. In this chapter we will discuss [illegible] the markup language, web scripting language and other technologies used to create websites.

HTML

HTML stands for Hypertext Markup Language. HTML consists of standardized codes or "tags" [illegible] are used to define the structure of information on a web page. These codes enable web pages [illegible] many features including bold text, italic text, headings, paragraph breaks and numbered or bulleted lists.

HTML defines several aspects of a web page including heading levels, bold, italics, [illegible] paragraph breaks and hypertext links to other resources. HTML can be compared to word processing. The text in a word processed file can be formatted in various ways. For example, a heading can be [illegible] and in larger font size than the rest of the document. Also, specific words can be italicized [illegible] emphasis.

HTML is a way of defining the formats of text in a web page. However, it goes further by [illegible] being able to define placement of graphics and hypertext links. HTML is a sub-language of SGML, [illegible] Standard Generalized Markup Language. SGML is a system that defines and standardizes [illegible] structure of documents. Both SGML and HTML utilize descriptive markup to define the structure [illegible] an area of text. In general terms, descriptive markup does not specify a particular font or point size for an area of the text. Therefore, in HTML, text is marked as a heading, sub-heading, numbered list, bold, italic, etc.

HTML Tags

HTML is standardized and portable. A document that has been prepared using HTML markup "tags" can be viewed using a variety of web browsers, such as Internet Explorer and Lynx. A browser interprets the tags in an HTML file and presents the file as a formatted, readable web page. In addition, HTML documents can be viewed on all types of systems, such as Macintosh, PC and UNIX machines.

HTML tags are used to define areas of a document as having certain characteristics. The tags used in HTML usually consist of a code in between two "wickets." These codes are called container tags because the formatting described by the tag affects only the text contained between the tags. For example, <B> and </B> are the starting and ending tags used to indicate an area as bold. HTML tags are used to define heading levels, such as <H1> and </H1>. Heading levels can go to <H6>, with each successive number indicating a smaller heading size.

For example, the following HTML code will generate the web page given Figure 29.1:

```
<html>
<head>
<title> Sample Page with Graphics</title>
</head>
<body>
<h1>Programmer's Prayer</h1>
<img src="prayer.jpg"><br>
<b>
Our Program who are in Memory.<br>
Hello by thy Name.<br>
Thy Operating System come.<br>
Thy Commands be done at the Printer as it is on the Screen.<br>
Give us this day our daily Data,<br>
And forgive us our I/O errors<br>
As we forgive those whose logic circuits are faulty.<br>
Lead us not into frustration, and deliver us from Power Surges.<br>
For Thine is the Algorithm, <br>
The Application,<br>
And the Solution <br>
Looping forever and ever.<br>
Return.<br>
</b>
</body>
</html>
```

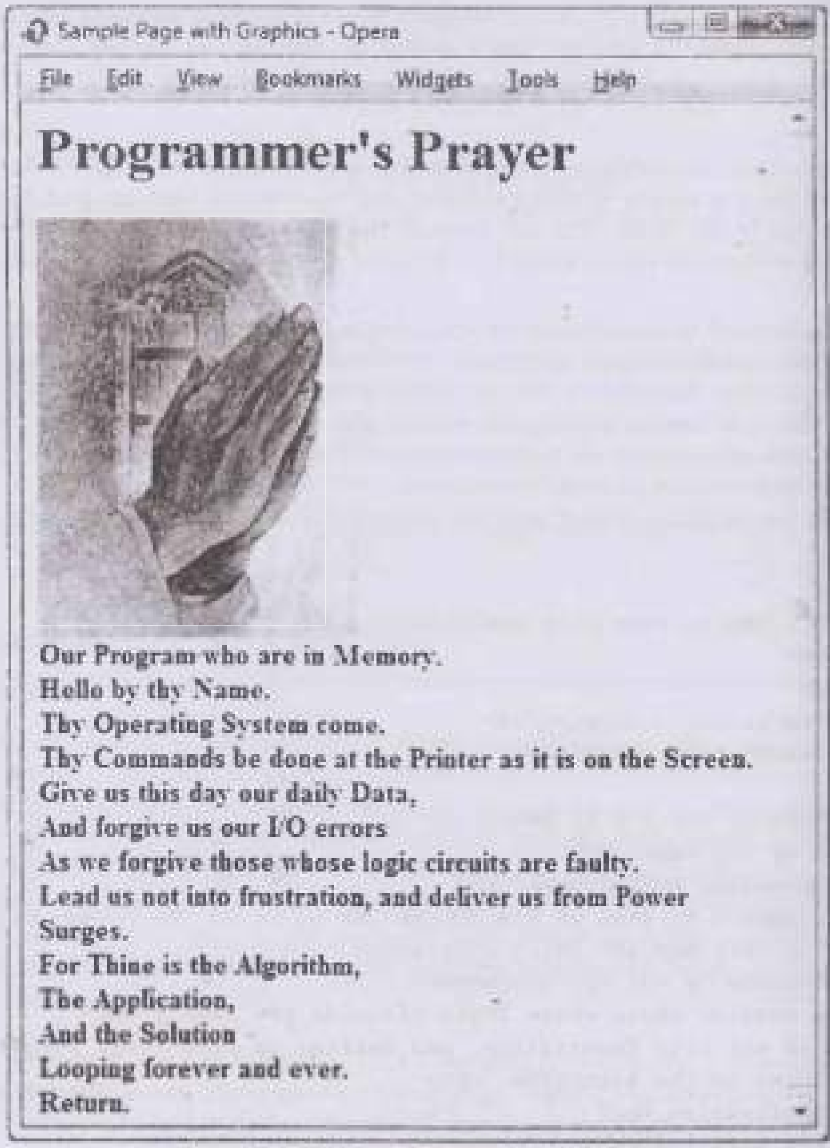


Figure 29.1 Web Page Generated by HTML Code

XHTML

The Extensible Hypertext Markup Language, or XHTML, is a markup language that has [illegible] depth of expression as HTML, but also conforms to XML syntax. XHTML is almost identical [illegible] 4.01, but it is a stricter and cleaner version of HTML. XHTML is HTML defined as an XML [illegible] and is a W3C Recommendation.

While, HTML prior to HTML5 was defined as an application of Standard Generalized [illegible] Language (SGML), a very flexible markup language. XHTML is an application of XML, [illegible] restrictive subset of SGML. Because they need to be well-formed, true XHTML documen[illegible] automated processing to be performed using standard XML tools—unlike HTML, which requires a relatively complex, lenient, and generally custom parser. XHTML can be thought of as the intersection of HTML and XML in many respects, since it is a reformulation of HTML in XML. XHTML 1.0 became a World Wide Web Consortium (W3C) Recommendation on January 26, 2000. XHTML 1.1 became a W3C Recommendation on May 31, 2001.

Why XHTML?

We have reached a point where many pages on the WWW contain "bad" HTML. The following HTML code will work fine if you view it in a browser, even if it does not follow the HTML rules like missing </head>, </h1>, etc.:

```
<html>
<head>
<title>This is bad HTML</title>
<body>
<h1>Bad HTML
</body>
```

XML is a markup language, where everything has to be marked up correctly, which results in "well-formed" documents. XML was designed to describe data and HTML was designed to display data. Today's market consists of different browser technologies, some browsers run Internet on computers, and some browsers run Internet on mobile phones or other small devices. The last-mentioned do not have the resources or power to interpret a "bad" markup language. By combining HTML and XML, and their strengths, we got a markup language that is useful now and in the future—XHTML.

XML

The Extensible Markup Language (XML) is a general-purpose specification for creating custom markup languages. It is classified as an extensible language, because it allows the user to define the markup elements. XML's purpose is to aid information systems in sharing structured data, especially via the Internet, to encode documents, and to serialize data; in the last context, it compares with text-based serialization languages such as JSON and YAML.

XML's set of tools help developers in creating web pages but its usefulness goes well beyond that. XML, in combination with other standards, makes it possible to define the content of a document separately from its formatting, making it easy to reuse that content in other applications or for other presentation environments. Most importantly, XML provides a basic syntax that can be used to share information between different kinds of computers, different applications, and different organizations without needing to pass through many layers of conversion.

XML began as a simplified subset of the Standard Generalized Markup Language (SGML), meant to be readable by people via semantic constraints; application languages can be implemented in XML. These include XHTML, RSS, MathML, GraphML, Scalable Vector Graphics, MusicXML, and others. Moreover, XML is sometimes used as the specification language for such application languages.

XML is recommended by the World Wide Web Consortium (W3C). It is a fee-free open standard. The recommendation specifies lexical grammar and parsing requirements. XML is not a replacement for HTML. XML and HTML were designed with different goals. XML was designed to transport and store data, with focus on what the data is. HTML was designed to display data, with focus on how data looks. HTML is about displaying information, while XML is about carrying information. Some of the advantages of XML are:

Use of CSS

Prior to CSS, nearly all of the presentational attributes of HTML documents were contained within the HTML markup; all font colors, background styles, element alignments, borders and sizes had to be explicitly described, often repeatedly, within the HTML. CSS allows authors to move much of that information to a separate style sheet resulting in considerably simpler HTML markup.

HTML tags were originally designed to define the content of a document. They were supposed to say "This is a header", "This is a paragraph", "This is a table" by using tags like <h1>, <p>, <table>, and so on. The layout of the document was supposed to be taken care of by the browser, without using any formatting tags. As the two major browsers - Netscape and Internet Explorer - continued to add new HTML tags and attributes (like the <font> tag and the color attribute) to the original HTML specification, it became more and more difficult to create websites, where the content of HTML documents was clearly separated from the document's presentation layout.

Prior to CSS, document authors who wanted to assign such typographic characteristics to, say, all h2 headings had to use the HTML font and other presentational elements for each occurrence of that heading type. The additional presentational markup in the HTML made documents more complex, and generally more difficult to maintain. In CSS, presentation is separated from structure. In print, CSS can define color, font, text alignment, size, borders, spacing, layout and many other typographic characteristics. It can do so independently for onscreen and printed views. CSS also defines non-visual styles such as the speed and emphasis with which text is read out by aural text readers. The W3C now considers the advantages of CSS for defining all aspects of the presentation of HTML pages to be superior to other methods. It has therefore, deprecated the use of all the original presentational HTML markup.

JAVASCRIPT

JavaScript is a scripting language widely used for client-side web development. It was the originating dialect of the ECMAScript standard. It is a dynamic, weakly typed, prototype-based language with first-class functions. JavaScript was influenced by many languages and was designed to look like Java, but be easier for non-programmers to work with. Although best known for its use in websites (as client-side JavaScript), JavaScript is also used to enable scripting access to objects embedded in other applications.

JavaScript, despite the name, is essentially unrelated to the Java programming language, although both have the common C syntax, and JavaScript copies many Java names and naming conventions. The language's name is the result of a co-marketing deal between Netscape and Sun, in exchange for Netscape bundling Sun's Java runtime with their then-dominant browser. The key design principles within JavaScript are inherited from the Self and Scheme programming languages. "JavaScript" is a trademark of Sun Microsystems. It was used under license for technology invented and implemented by Netscape Communications and current entities such as the Mozilla Foundation.

JavaScript was designed to add interactivity to HTML pages. As we have seen JavaScript is a scripting language, which means it is a lightweight programming language. JavaScript is usually embedded directly into HTML pages and it is an interpreted language so the scripts execute without preliminary compilation.

PHP

PHP (PHP: Hypertext Processor) is a scripting language originally designed for producing dynamic web pages. It has evolved to include a command line interface capability and can be used in stand-alone graphical applications. While PHP was originally created by Rasmus Lerdorf in 1995, the implementation of PHP is now produced by the PHP Group and serves as the de facto standard PHP as there is no formal specification. PHP is free software released under the PHP License; however it is incompatible with the GNU General Public License (GPL), due to restrictions on the usage of the term PHP. PHP is a widely used general-purpose scripting language that is especially suited for development and can be embedded into HTML. It generally runs on a web server, taking PHP code as its input and creating web pages as output. It can be deployed on most web servers and on every operating system and platform free of charge.

PHP can be used for command-line scripting and client-side GUI applications. It can also be deployed on most web servers, many operating systems and platforms, and can be used with relational database management systems. It is available free of charge, and the PHP Group provides the complete source code for users to build, customize and extend for their own use.

PHP primarily acts as a filter, taking input from a file or stream containing text and/or PHP instructions and outputs another stream of data; most commonly the output will be HTML. automatically detect the language of the user. From PHP 4, the PHP parser compiles input to byte-code for processing by the Zend Engine, giving improved performance over its predecessor.

Originally designed to create dynamic web pages, PHP's principal focus is server-side and it is similar to other server-side scripting languages that provide dynamic content from a server to a client, such as Microsoft's ASP.NET system, Sun Microsystems' JavaServer Pages, mod_perl. PHP has also attracted the development of many frameworks that provide building and a design structure to promote rapid application development (RAD). Some of these CakePHP, Symfony, CodeIgniter, and Zend Framework, offering features similar to other application frameworks.

The LAMP architecture has become popular in the web industry as a way of deploying applications. PHP is commonly used as the P in this bundle alongside Linux, Apache and although the P may also refer to Python or Perl.

As of April 2007, over 20 million Internet domains were hosted on servers with PHP installed, PHP was recorded as the most popular Apache module. Significant websites are written in including the user-facing portion of Facebook (www.facebook.com), MediaWiki(www.media Yahoo! (www.yahoo.com), MyYearbook (www.myyearbook.com), Digg (www.digg.com), (www.wordpress.org), etc.

DATABASES ON THE WEB

During the initial phases of web development, the concept of using databases was not very But as the technologies evolved and the complexity of data displayed on the website increased, of databases began to gain popularity. Now most of the websites that have data that changed or modified uses a database. The databases can vary anything from MySQL to Server or Oracle. MySQL is a fast, open-source Relational Database Management System that popular Structured Query Language (SQL). It is perfect for most websites that need functionality, and works hand-in-hand with PHP.

A database driven approach to web development simply refers to the use of a database a website's content. It involves the separation of a site's content (words and pictures) from (the look, feel, and navigation). The design is most typically stored in template files. When a requests a page by clicking a link, a template draws the appropriate information from the database before it displays the result as an HTML.

By contrast, a static website comprises a series of HTML files. These files are self-contained documents that appear the same to all users, regardless of where, how, when, or why they are viewing the document. A single static file holds all of the data for a particular page (text, images, navigational structure, etc) and the design and content are intertwined. When a site visitor requests a page, the HTML file is passed from the server to the visitor's browser. On a static site, visitors are simply viewing documents over the internet, in much the same way they might open files on their own hard drives.

To illustrate the difference between a static and a database driven site, consider a site that contains 25,000 product pages. Sites like Amazon.com contain millions of pages. Using a static web development model, a programmer would need to create 25,000 separate HTML pages with the same basic navigational structure, each containing an individual product's specifications and information. To add a new product to the site, the programmer would need to create a new copy of the product page file and insert the new product's information into the appropriate places within the file. To make a change to the structure of all 25 product pages, the programmer would need to adjust each of the 25 HTML pages by hand.

Using a database driven approach, the programmer would build a product table in the website's database. This table would contain a series of columns with pertinent information about the product line. For instance, the table might have the following columns: "product identification number," "product name," "product size," "price," "availability," "description," and "image." The programmer would then create a template file to use the information from the product table. This template file would contain the basic structure of a product page, identifying elements like the navigation system, where a product image is placed, where the description and other information goes on the page, and how all the data is to be formatted. When a user visits a particular product page, the template grabs the data associated with that product's identification number from the database, plugs the data into the template and presents the user with a complete product page "on the fly." Here, the combined use of CSS and database will make the job of managing and maintaining the website easier. The CSS will let the developers to make changes to appearance by modifying the style sheet. The database will let the developers make changes to the web content by modifying the database. A scripting language like PHP, Python or Pearl will create the web pages dynamically or 'on the fly' using the data from the database and in the style as defined by the style sheet.

REVIEW QUESTIONS

Descriptive Type Questions

1. What is the intent of web design?
2. What is a website?
3. What is HTML?
4. What are HTML tags?
5. What is XHTML?
6. How XHTML is different from HTML?
7. Why one should use XHTML?
8. What is XML?
9. What are the advantages of XML?
10. What is CSS?

11. What is the most common application of CSS?
12. What do style sheets define?
13. What are the uses and advantages of CSS?
14. What is JavaScript and what is it used for?
15. What is PHP and what are its advantages?
16. What are the advantages of having a database-backed website?

Fill in the Blanks

01. HTML stands for _______.
02. SGML stands for _______.
03. XHTML stands for _______.
04. XML stands for _______.
05. CSS stands for _______.
06. PHP stands for _______.

[**Answers:** (1) Hypertext Markup Language (2) Standard Generalized Markup Language (3) Extensible Hypertext Markup Language (4) Extensible Markup Language (5) Cascading Style Sheets (6) PHP Hypertext Processor]

True or False

01. HTML is a way of defining the formats of text in a web page.
02. HTML documents can be viewed on all types of systems, such as Macintosh, PC and UNIX machines.
03. XML is not a replacement for HTML.
04. Styles sheets define how HTML elements are to be displayed.
05. CSS can define color, font, text alignment, size, borders, spacing, layout and many other typographic characteristics.
06. JavaScript was designed to add interactivity to HTML pages.

[**Answers:** (1) True (2) True (3) False (4) True (5) True (6) True]

CHAPTER 30

Introduction to Computer Security

TOPICS COVERED

* Introduction
* Types of computer crimes
* Computer security
* Crime and security
* Computer crime by authorized users
* Computer crime through unauthorized access
* Malicious computer programs

Key Points

▲ Computer crime is any crime accomplished through the knowledge or use of computer technology. The computer crimes are increasing by the day.

▲ The main types of computer crimes are software piracy, software/hardware sabotage, hacking and electronic trespassing, etc.

▲ Computer security refers to protecting computer systems and the information they contain against unwanted access, damage, modification or destruction.

▲ Computer owners and administrators use a variety of security techniques to protect their systems like physical access restrictions, passwords, firewalls, codes, shields, security audits, backups, etc.

▲ There are several ways an authorized user of a computer, such as an employee using the company's computer, can accomplish unauthorized and illegal objectives. Unauthorized users gain access to computer systems by stealing or cracking passwords.

INTRODUCTION

Today the computer has replaced the gun and knife as the weapon of choice of many criminals. Computer crime is often defined as any crime accomplished through the knowledge or use of computer technology.

Nobody knows the true extent of computer crimes. Many computer crimes go undetected. Those which are detected often go unreported, because businesses fear that they can lose more from the negative publicity than from the actual crimes. But it is a fact that both businesses and the governmental agencies lose huge amounts of money every year to computer criminals.

India has the fourth highest number of Internet users in the world. According to the National Crime Record Bureau, cyber crimes under the Information Technology (IT) Act recorded a whopping [illegible] percent jump in 2007 over the previous year. What is more, the majority of offenders were under 30 years of age. Internet Crime Complaint Center, which the FBI helps to run, has recorded more than 1 million complaints since its founding in 2000 and numbers are now running about 18,000 to 20,000 per month.

Cyber criminals are using the credit crunch and the potential global recession as a way to cash in, warned security experts. McAfee highlighted in its 'Virtual Criminology Report' that the economic downturn is drawing increasing numbers of people to the web in a bid to save money but at the sametime offering cyber criminals more potential victims. McAfee also revealed the lack of law enforcement agencies with the specialist skills to stop online fraud, and the fact that Russia and China have become safe havens for hackers means less and less cyber criminals are being reprimanded. A lack of communication between different countries over cyber crime is also hindering the apprehension of those behind web scams. "Cybercriminals are exploiting the global recession by luring in susceptible victims through the promise of easy money. While governments and law enforcement bodies' attentions are diverted by the current economic crisis, the door is left open for cyber criminals to continue to target bank balances worldwide and to potentially damage the consumer trust needed to aid rapid recovery," said Dave DeWalt, CEO and President of McAfee. Governments need to commit to funding the resources needed to combat cybercrime. Everyone must play their part in the global battle that has only just begun and will continue long into 2009 and beyond, if it is not properly addressed.

More than half of the organizations reported attacks from employees and other insiders. These crimes are typically committed by clerks, cashiers, programmers, computer operators and managers who have no extraordinary technical ingenuity. The typical computer criminal is a trusted employee with no criminal record, who is tempted by an opportunity, such as the discovery of a loophole in the system security. Greed, financial worries and personal problems motivate these people to commit the crime. Of course, not all computer criminals fit this description. Some are former employees seeking revenge. Some are corporate or international spies seeking classified information. Organized crime syndicates are turning to computer technology to practice their trade with more efficiency!

The explosive growth of Internet is changing the demographics of computer crime. New more organizations are reporting outside attack through the Internet. According to Richard Power, Senior Analyst at the Computer Security Institute, San Francisco, "As all manner of commerce moves to cyberspace, all manner of crime is moving there as well."

TYPES OF COMPUTER CRIMES

There are many types of computer crimes ranging from pirating software, stealing information to sabotaging systems. We will see some of these in the following sections.

Software Piracy

Piracy or the illegal duplication of copyrighted software is the most common computer crime. Millions of computer users have made copies of programs that they have not legally bought. Now that most software companies have given in to user demands and removed physical copy protection from their products, copying software is as easy as duplicating a cassette tape or photocopying a book. Many people do this because they are not aware that this unauthorized copying is illegal; but many people do fully aware that they are doing something illegal.

Software/Hardware Sabotage

Another type of computer crime is sabotage of hardware or software. The word sabotage comes from the early days of industrial revolution, when rebellious workers damaged new machines by kicking wooden shoes, called sabots, into the gears. However, modern computer saboteurs use software rather than footwear for their destructive activities. They use viruses, worms, logic bombs and Trojan horses to destroy the computer hardware and software. More about this is given in Chapter 32.

Hacking and Electronic Trespassing

In the late 1970s, timesharing computers at Stanford University and Massachusetts Institute of Technology attracted informal communities of computer fanatics who called themselves hackers. In those days a hacker was a person who enjoyed learning the details of computer systems and writing clever programs—referred to as hacks. Hackers were, for most part, curious, enthusiastic, intelligent idealistic, eccentric and harmless. Many of those early hackers were in fact the architects of the microcomputer revolution.

But today's hackers are not so innocent and have very ominous intentions. They enter corporate and government computers using stolen passwords and security loopholes and steal information, transfer money to their accounts, and do a lot of other criminal activities. Sometimes they use modems to dial up the target computers directly; in other cases they 'travel' to their destinations through the Internet and other networks. Many hackers cover their tracks and leave without a trace; but many leave logic bombs, viruses and do a lot of malicious activities like changing passwords, shutting down or crippling the system. A growing number of hackers are part of the electronic crime rings intent on stealing credit card numbers and other sensitive information and this kind of theft is difficult to detect because, the criminals usually leave behind no evidence of their visit. You could read some real interesting stories of hackers and how brilliant security specialists caught them. Two books that we suggest are '**The Cuckoo's Egg**' by Cliff Stoll and '**Takedown**' by Tsutomu Shimomura.

COMPUTER SECURITY

With computer crimes on the rise, computer security has become an important concern for system administrators and computers alike. Computer security refers to protecting computer systems and the information they contain against unwanted access, damage, modification or destruction. According to a 1991 report of the American Congressional Research Service, computers have two inherent characteristics that leave them open to attack or operating error:

- ▲ A computer will do exactly what it is programmed to do, including revealing sensitive information. Any system than can be programmed can be reprogrammed by anyone with sufficient knowledge.
- ▲ Any computer can do only what it is programmed to do, it cannot protect itself from either malfunctions or deliberate attacks unless such events have been specifically anticipated and countered with appropriate programming.

Computer owners and administrators use a variety of security techniques to protect their systems, ranging from everyday low-tech locks to high-tech software scrambling. We will see some of these methods.

Physical Access Restrictions

One way to reduce the risk of security breaches is to make sure that only authorized personnel have access to computer equipment. Organizations use a number of tools and techniques to identify authorized personnel. The computer can perform some of these security checks; others are used by human security guards. Depending on the security system you might be granted access to a computer based on your identity card, user name and password, your voice print, retinal scans, fingerprints and so on. Since many of these security measures can be compromised, many systems use a combination of more than one control. For example, you might be asked to show your ID, unlock the door with a key and then type in your user name and password to use a secured computer.

In the days when corporate computers were isolated in basements, physical restrictions were sufficient for keeping out intruders. But in the modern scenario, computers and data are almost everywhere, and networks connect computers to the outside world. In a distributed and networked environment, security is much more problematic. It is not enough to restrict physical access to mainframes when the PCs and network connections are not restricted. Additional security techniques are needed to restrict access to remote computers.

Passwords

Passwords are the most common tool for restricting access to computer systems. We will see more about passwords and how computer criminals find the passwords a little later. Passwords are effective only if they are chosen carefully. Most computer users choose passwords that are easy to guess thus making the job of the unauthorized user easy. A growing number of security systems refuse to allow users to choose any real words as passwords, so hackers cannot use dictionary software to guess them systematically. Even the best passwords should be changed frequently.

Firewalls, Codes, Shields, and Audits

Many data thieves do their work without breaking into computer systems; they intercept messages as they travel between computers on networks. Passwords are of little use for hiding e-mail messages while they are bouncing off of satellite dishes or travelling through Internet links. Still Internet communication is far too important to sacrifice in the name of security. Many organizations use firewalls to keep their internal networks secure while allowing communication with the rest of the Internet. The technical details of firewalls vary considerably, but they are all designed to serve the same function: to guard against unauthorized access to an internal network. In fact, a firewall is a gateway with a lock—the locked gate is opened for information packet that passes one or more security instructions.

Of course, the firewall's digital drawbridge has to let some messages pass through; otherwise there could be no communication with the rest of the Internet. How can those messages be secured in transit? To protect transmitted information, many organizations use encryption software to scramble their transmissions. When a user encrypts a message by a secret numerical code, called an encryption key, the message can be transmitted or stored as an indecipherable garble of characters. The message can be read only after it has been reconstructed with a matching key.

For the most sensitive information, passwords, firewalls, and encryption are not enough. A diligent spy can 'listen to' the electromagnetic signals that emanate from the computer hardware and in some cases read sensitive information. To prevent spies from using these spurious broadcasts, the Pentagon has a program called Tempest to develop specially shielded machines.

Audit control software is used to monitor and record computer transactions as they happen, so auditors can trace and identify suspicious computer activity. Effective audit control software forces every user, legitimate or otherwise, to leave a trail of electronic footprints. Of course, this kind of software is of little value unless someone in the organization monitors and interprets the output.

Backups

Even the tightest security system cannot guarantee absolute protection of the data. Sabotage, human errors, power losses, machine failure, fire, flood, lightning and earthquakes can damage or destroy computer data along with hardware. Any complete security system must include some kind of plan for recovering from disasters. For mainframes and PCs alike, most widely used data recovery insurance is a system of making regular backups. For many systems, data and software are backed up automatically onto disks or tapes, usually at end of each working day. Most data processing shops keep several generations of backups so they can, if necessary, go back several days, weeks, or years to reconstruct data files. For maximum security, many computer users keep copies of sensitive data in several different locations.

Emerging Security Solutions

The migration from mainframes to personal computers is forcing experts to explore new security solutions. The PC's small size and physical accessibility can make it easy for criminals to steal the computer along with its data. Computer crime expert Donn Parker has suggested that, the companies install automated alarm systems that allow networked PCs to check on each other regularly and report any kidnapped machines. Security experts are constantly developing new technologies and techniques for protecting computer systems from computer criminals. But the same time, the criminals continue to refine their craft. In the ongoing competition between the law and the lawless computer security generally lacks behind. In the words of Tom Forester and Perry Morrison in Computer Ethics, "... computer security experts are forever trying to shut the stable door after the horse has bolted."

Human Security Controls

Ultimately, computer security is a human problem that cannot be solved by technology alone. Security is a management issue, and a manager's actions and policies are critical to the success of a security program. An alarming number of companies are lax about computer security. Many managers do not understand the problems and do not think they are at risk. It is important for managers to understand where the real threats are, make their employees aware of the problems, and build effective defenses against those threats.

CRIME AND SECURITY

We have seen that several types of computer crime scenarios exist. In some cases, the perpetrator has a legal right to operate the computer (such as an employee in a company), but uses it for unauthorized purposes. In other cases, the criminal gains unauthorized access to the computer, either by appearing that he belongs there or by breaking and entering. In a third type of crime, the criminal does not even have to be present; his programs find their way into the victim's computer and do the damage.

COMPUTER CRIME BY AUTHORIZED USERS

There are several ways an authorized user of a computer, such as an employee using the company's computer, can accomplish unauthorized and illegal objectives. One such way involves altering data as it is entered into the computer. Suppose you have a friend at the Records office at the University. You work out an arrangement that when he is entering your grades for the semester into the computer he change your actual grades. Only three people—you, your friend, and your teacher—know your actual grade, and the teacher is not likely to verify every grade on the roll, so there is little chance of getting caught.

Another crime is removing a copy of data from the system without evidence of removal. Imagine this scenario: You are about to graduate, and are applying for jobs. Employers will be requesting that you provide copies of your transcript. With your good grades this would be a good thing, except that the transcript also has an item indicating that you have been caught for copying and was banned for 6 months. You call your friend in the Records office, and he manages to "accidentally" delete that line from your transcript. Related stories are common in business, where friends of unscrupulous billing clerks have their charges "accidentally" deleted.

A variant of data leaking involves releasing the data to unauthorized parties. Suppose you are running for the political office. This time it is your opponent, who bribes the clerk in the Records office to snoop through your file and report anything, which he might be able to use against you. The Records clerk, seeing that you were caught for copying, forwards this information to your opponent.

An employee with access to the company's money management system via computer has an opportunity for embezzlement. However, if he adds a large sum to a customer's bill and diverts that amount to his personal account, he is likely to be caught. Therefore, a 'salami' technique is often employed. In this scheme, a small amount is skimmed off many accounts. A customer is not likely to notice a 0.50 rupee error in his bill (or is not likely to complain even if he does notice). If a billing diverts that 0.50 rupee to himself for each of the 2000 accounts he manages, he has made a 1000 rupees profit. (This technique is so named because the criminal is taking a small slice from account, much like taking a small slice from many salamis to make a meal.)

Disgruntled employees present a particular problem. An employee on his way out may the data on his computer, deleting customer records, bills owed, and so on, leaving a mess take months to straighten out. A related case is that of a disgruntled employee holding data For example, say a programmer, who has been developing a piece of software for a company and a half, is passed over for a raise. He could threaten not to deliver the final version of the to the company until his demands are met.

Preventing Employee Crime

Some tips to help prevent the scenarios described above:

- **Check references** — It is common to request three references when interviewing a employee; however, many employers never check these out. It is vital to call employers and get their assessment of the candidate's honesty.
- **Do not give two weeks' notice** — When firing an employee, it is common practice to two weeks' notice so he can begin looking for another job. In a computer-related field, this gives him two weeks to sabotage data, as well as copy data to sell to a competitor. employee is fired, have a security guard watch him clean out his desk, and then escort the door. This may mean giving him two weeks' pay for doing nothing, but this is better letting him stay around the office and potentially cause millions of rupees in damage sabotage.
- **Keep employee lists up to date** — Security guards get used to seeing the same day, and may let a former employee into an unauthorized (or formerly authorized because they think he still works there. It is important that security be kept up-to-date kind of personnel change.
- **Do not give more access than necessary** — Make sure that access to crucial data grades and payroll data is limited to those who must have it. For example, the programmer who wrote the grading program for the University is probably not the operator who scans in the grades. Therefore, even though he is involved in the process, he should access to the grades. (If he needs to test the program, he can generate his own sample this purpose, rather than using the actual data.)

COMPUTER CRIME THROUGH UNAUTHORIZED ACCESS

Someone who is not supposed to be using a computer network may gain access to it appearing that he/she belongs there, or by dialing or telnetting in and cracking a legitimate password.

Social Engineering

Hackers are not only great at computer programming and analysis; they're pretty good at too. The best hackers can walk into an office and gain the access they want without anyone them. Here are some examples of social engineering—outwitting legitimate users to gain access

- A hacker walks through the office. Dressed in business attire and perhaps armed with identity card, he wanders around without arousing suspicion. Everyone assumes he is employee. He snoops around the cubicles, paying attention to the area surrounding each employee's computer. He knows that many employees—especially non-computer-experts like secretaries—will write their username and password on a Post-It note and stick it on their monitor. Once he has located a username and password, he leaves, dials into the company modem bank, and gains access.

- A secretary receives a phone call from "technical support". The person asks if she has been experiencing problems with the computer system. Chances are she'll say yes—few computer systems in large offices run perfectly, and even when they do, inexperienced users will often blame the computer for their own mistakes. Now that the secretary's trust has been gained, the hacker says, "Give me your username and password and I will look into it." The secretary gives the information to the hacker.
- A legitimate user sits down at the computer. At the USERNAME: prompt, he types his username. At the PASSWORD: prompt, he types his password. The computer then replies, "Network not available right now" and the user walks away, grumbling about the stupid network not letting him log in. This user has just unknowingly given his username and password to a hacker who has written a program that looks identical to the normal login screen. However, this program has a hidden "feature"—it e-mails the username and password to the hacker. This is an example of a Trojan horse.

There are many, many more examples of social engineering. We will see how to lessen your chances of being outwitted. But first, let us point out that hackers may be able to get into your system without ever entering your building.

Cracking passwords

A good hacker is an effective researcher. He knows that names and words associated with you are good guesses for your password. He will learn who your friends are, what your interests are, what kind of jargon you use on the job. If that did not work, he may run a program called 'crack', which will try every word in the dictionary as your password. Here are some passwords to avoid:

- **Anything that resembles your username** — Sure, it is easy to remember, but for the same reason, it is easy to guess.
- **Proper names** — The crack program will check for common proper names. This does not mean it is OK to use a proper name that is not common, especially names of spouses, girlfriends, pets, etc. A good hacker will know what names are important to you.
- **Dictionary words** — Obviously bad choices, since 'crack' checks them.
- **Words of less than 6 characters** — A computer can check every possible combination of 5 characters or less in a short period of time.

Well, if all these are ruled out as potential passwords, what is left? Here are some passwords that are almost impossible for hackers to figure out:

- **Two short words run together** — There are too many words in the dictionary for the computer to try every combination of two words. Just make sure the words are unrelated, like KEYBOOK or CATCAR. Variations are to put a number or an underscore between the words (KEY7BOOK, CAT_CAR).
- **A purposely misspelled word** — The word PRESIDENT will appear in a good cracking program. The word PREZUHDINT will not. There are too many potential misspellings of each word. Just make sure you can remember your misspelling—do not write it on a Post-It note and place it on your monitor!

Tips for Defending Against Hackers

Given below are some guidelines to defend your system against hackers:

- ▲ Ask anyone who claims they are there to service the computers to show their identity ca
- ▲ Make a policy that passwords are never to be given over the phone – a network adminis does not need a user's password to diagnose problems.
- ▲ Make a policy that passwords are not to be left lying around near the computers.
- ▲ Implement caller ID technology. Make a list of all employee phone numbers. When so dials into the modem bank, hang up and compare the number that called in with the "good" numbers. If the number is on the list, call it back and establish a connection.
- ▲ Invest in a paper shredder to prevent snooping through the garbage.

MALICIOUS COMPUTER PROGRAMS

This is the third type of computer crime, where your systems can be sabotaged without anybody physically present. Some types of computer programs find their way into your computer, and out their instructions without your knowledge. These programs may be benign, simply prin message on the screen, or they may be malicious, reformatting your hard disk at an inoppo moment.

A **worm** is a program, which copies itself over and over, eventually causing the computer to when it runs out of RAM and/or hard disk space. An unfortunate incident occurred in 1988 w graduate student named Robert Morris wrote a worm for his thesis. He did not realize the com was hooked up to the Internet, and the worm crashed computers all over the network. It took a of weeks of diligent programming to repair the damage this worm caused. A **Trojan horse** program, which appears to have a useful function, but really has a secret malicious one. A example is the "Sexy Ladies" program for the Macintosh. Certainly the name inspires a lot of pe double-click on its icon. Instead of being rewarded with pictures of sexy ladies, though, its users see a "gotcha" message, and shortly thereafter, find that the data on their hard disk is gone. A b a virus, which waits a certain period of time before executing its code. It may wait for the access the computer a predetermined number of times before activating, or it may wait for a part date.

Defending Against Malicious Programs

You can buy or download anti-virus software, which will scan your disks and inform you programs it finds which looks like viruses or other malicious programs. In most cases you will b to remove the virus without harming your files (although it never hurts to have backups just in ca

Some anti-virus programs can be trained to scan a disk before the computer reads any data it – this way the virus never has a chance to infect your system. It is important to update your virus software regularly. An anti-virus program written on March 4 will not know about a written on March 5. Most virus software producers maintain bulletin boards or Internet sites you can download updates. A detailed discussion on viruses, anti-virus packages are given in Ch 32.

REVIEW QUESTIONS

Descriptive Type Questions

01. What is computer crime?
02. What are the different types of computer crimes?

03. What is software/hardware sabotage?
04. What is computer security?
05. What are the different security measures?
06. What are physical access restrictions?
07. What are the computer crimes committed by authorized users?
08. What is social engineering?
09. How to prevent employee crime?
10. How can an organization or individual defend against hackers?

in the Blanks

01. The explosive growth of ______________ is changing the demographics of computer crime.
02. ______________ is the illegal duplication of copyrighted software.
03. ______________ is the most common computer crime.
04. ______________ refers to protecting computer systems and the information they contain against unwanted access, damage, modification or destruction.
05. ______________ are the most common tool for restricting access to computer systems.
06. To protect transmitted information, many organizations use ______________ to scramble their transmissions.
07. A ______________ is a program which copies itself over and over, eventually causing the computer to crash when it runs out of RAM and/or hard disk space.
08. A ______________ is a program, which appears to have a useful function, but really has a secret malicious one.
09. A ______________ is a virus, which waits a certain period of time before executing its code.
10. ______________ is a gateway with a lock.

[**Answers:** (1) Internet (2) Software Piracy (3) Software Piracy (4) Computer security (5) Passwords (6) Encryption Software (7) Worm (8) Trojan Horse (10) Firewall]

ue or False

01. India has the fourth highest number of Internet users in the world.
02. A computer will do exactly what it is programmed to do, including revealing sensitive information.
03. Many data thieves do their work without breaking into computer systems.
04. A firewall is a type of password.
05. Passwords are effective only if they are chosen carefully.
06. An employee who is fired may sabotage the data on his computer.
07. A computer can do only what it is programmed to do.
08. In the ongoing competition between the law and the lawless, computer security generally lacks behind.
09. A complete security system must include some kind of plan for recovering from disasters.
10. A growing number of security systems refuse to allow users to choose any real words as passwords, so hackers cannot use dictionary software to guess them systematically.

[**Answers:** (1) True (2) True (3) True (4) False (5) True (6) True (7) True (8) True (9) True (10) True]

ıltiple Choice

01. Which of the following is a computer virus?
    (1) Logic Bomb (2) Worm (3) Trojan Horse (4) All of the above
02. What is a program which copies itself over and over, eventually causing the computer to crash?
    (1) Logic Bomb (2) Worm (3) Trojan Horse (4) None of the above

. A message is encrypted using a ___________.
(1) Password (2) Firewall (3) Shield (4) Key
. Which of the following is a technique used by hackers?
(1) Social studies (2) Social visits (3) Social engineering (4) None of the above
. Which of the following is a computer crime?
(1) Piracy (2) Sabotage (3) Hacking (4) All of the above

nswers: (1) Logic Bomb (2) Worm (3) Key (4) Social Engineering (5) All of the above]

CHAPTER 31

Cryptography

ICS COVERED

Introduction
Digital ciphers
Code breaking
Applications of encryption
Limitations of encryption

Key Points

▲ Cryptography does for electronic information what locks and lockers do for printed information. Information is protected by scrambling it in such a manner that it can be unscrambled only with a secret key.

▲ All encryption systems are built from two basic transformations—transpositions and substitutions. Transpositions (permutations) rearrange the bits or characters while substitutions replace bits, characters or blocks with substitutes.

▲ Data Encryption Standard (DES) developed by IBM is one of the most widely used encryption systems. Other widely used encryption systems include RC2, RC4 and RC5, all developed by RSA Data Security Inc.

▲ Encryption can be used to protect stored data, including complete files and objects within files or communications, including phone calls, fax transmissions, e-mail, web transactions, banking transactions, corporate extranets and other types of network applications.

RODUCTION

ptography does for electronic rmation what locks and lockers do printed information. Information is tected by scrambling it in such a nner, that it can be unscrambled with a secret key. The scrambled ssage called 'ciphertext' is totally ntelligible to anyone who does not w the key. The process of ducing the 'ciphertext' is called **ryption** and the reverse process of toring the original message called 'plaintext' is called **decryption**. A particular method of algorithm ncryption and decryption is called a **cryptographic system** or **encryption system** or **cipher**.

All encryption systems are built from two basic transformations—transpositions and stitutions. Transpositions (permutations) rearrange the bits or characters while substitutions lace bits, characters or blocks with substitutes. These transformations are keyed so that a single thod can be used with different keys to produce different results. To decrypt, one must know both method and the key under which it was encrypted. While the key is kept secret, the method is en made public, so that it can be shared by many people and implemented in hardware and tware products.

Consider the following example. Here an encryption system transposes a message in blocks of five racters each. The key to the system is a list specifying which plaintext character becomes the first hertext character, which the second and so on. For example if the key is (4 3 1 5 2), then the fourth intext character becomes the first ciphertext character and so on. For doing this first the plaintext is uped into blocks of five characters (ALEXIS LEON will become ALEXI SLEON) and the key is plied. So the plaintext 'ALEXIS LEON' will become 'XEAIL OESNL.' Decryption proceeds by versing the process.

The Caesar cipher illustrates a simple substitution cipher. Each letter alphabet is shifted forward 'K' positions, where 'K' is the key to the cipher (shifts past the end of the alphabet wrap around to the beginning). The cipher is named after Julius Caesar, who used it with K = 3. For example, the plain text 'ENCRYPTION' becomes 'HQFUBSWLRQ'. Decryption proceeds by shifting the ciphertext letters back by 'K' positions.

DIGITAL CIPHERS

Modern cryptographic systems are implemented with computer programs that have two inputs – the plaintext message and the key, both of which are represented as sequences of 0s and 1s. Following illustrates a digital substitution cipher. The plaintext message 'CAB' is represented as ASCII, where A=01000001, B=01000010 and C=01000011. The key is a random sequence of bits as long as the plaintext message. The encryption method is pair-wise addition, meaning that the first plaintext bit is added to the first key to produce the first ciphertext bit and so on. The addition proceeds without carries, i.e., 0 + 0 = 0, 0 + 1 = 1, 1 + 0 = 1 and 1 + 1 = 0. Normally, 1 + 1 would be '10' in binary. Without carries, the 1 is dropped, leaving behind only the 0 bit. This operation is the same as the 'exclusive' or XOR operation. The XOR operation yields 0 if two bits are the same (that is, 0 XOR 0 = O and 1 XOR 1 = 0) and 1 if the bits differ (that is, 1 XOR 0 = 1 and 0 XOR 1 = 1). So the CAB will be encrypted as follows:

	C	A	B
Plaintext	01000011	01000001	01000010
Key	11010001	01111001	00101011
Ciphertext	10010010	00111000	01101001

Note that the spaces between the letters are for readability only. The decryption process is exactly the same way as encryption; that is, each plaintext bit is computed as the XOR of its corresponding ciphertext and key bits. This is because subtraction without carries is equal to XOR. This encryption system is called a stream cipher because the key is a continuous stream of bits that is applied bitwise to the plaintext stream of bits.

The strength of an encryption system refers to its ability to withstand attack by someone who intercepts or seizes the ciphertext. With one exception, all encryption systems are at least theoretically breakable by trying all possible keys. However, this does not mean that they can be broken in practice. If the key length is sufficiently long, it is not feasible to test each and every key. In practice, the strength of a system needs only to be commensurate with the risk and consequence of breakage.

The one system that cannot be broken, even in theory, is the **'one-time pad'**. The one-time pad uses randomly generated key stream, also called **keypad**, as long as the message and never uses the same keypad more than once. The operation is XOR as illustrated above. To guarantee perfect secrecy, a truly random process must generate the keypad. The one-time pad is impractical in most cases because of the difficulties in getting the keypad to the receiver over a secure channel. Instead, stream ciphers simulate a one-time pad by using a pseudorandom generator, which may or may not be secure.

Data Encryption Standard (DES)

One of the most widely used encryption systems has been the Data Encryption Standard (DES). The system encrypts 64-bit blocks using 56-bit keys. First 64 bits are permuted. Then they go through a complex process that is repeated 16 times. Finally, all the 64 bits are permuted again, producing the ciphertext block. During each of the 16 repetitions or 'rounds' as they are called, the right half of the input block is used to create a short keypad that is XORed with the left half. The keypad is generated and encrypted under the sought-after key, an even more powerful 'chosen-plaintext' attack can be employed. In the absence of any plaintext, the code breaker must resort to a 'ciphertext-only' attack. The strongest encryption systems are designed on the assumption that the code breakers have known plaintext and can acquire the ciphertext for a chosen plaintext. The known-plaintext assumption is not unrealistic; messages often follow standard formats, for example, beginning with certain keywords such as 'login.' A chosen-plaintext attack is much harder to conduct, as it generally requires access to the encryption product so that the code breaker can submit plaintext and get back encrypted ciphertext.

Another way of getting the key is using brute force, that is, trying all possible keys until the right one is found. In general, if the key length is not more than 33 bits (about 8 billion possibilities) one can expect to find it within a day on an ordinary PC. At 56 bits (about 70,000 trillion possibilities), one needs a supercomputer.

APPLICATIONS OF ENCRYPTION

Encryption can be used to protect stored data, including complete files and objects within files or communications, including phone calls, fax transmissions, e-mail, web transactions, banking transactions, corporate extranets and other types of network applications. Some encryption systems will encrypt everything on a hard disk so that the computer is effectively unusable without knowing the key. Encrypting files and complete disks is particularly useful with laptop computers. If the computer is stolen, sensitive data will not be exposed.

Encryption is available in both hardware and software implementations. They can be obtained as stand-alone encryption devices and software packages or as a feature of other products. Many software applications and utility programs support encryption including software for word processing, spreadsheets, file management, databases, web browsing, e-mail, and Internet telephony. Increasingly, computer software comes with built-in encryption.

Communications can be either end-to-end encrypted or link encrypted. End-to-end encryption provides a secure channel between the end points of a message regardless of how many computers or links the message traverses. E-mail is usually end-to-end encrypted. Link encryption protects a message across a single link or sub-network but not across the entire path. Its advantage is that the endpoints need not support encryption or have compatible encryption. Global System for Mobile (GSM), which is used worldwide for digital cellular communications, uses link encryption to protect the over-the-air link between a mobile phone and a base station, which is the segment most prone to interception. The wireless link is encrypted regardless of whether the person at the other end of the conversation is using a cell phone or GSM. Between base stations, the communications travel through the public telephone network, where segments may or may not be independently encrypted.

One increasingly popular application of encryption is **Virtual Private Networks** (VPNs). A VPN connects the geographically dispersed facilities (networks) of an enterprise over a public network like the Internet. It essentially provides secure global communications across the enterprise without the need for private leased lines. The VPN can be implemented with dedicated hardware or with software or it can be integrated into a firewall. A VPN is a cheaper alternative to leased lines. VPN over the Internet can be implemented using IP-layer encryption.

The **Secure Socket Layer** (SSL) protocol is used extensively on the web to protect credit card numbers and other sensitive data transmitted between a user's web browser and an Internet web server through the HTTP protocol. SSL supports different encryption systems and key lengths. The protocol is bundled into the web browsers, so it does not depend on the host computer to support encryption. With SSL, a credit card number is encrypted by the customer's computer and decrypted e merchant's. With the number in hand, the merchant then charges the purchase against the account. is process has a weakness. Insiders and intruders with access to the merchant's customer records n potentially compromise the card number.

The **Secure Electronic Transaction** (SET) protocol addresses this vulnerability in SSL by providing encrypted channel between the customer and the bank. Upon receipt of an order, the merchant rwards the encrypted payment information to the bank. The bank decrypts the message, validates e payment information, and informs the merchant whether to go ahead with the sale. With this proach, a customer's credit card number is never made available to the merchant and never exposed the merchant's web site or available to the merchant.

MITATIONS OF ENCRYPTION

icryption is a powerful method for protecting data in transit or stored on media that are vulnerable snooping or seizure. Nevertheless, it has two fundamental limitations. First, it cannot protect data hile they are being processed on a computer. This is because data must be in the clear in order to be anipulated. Although it is possible to design encryption systems that allow operations to be rformed on ciphertext, such systems will either be weak or have extremely limited functionality. The nsequence of processing data in the clear is that if an intruder can gain access to the computer, the truder may be able to pick up sensitive data as it is being typed in or processed. One way this might done is with a keyboard sniffer program. These programs record the key stokes that you make on e keyboard and could send them over the Internet to the people who wrote them. A second nitation of encryption is that it can be no better than the weakest link. Even if the encryption gorithm is excellent, the implementation could be flawed or the key management system weak.

REVIEW QUESTIONS

escriptive Type Questions

01. What is cryptography?
02. How is encryption done?
03. What is code breaking?
04. What are the advantages of cryptography?
05. What are the limitations of cryptography?

ll in the Blanks

01. All encryption systems are built from two basic transformations ____________ and ____________.
02. DES stands for ____________.
03. The expansion of SSL is ____________.
04. SET is the abbreviation of ____________.
05. The expansion for VPN is ____________.

[**Answers:** (1) Transpositions, Substitutions (2) Data Encryption Standard (3) Secure Socket Layer (4) Secure Electronic Transaction (5) Virtual Private Network]

rue or False

01. Cryptography does for electronic information what locks and lockers do for printed information.
02. The encrypted message called plaintext is totally unintelligible to anyone who does not know the key.
03. The process of producing the ciphertext is called decryption and the reverse process of restoring the original message called plaintext is called encryption.

04. Encryption systems are also called ciphers.
05. GSM stands for Global System Management.
[Answers: (1) True (2) False (3) False (4) True (5) False]

Multiple Choice

01. A particular method of algorithm of encryption and decryption is called a ________.
    (1) Cryptographic System (2) Encryption System (3) Cipher (4) All of the above
02. Which of the following is an encryption system?
    (1) EDS (2) DES (3) EFR (4) None of the above
03. Which of the following is a DES model?
    (1) Output Feedback (2) Cipher Feedback (3) Cipher Block Chaining (4) All of the above
04. DES was developed by ________.
    (1) Microsoft (2) IBM (3) Google (4) None of the above
05. Which of the following is used to send credit card information over the Internet?
    (1) SCM (2) SEI (3) SSL (4) None of the above

[Answers: (1) All of the above (2) DES (3) All of the above (4) IBM (5) SSL]

CHAPTER 32

Computer Viruses, Bombs, and Worms

PICS COVERED

Key Points

▲ A computer virus is a computer program that can copy itself and infect a computer without the permission or knowledge of the user.

▲ A worm can spread itself to other computers without needing to be transferred as part of a host, and a Trojan horse is a program that appears harmless but has a hidden agenda. Worms and Trojans, like viruses, may cause harm to a computer system's hosted data, functional performance, or networking throughput, when they are executed.

▲ There are three major categories of viruses—boot sector, program, and macro—named after the types of hosts they infect. Multipartite viruses combine the first two, infecting both program files and boot sectors.

▲ The most popular technique to detect viruses is by scanning. Some of the most popular anti-virus vaccines are McAfee Internet Security from McAfee, Inc., Norton Internet Security from Symantec Corporation, Internet Security from Trend Micro, etc.

TRODUCTION

us is the generic term that people using these days to describe a up of willfully destructive puter programs. A **computer** is a computer program that can y itself and infect a computer hout the permission or knowledge the user. The term "virus" is also mmonly but erroneously used to refer to other types of malware, adware and spyware programs t do not have the reproductive ability. A true virus can only spread from one computer to another en its host (some form of executable code) is taken to the target computer, for instance, a user sent it r a network or the Internet, or carried it on a removable medium such as a floppy disk, CD, or USB ve. Viruses can increase their chances of spreading to other computers by infecting files on a twork file system or a file system that is accessed by another computer.

Viruses are sometimes confused with computer worms and Trojan horses, which are technically ferent. A worm can spread itself to other computers without needing to be transferred as part of a st, and a Trojan horse is a program that appears harmless but has a hidden agenda. Worms and ojans, like viruses, may cause harm to a computer system's hosted data, functional performance, or tworking throughput, when they are executed. Some viruses and other malware have symptoms ticeable to the computer user, but most are surreptitious. This makes it hard for the average user to tice, find and disable it and which is why specialist anti-virus programs are now commonplace. st personal computers are now connected to the Internet and to local area networks, facilitating the read of malicious code. Today's viruses may also take advantage of network services such as the orld Wide Web, e-mail, Instant Messaging and file sharing systems to spread, blurring the line

ween viruses and worms. Furthermore, some sources use an alternative terminology in which a
us is any form of self-replicating malware.

The first PC virus in the wild was a boot sector virus called Brain, created in 1986 by the Farooq
i Brothers, operating out of Lahore, Pakistan. Brain spread via infected floppy disks and was a
tively innocuous nuisance in contrast to modern Trojan, rootkits and other malware. The
earance of the first Windows malware nonetheless sets in a chain of events that led up to today's
iputer virus landscape. Boot sector viruses ceased to appear when floppy discs went out of fashion
they continued to be a nuisance between 1986 and 1995, when internet technology started to
etrate the consumer market. These types of viruses relied on people to exchange infected discs and
s outbreaks often took months to spread. The creation of macro viruses, which exploited security
knesses in Microsoft Word and other applications, meant that malware outbreaks peaked after
i instead of weeks and months. Macro viruses ruled the roost for around four years between 1995
1999 before e-mail became the main vector for viral distribution.

Harnessing the internet meant that the time it took the first e-mail worms, such as the Love Bug to
ad dropped from days to hours. Email worms such as the Love Bug and Melissa caused
spread disruption and confusion in 1999 before they were brought to heel. By 2001, network
ns such as Blaster were created that automatically and indiscriminately infected Windows PCs
out adequate protection. E-mail and network worms remain a problem today but the greatest
lem these days is posed by key-logging Trojans designed to snoop on user's private information
as online account details, and the many strains of malware that turn infected PCs into zombie
s under the control of hackers.

he three most common types of destructive computer programs are the Trojan horse, the logic
, and the worm. A virus is just a worm with a logic bomb or Trojan horse component. A worm is
gram that replicates itself. It creates an image of itself either in a file or at a particular location on
sk. Why bother duplicating itself? The original worm was intended only to be an experiment. **Trojan horse** program acts like the Trojan horse of Greek mythology. A malevolent program is hidden
another, apparently useful program. While the "useful" program is running, the malevolent
oes something nasty, like erase your FAT and directory. A **bomb** is a piece of code embedded in
gram or the operating system itself that waits for a particular event to occur. When that event
, the logic bomb "goes off," doing some kind of damage.

ou can also classify viruses by their preferred habitat. Some viruses attach themselves to other
ams; these are known as **parasitic viruses**. Others, which prefer lodging in the boot sector of
oppy or hard disk, are known as **boot sector viruses**. Parasitic viruses start when the executable
which they are attached is run. Some viruses have multiparts to them; the first part hides the
and another part that would change the first part into a virus. Boot sector viruses generally
hard drives. Once the computer reads the boot sector, the virus wakes up and springs into
Even if you do not boot from a certain drive/partition the computer will still read the boot
and activates the virus. Some viruses are called "**Stealth**" viruses. They get the name because
py a part of a program that gets replaced with the virus and once a virus scan is run, the virus
lace itself with the code that it replaced. Viruses can seem mysterious but computer viruses are
quite easy to understand. We have seen the definition of different types of viruses. In this
we will see exactly what viruses are, how they work, and how to protect against them.

uses are actually very simple. Once you understand exactly what they can and cannot do, it is
asier to take appropriate precautions. Viruses and anti-virus programs are both software
s, the only difference is that one is designed to cause damage, while the other is developed to

event the damage and protect your computer systems. Today computers are everywhere, so are the ruses; so it is critical that we all fully grasp how they work; so as to protect our machines and data.

'HAT DO VIRUSES DO?

ruses are potentially destructive software that spreads from program to program or from disk to sk. Computer viruses, like biological viruses, need a host to infect; in the case of computer viruses is host is an innocent program. If such a program is transferred to your computer, other programs on ur computer will become infected. Even though some viruses do not intentionally damage your ta, we must consider all viruses to be malicious software; since they modify your programs without ur permission with occasional disastrous results.

The bottom line is that; if you have a virus, you are no longer in control of your computer. Every me you boot your computer or execute a program the virus may also be executing and spreading its fection. While most viruses have not been written to be destructive, almost all viruses can cause amage to your files—mostly because the viruses themselves are very poorly written programs. If iruses destroy nothing else, they destroy your trust in your computer—something that is quite aluable.

Viruses are a problem but they are not the main thing that you should be concerned about. There re many other threats to your programs and data that are likely to harm much more than viruses. roblems such as hardware glitches, software conflicts, software bugs, and even typos are much more kely to cause undetected damage to your data than viruses. It is a fact that there are many more ccurrences of data corruption from other causes than from viruses. So, does this mean that viruses are othing to worry about? Emphatically, no! It just means that we need to address the other threats to ur data as well as viruses. Because viruses have been deliberately written to invade and possibly lamage your computer, they are the most difficult threat to guard against. It is pretty easy to nderstand the threat that disk failure represents and what to do about it, but the threat of viruses is nuch more difficult to deal with.

/IRUS PREVENTION GUIDELINES

t is important to keep viruses in perspective. They are, but one threat to your data and programs. They need not be regarded as mysterious and they are quite easy to understand. Here are a few tips to eep in mind when considering viruses:

- You can only get a virus by executing an infected program or booting from an infected CD, DVD, diskette or portable storage device. Any portable storage device can be infected by a boot sector virus, even non-bootable storage devices.
- You cannot get a virus simply by being on a Bulletin Board Service (BBS), the Internet, or an online service. You will only become infected, if you download an infected file and execute that file.
- Most viruses are transferred by booting from an infected CD, DVD or diskette (e.g., Stoned, Form, Stealth-B, AntiExe, Monkey). Remove the portable storage media like CDs, DVDs, or diskettes from their drives as soon as you are through with their use. If your CMOS permits it, change your boot order to boot from your hard disk first. If you do not know what CMOS is, check the manual of your computer; there is normally an option when you boot your computer to hit a specific key to enter CMOS setup. This allows you to change many options on your computer.

▲ Make sure you have at least two backups for all of your files. Backups are essential not o safely recover from virus infections, but also to recover from the other threats to your dat

▲ Be sure to check all new software for viruses. Even shrink-wrapped software from a publisher may contain a virus.

TYPES OF VIRUSES

Computer viruses are a specific type of program written deliberately to cause harm to some computer or to use that computer in an unauthorized way. There are many forms of mali software; sometimes the media calls all malicious software viruses, but it is important to under the distinction between the various types. Let us examine the different types of malicious softwar

▲ **Logic Bombs** — Just like a real bomb, a logic bomb will lie dormant until triggered by event. The trigger can be a specific date, the number of times executed, a random numb even a specific event such as deletion of an employee's payroll record. When the logic bo triggered it will usually do something unpleasant. This can range from changing a ra byte of data somewhere on your disk to making the entire disk unreadable. The changi random data on disk may be the most insidious attack since it would do a lot of da before it would be detected.

▲ **Trojans** — These are named after the Trojan horse, which delivered soldiers into the c Troy. Likewise, a Trojan program is a delivery vehicle for some destructive code (such logic bomb or a virus) onto a computer. The Trojan program appears to be a useful prog but when a certain event occurs, it will attack your computer in some way.

▲ **Worms** — A worm is a self-reproducing program that does not infect other programs virus will, but instead creates copies of itself, which in turn create even more copies. Thes usually seen on networks and on multi-processing operating systems, where the worm create copies of itself, which are also executed. Each new copy will create more copies qu clogging the system. The infamous Morris ARPANET/INTERNET "virus" was actua worm. It created copies of itself through the ARPA network, eventually bringing the net to its knees. It did not infect other programs as a virus would, but simply kept creating co of itself, which would then execute and try to spread to other machines.

CHARACTERISTICS OF VIRUSES

Viruses come in great many different forms, but they all potentially have two phases to execution—the infection phase and the attack phase.

When the virus executes, it will infect other programs. What is often not clearly understo precisely when it will infect the other programs. Some viruses infect other programs each time they executed, other viruses infect only upon a certain trigger. This trigger could be anything; it could day or time, an external event on your computer, a counter within the virus etc. Some viruses are selective about when they infect programs; this is vital to the virus's survival. If the virus infects often, it is more likely to be discovered before it can spread far. Virus writers want their program spread as far as possible before anyone detects them. So it is a serious mistake to execute a progra few times, find nothing infected and presume there are no viruses in the program. You can neve sure that the virus simply has not triggered its infection phase!

Many viruses go resident in the memory of your computer just as a TSR (Terminate and S Resident) program. This means the virus can wait for some external event such as inserting a CD DVD, copying a file, or executing a program to actually infect another program. This makes th viruses very dangerous, since it is hard to guess what trigger condition they use for their infection. Resident viruses frequently corrupt the system software on the computer to hide their existence.

The second phase is the attack phase. Many viruses do unpleasant things such as deleting files or changing random data on your disk, simulating typos or merely slowing your computer down; some viruses do less harmful things such as playing music or creating messages or animation on your screen. Just as the virus's infection phase can be triggered by some event, the attack phase also has its own trigger. Viruses usually delay revealing their presence by launching their attack only after they have had ample opportunity to spread. This means, that the attack may be delayed for years after the initial infection.

The attack phase is optional; many viruses simply reproduce and have no trigger for an attack phase. Does this mean that these are "good" viruses? No, unfortunately not! Anything that writes itself to your disk without your permission is stealing storage and CPU cycles. This is made worse since viruses, which "just infect", with no attack phase, damage the programs or disks they infect. This is not intentional on the part of the virus, but simply a result of the fact that many viruses contain extremely poor quality code.

One of the most common viruses, the 'Stoned' virus is not intentionally harmful. Unfortunately the author of the virus did not anticipate anything other than 360 K floppy disks, with the result that the virus will try to hide its own code in an area on 1.2 MB or 1.44 MB diskettes, which causes corruption of the entire diskette.

CATEGORIES OF VIRUSES

There are three major categories of viruses—boot sector, program, and macro—named after the types of hosts they infect. Multipartite viruses combine the first two, infecting both program files and boot sectors.

Boot Sector Viruses

A boot sector virus is a computer virus which infects the boot sector on hard disks, floppy disks, and theoretically also other bootable media such as CDs and DVDs. Every disk has a boot sector and so is potentially vulnerable to infection. Once the hard disk of a machine has been contaminated, the virus will be activated every time the machine is powered on. It will install itself in the memory and turn control over to the normal boot code. The virus subsequently infects any floppy, CD, DVD, or removable storage devices like USB drives that are inserted into the machine.

A boot sector virus need not be able to successfully boot the victim's computer to infect it. Because of this, even non-bootable media can spread a boot sector virus. Once the infected computer successfully boots, the boot sector virus stays in memory and infects floppies and other media when they are written to by the infected computer. Boot sector viruses have become increasingly less common as floppy disks have become rarer.

Program Viruses

A program virus contaminates files that contain computer code, especially '.exe' and '.com' files, but also files such as '.sys', '.dll' and '.ovl'. Whenever the user starts an application that runs the infected file, the virus is unleashed. For example, if the file 'netscape.exe' becomes infected, the virus will be activated every time the user starts Netscape. Program viruses can spread through any medium that is used to transport software, including floppy disks, CD-ROMs, e-mail attachments and network downloads. About 85 percent of the more than 10,000 known viruses are program viruses.

Macro Viruses

There is particular type of file virus that that many people do not understand. These are the files from the Microsoft Office applications (e.g., MS Word, MS Excel, MS Access, etc.). These programs all have their own macro languages (a BASIC like language) built in. The associated files (MS Word documents or templates and MS Excel spreadsheet files) are usually thought of only as data files so many people are surprised that they can be infected. But these files can contain programs (the macro language) that are executed when you load one of these files into the associated product. The program inside of these files is interpreted by the MS Office application. What is now a language originally began as a very simple macro language that the user could use to combine keystrokes to automate some routine. The macro language in these products has since grown substantially and now is a fully capable language based on Visual Basic (VBA). Since a virus can potentially infect anything that contains a program, these files can harbor viruses.

What gives these viruses a chance to execute is the fact that, Microsoft has defined special macros that will automatically execute. The mere act of opening an infected MS Word document or an infected MS Excel spreadsheet can allow the virus macros to be executed. Macro viruses have been very successful because most people regarded spreadsheets and documents as data, not as programs.

ANTI-VIRUS SOFTWARE OR VIRUS VACCINES

There are several techniques that can be used to detect or eliminate viruses. Each technique has its strengths and weaknesses. It is vital to understand exactly how much protection your anti-virus software can offer you. It would be ideal if anti-virus software actually stopped viruses from infecting your computer. One type of software (the interceptor) attempts this but it is no longer regarded as a primary defense against viruses since viruses can easily bypass this type of protection. The other anti-virus techniques attempt to detect viruses. If you can detect an existing virus, you can remove it and prevent it from spreading. The most popular technique to detect viruses is by scanning. Some of the most popular anti-virus vaccines are McAfee Internet Security from McAfee, Inc., Norton Internet Security from Symantec Corporation, Internet Security from Trend Micro, etc.

Virus Scanners

Once someone has detected and analyzed a virus, it is possible to write programs that look for telltale code (signature strings) characteristic of the virus. Remember, a virus must add its code to the infected file or boot sector. The writer of the scanner extract identifying pieces (signature strings) from code that the virus inserts. The scanner uses these signature strings to search memory, your files and system sectors. If there is a match, the scanner announces that it has found a virus. This obviously detects only known, pre-existing, viruses and may result in a false virus indication (false positive) if an innocent program contains code similar to a virus.

A major drawback to scanners is that it is hazardous to depend upon an old scanner. With the dramatic increase in the number of viruses appearing (more than 6,000 different viruses as this is being written), it is risky to depend upon anything other than a current scanner. Even that latest scanner is necessarily a step behind the latest crop of viruses since a lot of events have to occur before the scanner is ready to handle the new virus:

- The virus has to be detected somehow to begin with. Since the existing scanners cannot detect the new virus, it has time to spread before someone detects it by other means. This requires something other than a scanner to detect the virus to begin with. If everyone depended only upon scanning, new viruses might never be detected.

- The newly discovered virus must be sent to the programmers to analyze and extract a suitable signature string. This string must be tested for false positives on legitimate programs.
- This string must be incorporated into the next release of the virus scanner.
- The virus scanner must be distributed to the customer.
- For some viruses it is impossible to isolate a small section of code to use as a signature string. These viruses are called polymorphic and require the writer of the scanner to write special code to recognize this virus. This requires a lot more work than simply isolating a signature string to scan for the virus.
- In the case of retail software, the software must be sent to be packaged, to the distributors, and then on to the retail outlets. Commercial retail software may take so long to get to the shelves that it is important to check that you are buying a recent version. Check the dates on the files and if they are fairly old be sure to get an update to the software. Do not assume the software is current just because it was freshly purchased.

Scanning is the only technique that can recognize a virus while the virus is still safely sitting on a diskette or in an upload directory. Therefore, scanning is the primary automatic technique that BBS sysops and software librarians use to check new programs. If scanning is your only defense against viruses, you can dramatically improve the odds that you will detect a new virus by using two or more scanners. If you run any scanner there will be many viruses missed by that scanner, but if you run the current releases of two or three best scanners the chances of missing the virus is less.

Disinfectors

Most vendors who sell scanners also sell a disinfector (often it is the same program). A disinfector has the same limitations that a scanner has, in that it must be current to be safe to use and it is always one step behind the latest crop of viruses. The disinfector, however, has an even bigger disadvantage: many viruses simply cannot be removed without damaging the infected file. There have also been many reports that files are still damaged even when the program claims to have disinfected the file. A disinfector like a scanner can be a very handy tool in your anti-virus arsenal, but it must be used with care. If you use a disinfector, be sure you have the latest version and be sure to use a tool to verify that all files and system sectors are correctly restored.

There are a large number of viruses that no product can disinfect or remove from infected files at all. These viruses modify the programs in such a way that removal is not possible. The most common of these are the viruses that overwrite part of the programs they infect. The only way to remove these viruses is to restore the infected files from a backup. It is ironic that even the most common program virus of all will not be safely disinfected from all files. One of the oldest and most common program viruses is the Jerusalem (1813) virus. Naturally all disinfectors claim to be able to remove Jerusalem and its many variants. While Jerusalem will be correctly removed from many programs, there are some programs from which Jerusalem cannot be removed without damaging the original program. In spite of this, most (if not all) disinfectors claim to disinfect Jerusalem infected programs.

Disinfectors are helpful, but they should be viewed only as an aid. Disinfectors cannot remove many viruses at all and cannot remove even the most common viruses from some files; it is simply not safe to expect a disinfector to be able to remove viruses from files. A further problem with many disinfection programs is that some of your programs may no longer work after being disinfected yet the disinfector gives you no indication that it has failed to correctly restore the original program. You can more safely use a disinfector if you have the capability to verify that the original file was correctly rebuilt. Unless you have a product capable of full integrity checking, we strongly suggest that you restore your files from a backup, rather than depending upon the disinfector to do the job correctly.

caused by a virus. These products use scanning and other anti-virus techniques along with integrity checking to improve its intelligence and ease of use.

REVIEW QUESTIONS

Descriptive Type Questions

01. What is a computer virus?
02. What is a logic bomb?
03. What is a worm?
04. What are Trojan horses?
05. What is a parasitic virus?
06. What is a boot sector virus?
07. What is a macro virus?
08. What are ant-virus vaccines?
09. What is a disinfector?
10. What is an integrity checker?

Fill in the Blanks

01. A ____________ is a piece of code embedded in a program or the operating system itself that waits for a particular event to occur.
02. Viruses that attach themselves to other programs are known as ____________.
03. The infamous Morris ARPANET/INTERNET "virus" was actually a ____________.
04. All viruses have two phases to their execution, the ____________ and the ____________.
05. TSR stands for ____________.

[**Answers:** (1) Bomb (2) Parasitic viruses (3) Worm (4) Infection, Attack (5) Terminate and Stay Resident]

True or False

01. The original worm was intended only to be an experiment.
02. A virus is just a worm with a logic bomb or Trojan horse component.
03. Resident viruses frequently corrupt the system software on the computer to hide their existence.
04. Any piece of executable code can suddenly become a Trojan delivery vehicle for the virus.
05. Viruses can remain dormant on your machine for years before they start attacking.

[**Answers:** (1) True (2) True (3) True (4) True (5) True]

Multiple Choice

01. Which of the following is a virus?
    (1) Trojan Horse (2) Worm (3) Bomb (4) All of the above
02. Which of the following will trigger at a specified time or at occurrence of a specified event?
    (1) Trojan Horse (2) Worm (3) Bomb (4) None of the above
03. Which virus infects the boot sector and related areas on a hard or floppy disk?
    (1) Boot sector virus (2) Cipher virus (3) Inoculators (4) All of the above
04. Which of the following is an anti-virus software?
    (1) Scanner (2) Integrity checker (3) Disinfector (4) All of the above
05. Which of the following is a virus vaccine?
    (1) McAfee (2) Happy99 (3) Brain (4) None of the above

[**Answers:** (1) Bomb (2) Bomb (3) Boot sector virus (4) All of the above (5) McAfee]

CHAPTER 33

Introduction to Multimedia

TOPICS COVERED

- Introduction
- Multimedia
- Multimedia systems
- Multimedia elements
- Multimedia authoring tools
- Types of presentations

> **Key Points**
>
> ▲ Multimedia is typically used to mean the combination of text, sound, and/or motion video. Multimedia has entered the mainstream because of its capability to attract people and to hold their attention.
>
> ▲ Multimedia is widely used in the entertainment and education fields. For entertainment, one can play computer games that are almost lifelike, complete with sound and motion. Now, full-length animated movies are made using multimedia tools and computers.
>
> ▲ A multimedia system is a system capable of processing multimedia data and applications. A multimedia system is characterized by the processing, storage, generation, manipulation and rendition of multimedia information.
>
> ▲ Interactive multimedia can weave five basic types of media into a multimedia production—text, graphics, images, audio, video and animation.
>
> ▲ Multimedia is being used extensively in all most all fields from entertainment to education.

INTRODUCTION

The word "Multimedia" simply means being able to communicate in more than one way. All of us give multimedia presentations without being aware of it. For example, if you rub your temples while telling someone that you have a headache or when you point to a diagram on a board whilst speaking to a class of students, you are using multimedia to get your point across.

So, multimedia is all about communicating in several ways. Your computer is capable of fla[...] text and beeping when there is a problem. It is already a multimedia computer—anything el[...] matter of degree. In other words, the more capable is your computer at handling sound, vide[...] graphics the better your multimedia packages will look. The origin of multimedia can be traced [...] to computer games, but today it plays a major role in varied areas such as interactive co[...] computer based training, presentations, interactive and dynamic web pages, and so on. Multime[...] one of the fastest growing and most exciting areas in the field of information technology. Thous[...] people are putting together text, pictures, animations, movies and sound to create mul[...] presentations, courses, interactive web pages and so on. The results of these efforts range from s[...] slide shows to dazzling, breathtaking, awe-inspiring and interactive presentations.

Not too long ago, the term multimedia referred to a room having slide projectors, ov[...] projectors, tape decks, and movie projectors. Multimedia presentations were hard to put togethe[...] even harder to run. Many of them took weeks of preparation and required special skills. The co[...] has changed all of that. Now multimedia is moving to the center stage. It is now easier to m[...] multimedia presentation on the computer and it does not need any special skills. Anybody w[...] familiar with the computer can create reasonably good multimedia presentations—the one's w[...] used to take weeks—very quickly.

MULTIMEDIA

Multimedia is the field concerned with the computer controlled integration of text, graphics, drawings, still and moving images (video), animation, audio, and any other media, where every type of information can be represented, stored, transmitted and processed digitally. A **multimedia application** is an application, which uses a collection of multiple media sources e.g. text, graphics, images, sound/audio, animation and/or video.

Multimedia, as we have seen, is the convergence of various methods of communication. It utilizes several formats at once—including text, video, spoken word, sound and music. In many cases multimedia is used interactively. This means that the viewer's actions control what he or she sees and hears whilst experiencing the multimedia program. By using touch applications we create a Man-Machine Interface (MMI). This technology is intuitive and efficient in conveying the information, or message across to the user in a simple manner.

Multimedia is widely used in the entertainment and education fields. For entertainment, one can play computer games that are almost lifelike, complete with sound and motion. Now full-length animated movies are made using multimedia tools and computers. Movies like *'Bee Movie'*, *'Kung Fu Panda'*, *'Ratatoullie'* and *'Cars'* are examples of the possibilities of multimedia in entertainment. In education, interactive multimedia programs allow one to study and progress at his/her own pace and branch into areas of interest when he/she wants to.

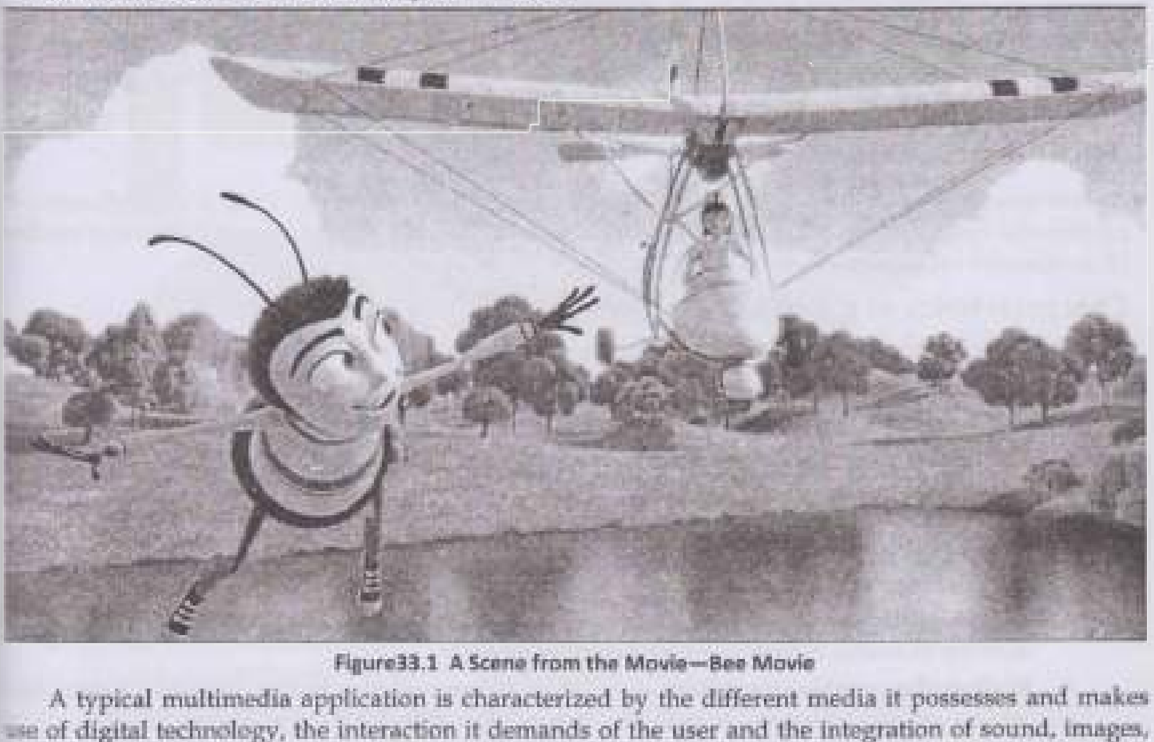


Figure33.1 A Scene from the Movie—Bee Movie

A typical multimedia application is characterized by the different media it possesses and makes use of digital technology, the interaction it demands of the user and the integration of sound, images, text and data into seamless applications.

The multimedia is now approachable to the common man—a person who does not have any formal training in multimedia tools. Now you can develop professional looking multimedia presentations using tools like Microsoft PowerPoint, Lotus Freelance Graphics and so on. One ca embed sound or video into spreadsheets and word processor documents.

Multimedia has entered the mainstream because of its capability to attract people and to hold the attention. Multimedia presentations are more effective than an ordinary presentation using charts a white board. Today, multimedia is used everywhere from business presentations to movies. It is us for training, employee orientation and marketing.

In the pre-multimedia era, various media have been developed to inform as well as entertai paintings, movies, books, magazines, newspapers, radio, photography, etc. Using compu multimedia fuses two or more of these media together on the premise that the combination is be than any of the individual components. Multimedia can be used for entertainment, corpo presentations, sales presentations, education, training, simulations, kiosks, digital publica electronic reference materials and so on.

Why Use Multimedia?

The deployment of multimedia to establish an indelible impression on one's mind is the m successful means of getting a message across. How quickly the human brain recalls a message dep on the impact of the message when it was first introduced. In today's very competitive comme arena, multimedia is the obvious choice, when it comes to promoting and marketing your busine will launch your product or services to the fore providing that edge over other challeng Multimedia also helps to demonstrate subjects that require time and movement to understand working of a machine), supports different learning styles, adds interest to learning materials supports those with special needs.

MULTIMEDIA SYSTEMS

A **multimedia system** is a system capable of processing multimedia data and applicatio multimedia system is characterized by the processing, storage, generation, manipulation and rend of multimedia information.

Characteristics of a Multimedia System

A multimedia system has four basic characteristics:

- Multimedia systems must be **computer controlled**.
- Multimedia systems are **integrated**.
- The information they handle must be represented **digitally**.
- The interface to the final presentation of media is usually **interactive**.

Features of a Multimedia System

The following features are desirable (if not a prerequisite) for a multimedia system:

- **Very high processing power** — Needed to deal with large data processing and real ti delivery of media. Special hardware commonplace.
- **Multimedia capable file system** — Need to deliver real-time media. Example: Video/Au Streaming. Special hardware/software needed. Example: RAID technology.
- **Data representations/file formats that support multimedia** — Data representations/fi formats should be easy to handle yet allow for compression/decompression in real-time.
- **Efficient and high I/O** — Input and output to the file subsystem needs to be efficient and fa Needs to allow for real-time recording as well as playback of data. Example: Direct to D recording systems.

- **Special operating system** – To allow access to file system and process data efficiently and quickly. Needs to support direct transfers to disk, real-time scheduling, fast interrupt processing, I/O streaming etc.
- **Storage and memory** – Large storage units (of the order of 50-100 GB or more) and large memory (50-100 MB or more). Large Caches also required and frequently of Level 2 and 3 hierarchy for efficient management.
- **Network support** – Client-server systems as common as distributed systems.
- **Software tools** – User friendly tools needed to handle media, design and develop applications, deliver media.

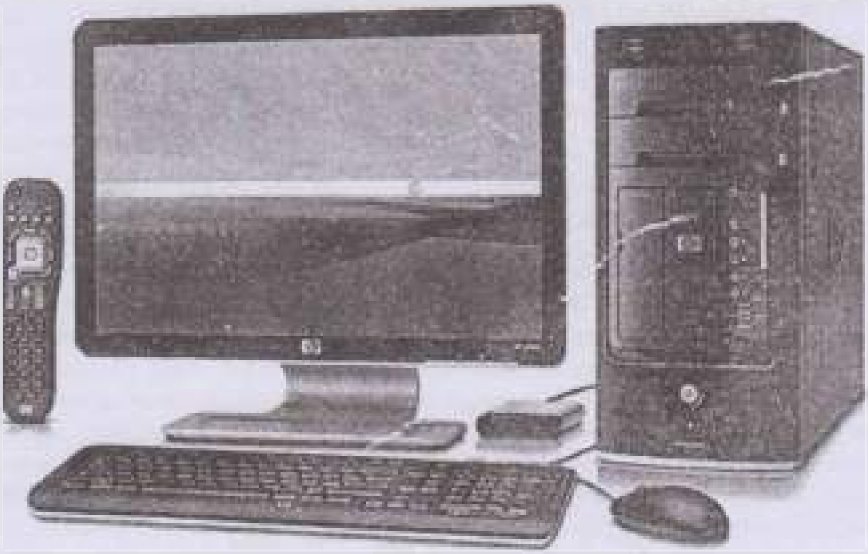


Figure 33.2 Multimedia Computer System

Components of a Multimedia System

Now let us consider the components (hardware and software) required for a multimedia system (see Figure 33.2):

- **Capture devices** – Video camera, video recorder, audio microphone, keyboard, mouse, graphics tablet, 3D input devices, tactile sensors, VR devices, digitizing/sampling hardware
- **Storage devices** – Hard disks, CDs, DVDs, Jaz/Zip drives, etc.
- **Communication networks** – Ethernet, token ring, Fiber Distributed Data Interface (FDDI), Asynchronous Transfer Mode (ATM), intranets, Internet.
- **Computer systems** – Multimedia desktop machines, workstations, MPEG/VIDEO hardware
- **Display devices** – CD-quality speakers, high definition TV (HDTV), SVGA, high-resolution monitors, color printers etc.

Applications

Examples of multimedia applications include World Wide Web, hypermedia courseware, video conferencing, video-on-demand, interactive TV, groupware, home shopping, games, virtual reality, digital video editing and production systems, multimedia database systems, etc.

MULTIMEDIA ELEMENTS

Once in a while a new tool is developed that can have great impact on the way things are. Interactive multimedia is such a tool. Yet, the elements used in multimedia have all existed before. Multimedia simply combines these elements into a powerful new tool. Interactive multimedia can weave five basic types of media into a multimedia production—text, graphics, images, audio, video and animation. This is shown in Figure 33.3. Now we will see the different multimedia elements.

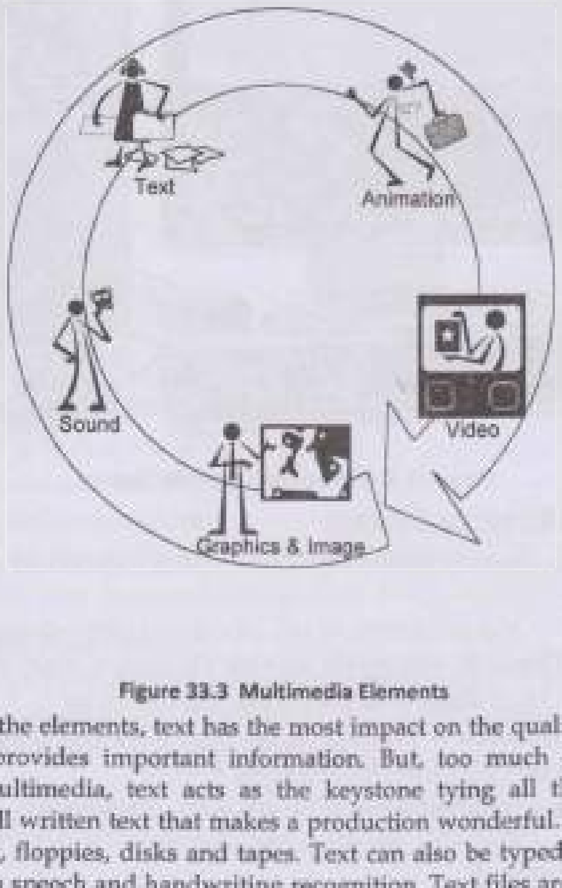


Figure 33.3 Multimedia Elements

- **Text** – Of all of the elements, text has the most impact on the quality of the multimedia use. Generally, text provides important information. But, too much text on a page can be a detriment. In multimedia, text acts as the keystone tying all the other media elements together. It is well written text that makes a production wonderful. The sources of this media are the keyboard, floppies, disks and tapes. Text can also be typed in, scanned with OCR or captured through speech and handwriting recognition. Text files are usually stored and read character by character. Files may contain raw text or formatted text e.g. HTML, Rich Text Format (RTF) or a program language source (C, Pascal, etc.). The basic storage of text is 1 byte per character (text or format character). For other forms of data, e.g. spreadsheet files, and formats may store as text (with formatting) others may use binary encoding. The storage requirements of this type of data are never high.

▲ **Graphics** — Graphics provide the most creative possibilities for a title. In multimedia the selection of the graphic is crucial. The graphic should complement the text on the page. Graphics are usually constructed by the composition of primitive objects such as lines, polygons, circles, curves and arcs. Graphics are usually generated by a graphics editor program or automatically by a program. Graphics are usually editable or revisable (unlike images). Graphics input devices include keyboard (for text and cursor control), mouse, trackball or graphics tablet. Graphics files may adhere to a graphics standard (OpenGL, PHIGS, GKS, etc.). Graphics files usually store the primitive assembly and do not take up a very high overhead.

▲ **Images** — Images are still pictures which (uncompressed) are represented as a bitmap (a grid of pixels). They can be photographs, drawings, graphs from a spreadsheet, pictures from CD-ROM, etc. With a scanner, hand-drawn work can be included. Images may be generated by programs similar to graphics or animation programs. But images may be scanned for photographs or pictures using a digital scanner or from a digital camera. Some video cameras allow for still image capture also. Analog sources will require digitizing. Images may be stored at 1 bit per pixel (black and white), 8 bits per pixel (grey scale, color map) or 24 bits per pixel (true color). Thus a 512 x 512 grey scale image takes up 1/4 MB, a 512 x 512, 24 bit image takes 3/4 MB with no compression. This overhead soon increases with image size so compression is commonly applied.

▲ **Animation** — Animations are primarily used to demonstrate an idea or illustrate a concept. Video is usually taken from life, whereas animations are based on drawings. There are two types of animation—cel based and object based. **Cel based animation** consists of multiple drawings, each one a little different from the others. When shown in rapid sequence, the drawing appears to move. Cel animation can be used to show, for example, how an engine's crankshaft works. **Object based animation** (also called slide or path animation) simply moves an object across a screen. The object itself does not change. Object animation is mainly used to illustrate a point—imagine the route of a motor rally represented by sliding arrows on the map of the area.

▲ **Audio** — Audio signals are continuous analog signals. They are first captured by microphones and then digitized and stored—usually compressed as CD quality audio which requires 16-bit sampling at 44.1 KHz. So 1 minute of Mono CD quality audio requires 60 x 44100 x 2 bytes, which is approximately 5 MB.

▲ **Video** — Analog video is usually captured by a video camera and then digitized. There are a variety of video (analog and digital) formats. Raw video can be regarded as being a series of single images. There are typically 25, 30 or 50 frames per second. Therefore, a 512 x 512 size monochrome video images take 25 x 0.25 = 6.25 MB for a minute to store uncompressed. Digital video clearly needs to be compressed.

MULTIMEDIA AUTHORING TOOLS

Once you have assembled your text, graphics, sound, animations, and movies for a multimedia presentation, you blend or stitch them together with a program that allows you to import file formats from many applications and control such external hardware as videodisks, CDs or DVDs, videotape players, and special effects cards. There is an amazing variety of software available for this task ranging from very simple slide-show programs to very complex professional packages.

TYPES OF PRESENTATIONS

There are two basic types of multimedia presentations -- non-interactive and interactive. The type you choose affects the tools you select to create the presentation. Non-interactive or linear presentations are like movies. They look the same each time you run them. In the automatic mode everything appears on the screen only for the time determined by the developer. There is no provision for user input, and user interaction is limited to clicking a 'Forward' or 'Done' button. These shows are typically used for presentations at sales meetings or conventions. At a minimal level interactive presentations require that you click hyperlink buttons or graphics to continue. However, they can be much more complex and allow viewers to take multiple paths through the material. Interaction is used for games, entertainment, and education. To engage and hold the viewer's interest and attention, the program allows one to select topics affecting actions, or to navigate according to the one's own will.

Presentation Graphics Programs

Easy-to-use presentation graphics programs allow typical end-users to put together multimedia shows for presentations on their own. Originally designed to create overhead transparencies they originally allowed you to add text, create outlines and bulleted lists, and illustrate key points using charts and graphs. Current versions of these programs have been greatly enhanced and you can sequence files from draw, paint, and animation programs and digitized movies and sound. The final show can be a self-running screen show, or a series of slides or overhead transparencies. In a screen show, you can control how long each slide is on the screen, specify when a sound or video should play, and use transitional effects between slides such as screen wipes, zooms, and dissolves. The latest versions of these programs allow you to create animations by sequencing together frames of still graphics. When played back, these frames create the appearance of motion like a movie or a cartoon. Examples of such programs are Microsoft PowerPoint, Lotus Freelance Graphics, etc.

Professional Development Tools

Professional multimedia development programs called 'authoring software' give you total control over an interactive presentation. In addition, to allowing you to give the viewer interactive control over the sequence and timing of sounds, videos, graphics, and animations, they provide a scripting language (also called a programming, macro, or authoring language) in which you write programs to control the action. Some examples of these programs are: Adobe Director, Adobe Authorware, Adobe Flash, Adobe After Effects, Scala Designer, etc.

REVIEW QUESTIONS

Descriptive Type Questions

01. What is multimedia?
02. What is a multimedia application?
03. Why use multimedia?
04. What is a multimedia system?
05. What are the characteristics of a multimedia system?
06. What are the desirable features of a multimedia system?
07. What are the components of a multimedia system?

08. What are the different multimedia elements? Explain each of them in detail.
09. What are multimedia authoring tools?

Fill in the Blanks

01. ___________ is the field concerned with the computer-controlled integration of text, graphics, drawings, still and moving images (video), animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed digitally.
02. ___________ is an application, which uses a collection of multiple media sources e.g. text, graphics, images, sound/audio, animation and/or video.
03. ___________ is a system capable of processing multimedia data and applications.
04. Interactive multimedia can weave five basic types of media into a multimedia production—___________, ___________, ___________, ___________ and ___________.
05. ___________ consists of multiple drawings, each one a little different from the others. When shown in rapid sequence, the drawing appears to move.
06. ___________ simply moves an object across a screen.

[**Answers:** (1) Multimedia (2) Multimedia application (3) Multimedia system (4) Text, Graphics, Images, Audio, Video and Animation (5) Cel based animation (6) Object based or path animation]

CHAPTER 34

Multimedia Applications

TOPICS COVERED

- Introduction
- Multimedia in education and training
- Multimedia in entertainment
- Multimedia in marketing

> **Key Points**
>
> ▲ A multimedia application uses technology for busine education, and entertainment.
>
> ▲ Students use computer-based training (CBT) to learn a complete exercises with instructional software, such as the Sk Assessment Manager (SAM) or Training Online Manager (TO
>
> ▲ Web-based Training (WBT) is an approach to comput based training (CBT) that employs the technologies of t Internet and the World Wide Web.
>
> ▲ Multimedia applications are used to teach students of a ages. Multimedia can be an extremely effective tool for delive educational material to potential learners, making learning m exciting and interesting.
>
> ▲ Multimedia is being used in moviemaking very extensiv With the help of multimedia, the moviemakers now have t capability of creating what they want—the imagination is t only limitation.
>
> ▲ Multimedia can be used in product marketing a advertising. Using multimedia, your products and services m be presented to the users or decision makers in a most effec manner.
>
> ▲ Interactive kiosks consisting of a multimedia deli platform that draws on information stored on a CD or videod can be used to promote products, provide informatio a customer services, or even sell a product on a 24-h unattended basis.

INTRODUCTION

A multimedia application uses technology for business, education, and entertainment. Businesses use multimedia, for example, in interactive advertisements and for job and skill training applications. Teachers use multimedia applications to deliver classroom presentations that enhance student learning.

Students, in turn, use multimedia applications to learn by reading, seeing, hearing, and interacting with the subject content. A wide variety of computer games and other types of entertainment also use multimedia applications. Another important application of multimedia is to create simulations, which are computer-based models of real-life situations. Multimedia simulations o replace costly and sometimes hazardous demonstrations and training in areas such as chemi biology, medicine, and aviation.

MULTIMEDIA IN EDUCATION AND TRAINING

We have seen what multimedia is and the various multimedia elements in Chapter 33. As technolo usage grows in our schools, a greater number of multimedia equipped machines are being purcha Yet to many these machines are a mystery. What can they do? What is multimedia? Just how pow a tool is it? How can it become an effective addition to the curriculum? This section helps to ans these questions. Multimedia is extensively used for education and training in schools, business and home. Multimedia education allows one to proceed at one's own pace. It brings presentations a

Installing CBT software on an employee's computer or on the company network provides even more flexibility by allowing employees to update their job skills at their desks, at home, or while traveling.

Computer-based training provides a unique learning experience because learners receive instant feedback in the form of positive responses for correct answers or actions, additional information on incorrect answers, and immediate scoring and results. Testing and self-diagnostic features allow instructors to verify that a learner has mastered curriculum objectives and identify those who need additional instruction or practice. CBT is especially effective for teaching software skills if the CBT is integrated with the software application because it allows students to practice using the software as they learn. Some of the many other advantages of CBT over traditional training include self-paced study, reduced training time and costs, and unique multimedia content. Many CBT trainers find they can increase their time helping trainees because computers handle test delivery and grading.

Web-based Training and Distance Learning

Web-based Training (WBT) is an approach to computer-based training (CBT) that employs the technologies of the Internet and the World Wide Web. As with CBT, Web-based training typically consists of self-directed, self-paced instruction on a topic. Because it is delivered via the Web, however, WBT has the advantage of being able to offer up-to-date content on any type of computer platform.

Figure 34.2 Web-based Training Center

During the past few years, the number of organizations using Web-based training has exploded. Today, many major corporations around the world provide employees with some type of Web-based training to teach new skills or to upgrade their current skills. Web-based training, computer-based training, and other materials often are used as materials for distance learning courses. Distance learning, also called **distance education**, is the delivery of education from one location while the learning takes place at other locations. Some national and international corporations also save millions of dollars by using distance learning to train employees, thus eliminating the costs of airfare, hotels, and meals for centralized training sessions.

Many colleges and universities offer numerous distance learning courses, usually in the form of Web-based or Web-enhanced courses. Web-based courses offer many advantages for students who live far from a college campus or work full time, allowing them to complete coursework from home or at any time that fits their schedules. A number of colleges and universities now offer master's and doctorate degree programs in which every required course is taught over the Web. Web-based training is also available for individuals at home or at work. Today, anyone with access to the Web can take advantage of hundreds of multimedia tutorials offered online. Such tutorials cover a wide range of topics, from how to change a flat tyre to creating presentations in Microsoft PowerPoint. Many of these websites are free; others ask users to register and pay a fee to take the complete Web-based course.

Classroom and Special Education

Multimedia applications are used to teach students of all ages. From interactive CDs and DVDs to presentations, multimedia can be an extremely effective tool for delivering educational material to potential learners, making learning more exciting and interesting. Often, isolated rural schools are leaders in connecting classrooms to the Internet and using multimedia applications to enhance learning.

Figure 34.3 Training DVD

Multimedia applications make the learning process more interesting, allow students to perform experiments in a risk-free environment, and provide instant feedback and testing. Virtual dissection of a frog is possible. This software also appeals to various learning styles and provides a new type of learning experience. A student using a multimedia study guide, for example, could listen to a speaker reciting French vocabulary to help with the pronunciation of difficult words. You can buy many multimedia programs such as these on CDs or DVDs from a local retailer or merchant on the web.

Research has shown that, when properly evaluated and integrated into teaching at the point of instruction, multimedia applications are a highly effective teaching tool. When using a multimedia application, students become actively involved in the learning process instead of passive recipients of information. Interactive multimedia applications engage students by asking them to define their own paths through an application, which often leads them to explore many related topics.

Multimedia applications are well suited for both physically impaired and learning [illegible] students. Students who are visually impaired, for example, benefit from the audio capa[illegible] multimedia applications, as well as the use of graphics and larger font sizes. Visual materials, [illegible] graphics, animation, and video, also make learning easier for students who are hearing [illegible] Many educational software companies offer multimedia products with closed captioning [illegible] language to enhance the learning experience for hearing-impaired students. The ability of in[illegible] to work, practice, and review at their own pace is a major benefit for the learning disabled. [illegible] a digitized frog eliminates the expense of actually dissecting a real frog in a biology [illegible] interactive programs allow you to view and remove organs and to make a movie of your pro[illegible] web pages are available in various languages.

Electronic Books

One type of electronic book is a digital text that gives the user access to information throu[illegible] which often are bold or underlined words. These electronic books have many of the elem[illegible] regular book, including pages of text and graphics. Users generally click icons to turn pag[illegible] type of electronic book. A table of contents, glossary, and index are available at the click of a [illegible] display a definition or a graphic, play a sound or a video sequence, or connect to a web[illegible] simply can click a link.

Figure 34.4 E-book

A newer type of electronic book, called e-book, uses a small book-sized computer that [illegible] to 4,000 pages, or about ten books' worth of text and small graphics. By clicking a button, [illegible] forward or backward, add notes, and highlight text stored in the e-book. Readers also [illegible] books on a handheld computer, with the text supplied from various sources. One of these [illegible] **Project Gutenberg** (*http://gutenberg.net/*), which makes thousands of literary and reference [illegible] materials available free to the general public.

Electronic Reference Books

An electronic reference text, sometimes called e-text, is a digital version of a reference book that uses text, graphics, sound, animation, and video to explain a topic or to provide additional information. The multimedia encyclopedia, *Microsoft Encarta*, for example, includes the complete text of a multivolume encyclopedia. In addition to text-based information, *Microsoft Encarta* (*http://encarta.msn.com/*) includes thousands of photographs, animations, audio and video clips, and detailed illustrations. This array of multimedia information is accessible via menus and links, and regular updates are available via the web. Many other reference texts are used in a variety of fields and professions. Health and medicine are two areas in which multimedia reference texts play an important role. Instead of using volumes of books, health professionals and students rely on reference CDs and DVDs for information, illustrations, animations, and photographs on hundreds of health and first-aid topics.

How-to Guides

Numerous interactive multimedia applications are available to help individuals in their daily lives. These multimedia applications fall into the broad category of how-to guides. How-to guides are multimedia applications that include step-by-step instructions and interactive demonstrations to teach practical new skills. Much like the computer-based training applications used by businesses, how-to guides allow users to acquire and test new skills in a risk-free environment. The skills learned with a how-to guide, however, usually are oriented toward personal enrichment, rather than workplace skills. How-to guides can help with activities such as buying a home or a car, designing a garden, planning a vacation, improving a home, and repairing a car or a computer. Multimedia how-to guides are also available on DVD and the web.

Newspapers and Magazines

A multimedia newspaper and a multimedia magazine are digital versions of a newspaper or magazine distributed on CD, DVD, or via the World Wide Web. Today, many print-based magazines and newspapers have companion websites, which provide multimedia versions of some or all of their printed content. Multimedia newspapers and magazines usually include the sections and articles found in their print-based versions, including departments, editorials, and more. Unlike printed publications, however, multimedia magazines and newspapers use many types of media to convey information. Audio and video clips, for example, can showcase recent album or movie releases, and animations can depict weather patterns or election results.

MULTIMEDIA IN ENTERTAINMENT

One of the earliest applications of multimedia was for computer games. At that time many people believed that multimedia was useful only for computer games. There is no question that multimedia can improve the quality of computer games, and it is that very game-like quality of multimedia that can enhance a learning experience. Multimedia is being used in movie-making very extensively. With the help of multimedia, the moviemakers now have the capability of creating what they want—the imagination is the only limitation. With the arrival of the CD and the Internet, the entertainment industry made a huge leap into a new era with a winning card—multimedia. Armed with images, sounds, full-motion video and interactive capability, multimedia become a dominant factor in today's technological world.

The concept of multimedia and entertainment was first introduced in games on the Atari systems during the sixties and seventies. The combination of sound, animation and user interaction made games like "*Space Invaders*" and "*PacMan*" cultural icons of the decade. Years later, with the arrival of the first personal computer, the Apple Macintosh, multimedia once again announced its existence through primitive games and learning software. The IBM and PC-compatible computers followed the same road. However, the concept of multimedia was not well known until the early nineties with the arrival of the CD. The storage capacity and the processing speed of the CD allow software and game developers to unleash their creativity. Fast but steady growth of electronic technology allows multimedia to become advanced and popular in a very short time. By the middle of the nineties almost all personal computers were equipped with sound cards and CD for the sole purpose of running multimedia applications. Movies and cartoons, which were only available on VHS tapes, are stored on CD (VCD) and allow the users to watch on their computer screen. At the present, the DVD with more storage capacity and even higher processing speed, is making its way into the market and slowly replaces the CD.

Multimedia in entertainment includes games, films, and animations. As we all realize, multimedia in fact adds a lot to the field of entertainment. The application of multimedia can be applied to those times described above, not only because multimedia provide a new way to create entertainment, but also its great flexibility has been widely acknowledged. People used to have plain games, films, and animations too, but none of them interacted with those entertainment products. They had games with only flat images, monotone sounds, which does not give the user any sense of reality. People also produced films, but the time and money spent was too lavish and not economical at all. People created cartoons and animations, but still, they had spent too much time, and what was the worst, the reusability was really small. However, with the growth of multimedia, smart people started to apply this technology to help them on their jobs. Entertainment becomes more prosperous, affordable, and interesting.

What does Multimedia do to Gaming?

As we observe from the fast changing gaming industry, games become more and more complicated in terms of the level of the use of multimedia. Better multimedia technologies give game developers a way to produce a better game product. We often hear, "crisp images and stunning sounds," which contributes to a really improved gaming experience, which a massive amount of players would appreciate. As one aspect of increasingly enhanced multimedia technologies, new multimedia hardware gives both the end users and the game developers the power to have a faster speed and better sound/images when enjoying new gaming technologies, which rely a lot on multimedia technologies. For example, as the prices of advanced hardware/technologies go down, and the productivity goes up, games are now "3D-lized." More and more 3D technologies are involved in game development both in sound effects and graphics. Unlike earlier when people used to "watch" the game, now with multimedia capability, people can actually "play" the game. All of them make games more realistic and interactive.

Movie has been one of the most popular pervasive entertainment for a period of time. More and more multimedia is used for filmmaking to create realistic special effects. Some well-known examples are morphing, superimposition, and digital recasting animation. Today, making a film need the use of a great deal of multimedia. However, seeing a film is not considered as multimedia since we cannot have interaction with it. There are short movie clips called "trailers" available on the Internet for you to interact with them to let you sneak preview the movies or use for some other references.

Ever since people realized that we can use multimedia to supplement/assist our jobs, those movie producers also realized how computer technologies can help them create better films and reduce certain degrees of difficulties while producing a movie. For example, they use special effects to help them do something they usually cannot accomplish or hard to be done. An instance of this kind of use is Morphing. Morphing is a multimedia effect that uses computer techniques to transform one image into another in a seamless, uninterrupted segment. Today, morphing is very advanced, and it is used very commonly in many movies to make the films look more interesting. Another well-known use of multimedia technology to aid film production is to use computers to process some scenes that are too dangerous to create, usually a huge explosion, for example.

The revival of animation is also one of the impacts that multimedia brings about. By definition, animation is artificially generated sequence of images. Traditionally, it is the use graphic technique and drawing technique to create a picture of images, animals, human characters, plants, etc. In old times we also had animations. However, the traditional way of producing animation just wastes too much time. As the technology improves, people create better animation than before, and the amount of time they contribute to produce an animation will come down. Films such as "*Kung Fu Panda*," "*Cars*," and "*Wall-E*" are good example of animation multimedia.

Entertainment and Edutainment

Multimedia combines the media elements of television and interactivity, thus making it ideal for entertainment. Multimedia computer games, for example, use a combination of graphics, audio, and video to create a realistic and entertaining game situation. Often the game simulates a real or fictitious world, in which users play the role of a character and have direct control of what happens in the game. The music industry also sells interactive multimedia applications on CD and DVD. Some interactive music CDs, for example, allow budding musicians to play musical instruments along with their favorite musicians, read about the musician's life and interests, and even create their own versions of popular songs. Like interactive games, these applications give users a character role and put them in control of the application. Other multimedia applications are used for edutainment, which is an experience meant to be both educational and entertaining. Many edutainment CDs and DVDs provide content for individuals of all ages, while others are created specifically to teach children in a fun and appealing environment.

MULTIMEDIA IN MARKETING

In this information age, it would be foolish to restrict your company's image to a printed catalogue or still photographs while you can dazzle your potential clients with a full-fledged multimedia brochure on a fancy CD. Using multimedia, your products and services may be presented to the users or decision makers in most a most effective manner.

The key element of multimedia concept is interaction – the user is allowed to control the flow of information according to his need and taste. Hence, appropriate look and tone consistent throughout all aspects of the design is critical to ensure the confidence, interest and participation of the target users. The design must be captivating, with simple navigation between various sections yet filled with relevant content (text and images) to inform and engage the users. Many businesses and industries use multimedia to create marketing presentations that advertise and sell products. Advertisers, for instance, save time and money by using this software to produce television commercials with unique media effects. Sales representatives also use multimedia in marketing presentations created using presentation graphics software. To deliver these presentations to a large audience, a user can connect the computer to a multimedia projector (see Chapter 10) that displays the presentation on a full screen.

Interactive **kiosks** consisting of a multimedia delivery platform that draws on information stored on a CD or videodisk can be used to promote products, provide information and customer services, or even sell a product on a 24-hour unattended basis. A kiosk is a computerized information or reference center that allows users to select various options to browse through or find specific information. Kiosks provide a excellent means to market and advertise products and also gather customer preferences. A typical kiosk is a self-service structure equipped with computer hardware and software. Kiosks often use touch screen monitors or keyboards as input devices and contain all of the data and information needed for the application stored directly on the computer. Kiosks often provide information in public places where visitors or customers have common questions. Locations such as shopping centers, airports, museums, and libraries, for example, use kiosks to provide information on available services, product and exhibit locations, maps, and other information. Kiosks also are used for marketing. A kiosk might contain an interactive multimedia application that allows you to try options and explore scenarios related to a product or service. For example, you might be able to try different color combinations or take short quizzes to determine which product best meets your needs. The interactive multimedia involves customers with the product, thus increasing the likelihood of purchase.

Figure 34.5 Kiosks

Advertising has been one of the key factors of growth and success in business. Smart businessmen always know how important marketing is. All possible types of promoting different products have been used, but before 1980s computers were something difficult for business people to use and understand. At the same time most of the people who worked with computers thought about computers as about serious technical and science tool, and for many of them science and marketing were two things that could not be together. In reality only at the beginning of this decade computers really became considerably inexpensive, small in size, and freely available to many people. It was the time when computers started to play considerable role in marketing, and became a powerful tool of advertising and started to bring a lot of money to people who knew how to use them in real business.

There are many ways to use computers in advertising. One of them is the use of multimedia in advertising and promoting products, and another one is the utilization of the Internet. Now-a-days different applications of multimedia are used everywhere from a desktop presentation in a small [illegible] agency to amazing multimedia exhibitions on computer shows. Modern computers are very user friendly. Many applications do not require sophisticated computer literacy. Animation, computer graphics, sound and video make computer presentations attractive to all people. Demo floppies and

CDs are often used to promote different types of products and services. Interaction is one of the major advantages of multimedia. In most cases potential customer does not just observe the action like it works with TV commercials. He or she gets a response from the computer, has a choice what to look for, when to start and to finish. It is new, interesting, attractive, and therefore such advertising works. Another advantage of multimedia advertising is its low cost. Many books and magazines are now shipped with some kind of demo or advertising material. Demo CDs and floppies are inexpensive, and of course it is difficult to imagine something that would fit so much information as we can put one demo CD. More and more companies are using demo CDs as their free catalogs that they ship to their customers. These catalogs are user friendly and easy to use, so, usually, it takes only a few minutes to find any part or a product, print out an order form and order the item. A slick multimedia presentation is a compelling brand proposition, reflects what a company is all about and it can be used as an effective sales promotion tool. Having a CD, potential clients will have the freedom to learn about you and your products at their leisure.

REVIEW QUESTIONS

Descriptive Type Questions

01. What are the applications of multimedia in education and training?
02. What are CBTs and what are they used for?
03. What are the advantages of CBTs?
04. What is web-based training and what are its advantages?
05. What is distance learning?
06. How multimedia helps in classroom training?
07. How multimedia helps in teaching students with learning disabilities and physical challenges?
08. What are electronic books and what are their advantages?
09. What are the applications of multimedia in entertainment?
10. How is multimedia used in games?
11. What is the role that multimedia plays in entertainment and edutainment?
12. How does multimedia help in marketing and advertising?

Essay Questions

01. Explain the role of multimedia in education and training.
02. Describe the contribution of multimedia in entertainment.
03. How is multimedia used in marketing and advertising?

Fill in the Blanks

01. CBT stands for ____________.
02. CAI stands for ____________.
03. WBT stands for ____________.
04. ____________ combines the media elements of television and interactivity, thus making it ideal for entertainment.
05. ____________ consisting of a multimedia delivery platform that draws on information stored on a CD-ROM or videodisk can be used to promote products, provide information and customer services, or even sell a product.

[**Answers:** (1) Computer based training (2) Computer-aided instruction (3) Web-based training (4) Multimedia (5) Interactive kiosks]

CHAPTER 35

Introduction to Virtual Reality

TOPICS COVERED

- Introduction
- Brief history of virtual reality
- Present uses of virtual reality
- Future of virtual reality

Key Points

- Virtual reality is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment.
- On a computer, VR is primarily experienced through two of the five senses: sight and sound. The simplest form of virtual reality is a 3D image that can be explored interactively at a personal computer, usually by manipulating keys or the mouse so that the content of the image moves in some direction or zooms in or out. This is called non-immersive VR.
- More sophisticated efforts (immersive VR) involve such approaches as wrap-around display screens, actual rooms augmented with wearable computers, and devices capable of providing touch (tactile) sensation and control and let you feel the display images.
- Virtual reality can be divided into: (1) the simulation of a real environment for training and education (2) the development of an imagined environment for a game or interactive story.
- Popular products for creating virtual reality effects on personal computers include Bryce, Extreme 3D, Ray Dream Studio, trueSpace, 3D Studio MAX, and Visual Reality.
- The Virtual Reality Modelling Language (VRML) allows the creator to specify images and the rules for their display and interaction using textual language statements.

INTRODUCTION

Virtual Reality (VR) is described as being both a set of technical projects and a utopian concept. The term 'virtual reality', by definition appears to be a contradiction. The word 'virtual' suggest some sense of unreality, while the word 'reality' speaks for itself. Therefore, one can technically envisage VR as being 'unreal reality'! However, within the conventional way of thinking, VR is seen as an environment, or a world which is perceived as real, though in theory, we diagnose it as being unreal. A more layman's definition of VR would be a computer generated, 3D environment that appears real and can be explored in 3D.

The image perceived by the term Virtual Reality, is of a person wearing a head mounted display and a sensor glove. VR is both more and less than that—it is, in its simplest form, an addition to, or replacement of, one or more senses. The "reality" which is then detected by that sense may or may not have any relationship to real life. It would appear that the whole philosophy and ideology behind VR is to do with experience, and is therefore, subjective. It is an experience and not a piece of technology. However, VR could be perceived as a piece of technology, in which we can have an experience through a game or a simulated situation. VR is described as being both non-immersive i.e. still in touch with reality like working through a PC screen, or immersive i.e. wearing a headset and data gloves inside a VR environment as shown in Figure 35.1.

Through VR, we can observe a development towards a greater sense of vividness and involvement. More unexpected, perhaps is the need to reach out, touch, and interact with the media images that are created. What truly sets virtual reality apart from other media is the technological need to directly put the body of the user inside the illusion, to surround the user with a space that stretches infinitely in all directions, a world of unexpected experiences.

Figure 35.1 Virtual Reality Session

BRIEF HISTORY OF VIRTUAL REALITY

The origin of VR can be traced back to the 1930s when the very first flight simulator was built. This simulator, which possessed the "bare minimum of audio and visual cues", was said to be the start of the development of VR. Since then, flight simulators have become more complex and demanding to cater to the specific needs of different airlines.

VR was also influenced by film techniques such as stereoscopic, or 3D cinema, and several wide-screen systems that Hollywood filmmakers were experimenting with during the early 1950s. Also, through the conception of the computer age in the 1950s, engineers and technicians began to conceive how they could display data via a computer screen. Evidence further suggests, that much of the progress on VR, was conducted by those in the science and industry trade who could gain the most from VR technology. The first head-mounted display was produced by Ivan Sutherland in 1966. By the 1970s simple computer-based flight simulators were being used, and this development of flight simulators continued through the 1980s and 1990s. This form of VR was overtaken by the emergence of VR video games into the entertainment market, both in amusement arcades and at home on video games consoles.

PRESENT USES OF VIRTUAL REALITY

VR is primarily used as a visualization tool and its power lies in its ability to penetrate many areas of our lives. The variety of applications is limited only by imagination. Needless to say, there are numerous areas, which incorporate VR as a means of sampling or developing situations, devices and techniques for use in the real world. One such example is an experiment carried out by psychologists at Leicester University. They reproduced a VR construction of their department, on computer, for children with disabilities ranging from arthritis to spinal bifida to explore through the computer. After about an hour, they were asked to find the fire exits in the real department, which they were able to find more efficiently than a controlled group of able-bodied children. One of the psychologists asserted that Virtual Reality was going to be used increasingly in schools. "We are showing that we can use it in order to help children as well as entertain them." This appears to be one of the many functions that VR is performing within society today.

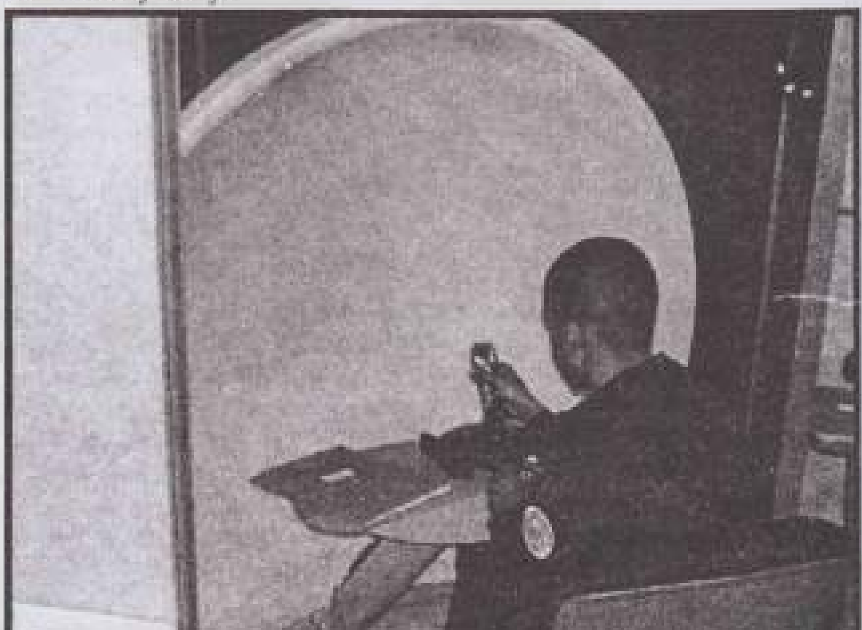


Figure 35.2 Virtual Reality Flight Simulator

Within the games market, VR appears to be forming a stronghold in the advent of video and PC games such as Doom and its sequels, Resident Evil and Formula One, which like the original concept of VR with the headset and data glove, gives the player a sense of 'realism' in a world confronting ifferent images and enemies. By placing the player in the cockpit of a car or in the body of an armed ghter, the player will gain an experience of what it might be like to actually be in a real situation.

Do-it-yourself manufacturers are using VR in designing furniture units for customers, to view ow kitchen units or furniture suite will look in a designed setting. The same can be applied to civil ngineering, architectural and interior design, where VR is enabling designers to create or change omputer-generated simulations of proposed environments through 3D images, rather than through and-drawn perspectives.

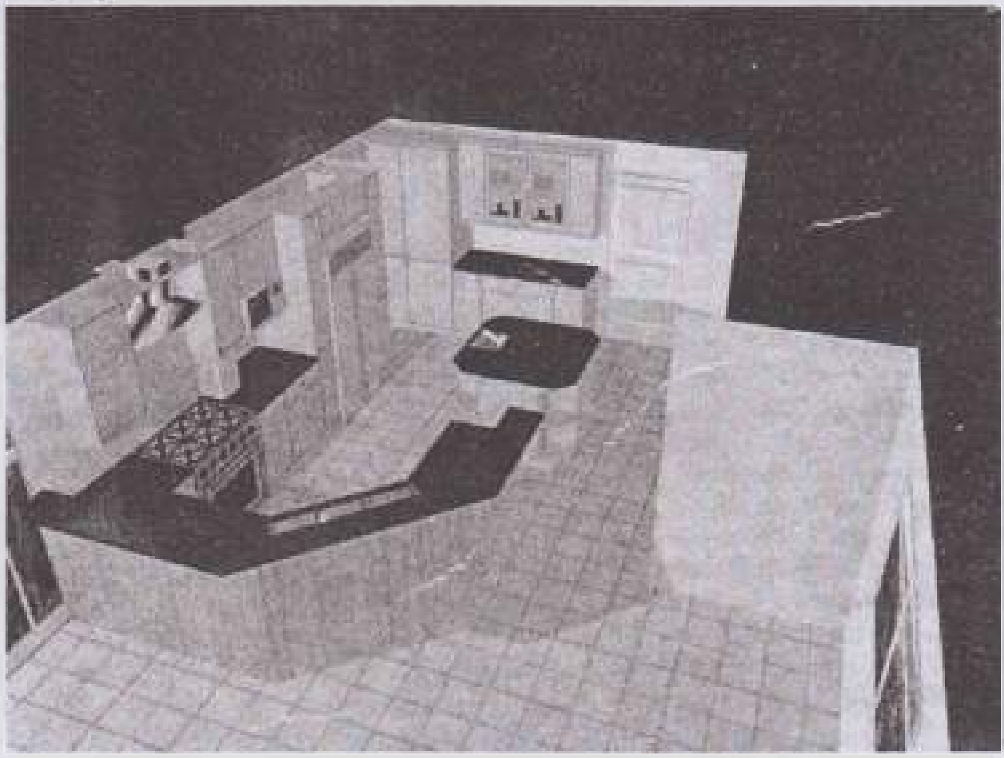


Figure 35.3 Virtual Kitchen Unit

As stated earlier, VR is an experience, which we sample, more than being a technology tool that we use. However, as Personal Computers and software become more complex and advanced, so do their boundaries and capabilities of working for us, instead of merely entertaining us. One of the main innovations of VR will have to be the development of the flight simulator.

The evolution of creating an environment, whereby, real life situations can be recreated, altered and simulated in order for aircraft pilots or fighter pilots to react to and rehearse in constant or changing scenarios appears to be invaluable. The obvious benefit of this is the vast amount of knowledgeable experience gained by the pilots and cockpit crews, whilst also ensuring the safety of thousands of lives that could be in jeopardy if such a situation occurred, via internal or external factors which the pilots are not familiar with.

Graphics designers also appear to be 'cashing in' on the VR phenomenon. For some time now, car designers have been using VR techniques in designing, modifying and creating cars from 3D perspectives, and as already mentioned, the more complex equipment the becomes, the broader will be [illegible] of car design. Manufacturers are also performing virtual tests on cars.

Other fields and environments are also benefiting from the experience of VR. Surgeons are being given the opportunity to perform delicate operations through VR. This will provide them with a better understanding, as well as experience when they actually perform the surgery on real people. Weather forecasting is another area, which is benefiting from the utilization of VR.

FUTURE OF VIRTUAL REALITY

As with the computer industry as a whole, VR technology appears to be advancing all the time. Ideas that were thought to be years away, maybe developed sooner. The emergence of the Internet seems to have played a part in some of the current trends, which VR is taking. VRML (Virtual Reality Modeling Language) is a language that allows 3D information to be put on the World Wide Web. This, it is thought will enhance the image of the Internet, enabling users to walk through a virtual website. In some cases, this appears to have been implemented already. It is believed that VR, like the Internet, will enhance our imagination, and help our perception of the real world.

In the not too distant future, many areas of society in general will be affected by the influence of VR. The world of business will no doubt profit from the scope of VR in terms of development and training for staff, business ventures and proposal presentations. It is now possible for the company bosses and executives to have meetings with one another in virtual boardrooms. This concept appears to have obvious advantages in terms of less time and money being spent travelling around countries, continents, or the world.

Education is another area that will profit from the impact of VR. Research states that VR could be used for letting students experience the content of subject areas in a completely new way. This will help stimulate the interests of the students studying the subjects taught using VR technology. Examples of this could be allowing students to create 3D biological or molecular patterns through the process of VR, or explore virtual solar systems to study the ecology of star systems through virtual demonstrations. One disadvantage of this is the cost of obtaining the specific VR equipment, and the required VR software to run such procedures. Another possibility could be the advent of a 'virtual classroom'. The suggestion here is that schools could be accessed via the students computer at home allowing the student to access the different aspects of school life i.e. school notice boards, homework essays, course syllabus and attainment grades. This could inevitably lead to students hardly attending school itself.

The entertainment industry will also gain substantially from the future progress of VR, particularly the games market. As previously mentioned, the games industry has profited from the development of VR type video games such as Formula One and Doom, and one could speculate that games like these will be further developed to be more advanced than how they are at present. This would present more sophisticated VR type games to the market, giving more realistic sensations of actually being in the game. The concept of actually buying a headset to complement your games console could become the norm, as VR becomes more mainstream and as prices begin to decline. One could perceive that VR technology will be connected to every home, and will be an option for viewers to select in parallel with their television, offering live interaction through games or various other situations via their television. Viewers could also have the chances to visit virtual art galleries and theatres from their home.

The medical field will also profit from the future development of VR. Medical research can benefit from further development of VR to educate, learn, prototype, test and evaluate new treatments and analyze new diseases and conditions. The expansion of more surgical simulators, which could present better resolution graphics, realistic reactions to situation such as bleeding, can project the future of VR technology in medicine into the next decade.

With the advancement in technology, negative limitations too surface. VR technology is still relatively expensive for small time users to obtain; accessibility is restricted to governmental and scientific research as well as scientific industries such as British Aerospace and NASA. Most VR environments, apart from the highly sophisticated ones for scientific organizations, are silent. Therefore, further developments need to be made in mainstream VR to produce sound. One other limitation is that most VR systems are designed for set purposes, and cannot be adapted for other situations. Nevertheless, with the advancement of computer technology in general, VR technology can only get better.

REVIEW QUESTIONS

Descriptive Type Questions

01. What is virtual reality?
02. What is the difference between immersive and non-immersive virtual reality?
03. Describe the history of virtual reality?
04. What are the uses of virtual reality?
05. What are the future-trends in virtual reality?

Fill in the Blanks

01. In the case of ____________ virtual reality the user wears a headset and data glove inside a VR environment.
02. The first head-mounted display was produced by ____________ in ____________.
03. VRML stands for ____________.
04. It is believed that ____________, like the ____________, will enhance our imagination, and help with our perception of the real world.
05. ____________ would be a computer generated, 3D environment that appears real and can be explored in 3D.

[**Answers:** (1) Immersive (2) Ivan Sutherland, 1966 (3) Virtual Reality Modeling Language (4) VR, Internet (5) VR]

True or False

01. Virtual reality can be traced back to the 1930's when the very first flight simulator was built.
02. VR was also influenced by film techniques such as stereoscopic, or 3D cinema, and several wide-screen systems that Hollywood filmmakers were experimenting with during the early 1950's.
03. Do-it-yourself manufacturers are using VR in designing furniture units for customers to view how kitchen units or furniture suite will look in a designed setting.
04. Car designers have been using VR techniques in designing, modifying and creating cars from 3D perspectives.
05. Surgeons are being given the opportunity to perform delicate operations through Virtual reality.

[**Answers:** (1) True (2) True (3) True (4) True (5) True]

CHAPTER 36

Introduction to Hypermedia

TOPICS COVERED

- Introduction
- Characteristics of hypermedia
- Components of hypermedia
- Hypermedia applications

> **Key Points**
>
> ▲ Hypermedia, a term derived from hypertext, extends the notion of the hypertext link to include links among any set of multimedia objects, including sound, motion video, and virtual reality. It can alsd connote a higher level of user/network interactivity than the interactivity already implicit in hypertext.
>
> ▲ The World Wide Web is a classic example of hypermedia, whereas a non-interactive cinema presentation is an example of standard multimedia due to the absence of hyperlinks.
>
> ▲ The first hypermedia application was the Aspen Movie Map. Atkinson's HyperCard popularized hypermedia writing, while a variety of literary hypertext and hypertext works, fiction and nonfiction, demonstrated the promise of links. Most modern hypermedia is delivered via electronic pages from a variety of systems including media players, web browsers, and stand-alone applications. Audio hypermedia is emerging with voice command devices and voice browsing.

INTRODUCTION

The term hypermedia comprises a set of ideas, although it seems to be understood somewhat differently within different disciplines. We will therefore start by examining what some of the better known researchers and developers of hypermedia say about it, in order to find some typical, common features.

The very first person to directly formulate the hypermedia concept was Vannevar Bush. American President Roosevelt, appointed him manager of the organization, which coordinated technological research in the USA during World War II. In 1945, he published the article "As we may think" in the magazine *The Atlantic Monthly* addressing some of the problems faced by modern science. Even at that time, the number of scientific publications was high, and Bush emphasized two resultant problems: finding the time to keep up-to-date professionally, and remembering all the information. He also pointed out the dynamic aspects of scientific publications, claiming "A record, if it is to be useful to science, must be continuously extended, it must be stored, and above all it must be consulted."

In proposing a solution, he launched the idea of an imaginary machine, to handle these problems – The **Memex**. The Memex was intended to structure information by association, in contrast to the traditional structuring by index. Using links ("trails"), information units would be chained, and these were to be followed through a series of associations by pressing a button. The Memex was never realized, but many people consider this as the precursor to hypermedia.

The concept of hypertext, and later hypermedia was created by Theodor Holm Nelson, the man behind the hypermedia system **Xanadu**. Fascinated by the ideas of Bush, from the 1960s onwards Nelson developed them further, placing the following content in the concept of hypermedia. "Well, by 'hypertext' I mean non-sequential writing – text that branches and allows choices to the reader, best read at an interactive screen."As we see, Nelson assumes that both the reading and the writing processes would be supported by hypertext. Nelson placed special emphasis on the non-sequential nature of hypertext. Information must follow its natural structure, not being constrained by the linear structure to which traditional writing must adhere, for example, a textbook, which has to be read from cover to cover. Generally, this is also what Bush meant by following information via links ("trails"), while Nelson introduced the term links for these paths through information.

It is well worth noting that, Nelson does not assume the use of information technology to represent hypermedia. Hypermedia is rather a method for structuring information. New information is accessed by "jumping" from a reference point directly to the referenced information. Nelson cites a newspaper front page as an instance of "manual hypertext", the headlines with their page references being the reference points for the information found in the paper. In parallel with Nelson, Douglas Engelbart researched some of the same ideas at the Stanford Research Institute. This yielded the development of NLS (oNLine System), which later came to be known as Augment. In contrast to Bush and Nelson, Engelbart assumed an overarching hierarchical structure of information in hypertexts, enabling links across these structures. In general, nonetheless, Engelbart's theories agree with those of Nelson and Bush.

Engelbart focused especially on the opportunities provided by hypertext for group work, and much of his research was on using hypertext as a tool for work groups. Several persons might share the same document, working on it at the same time. It would also be possible to work on the same document on the same screen at the same time, so that two persons would sit in different locations while seeing the same screen, which they could both edit. WYSIWIS -"What You See Is What I See". Furthermore, electronic mail was used to transfer documents and structures. All of these features have now been implemented in Augment.

Another major figure in hypermedia research, Jeff Conclin, offers a more pragmatic description of hypertext. "The concept of hypertext is quite simple: Windows on the screen are associated with objects in a database, and links are provided between these objects, both graphically (as labeled tokens) and in the database (as pointers)." This is a direct description of how a typical hypertext system organizes information. Conclin assumes the use of a computer with a graphical interface. The information is stored in a database, suggesting that some typical database routines, such as taking back-up copies, data integrity and real-time transactions are handled for the user by the system.

Hypertext was originally constructed for purely text-based systems, but as computer features evolved, making it possible to represent other information as well, for example, computer graphics, the term hypermedia was introduced. This concept was also created by Theodor Holm Nelson. As today's workstations are able to represent different types of multimedia, this difference has become less important. The rest of this text will thus employ the term hypermedia.

Aspen Movie Map

The World Wide Web is a classic example of hypermedia. The first complete hypermedia application was the **Aspen Movie Map**. The Aspen Movie Map was a revolutionary hypermedia system developed at MIT by a team working with Andrew Lippman in 1978 with funding from Advance Research Projects Agency (ARPA). The Aspen Movie Map allowed the user to take a virtual tour—travel surrogately—through the city of Aspen, Colorado. It is an early example of a hypermedia system.

A gyroscopic stabilizer with four 16 mm stop-frame film cameras was mounted on top of a car with an encoder that triggered the cameras every ten feet. (The distance was measured from an optical sensor attached to the hub of a bicycle wheel dragged behind the vehicle.) The cameras were mounted in order to capture front, back, and side views as the car made its way through the city. The car was carefully driven down the center of every street in Aspen, to enable registered match cuts.

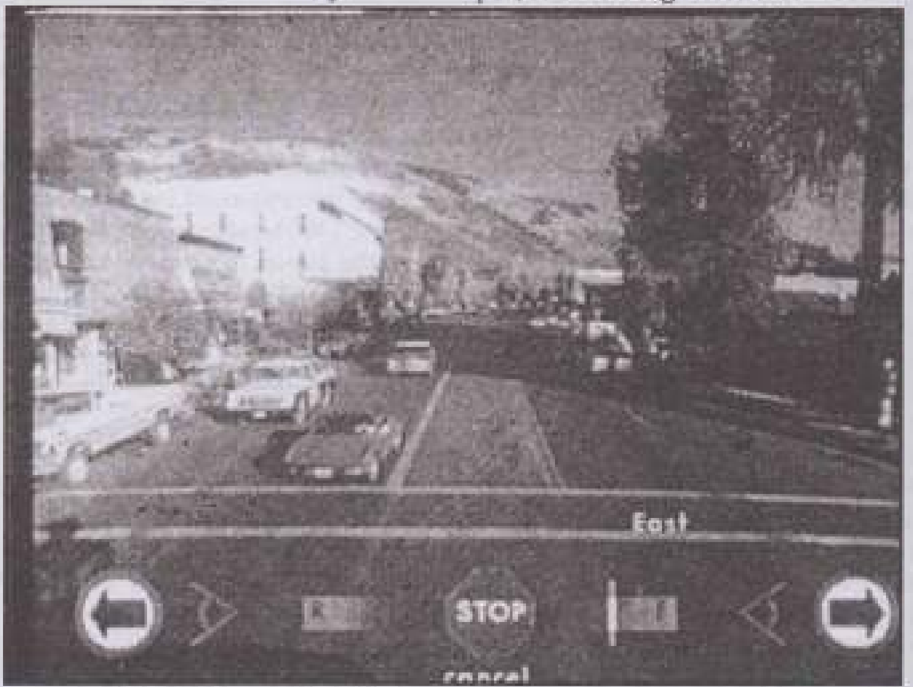


Figure 36.1 Screen Shot of the Aspen Movie Map Touch-Screen Interface

The film was assembled into a collection of discontinuous scenes (one segment per view per block) and then transferred to laser disc, the analog-video precursor to DVD technology. A database was made that correlated the layout of the video on the disc with the two dimensional street plan. Thus linked, the user was able to choose an arbitrary path through the city; the only restrictions being the necessity to stay in the center of the street; move ten feet between steps; and view the street from one of the four orthogonal views.

Another feature of the system was a navigation map, that was overlaid above the horizon at the top of the frame; the map both served to indicate the user's current position in the city (as well as a trace of streets previously explored) and to allow the user to jump to a two dimensional city map, which allowed for an alternative way of moving through the city. Additional features of the map interface included the ability to jump back and forth between correlated aerial photographs and cartoon renderings with routes and landmarks highlighted and the ability to zoom in and out.

ARPA funding during the late 1970s was subject to the military application requirements of the notorious Mansfield Amendment introduced by Mike Mansfield, which had severely limited funding for hypertext researchers like Douglas Engelbart.

The Aspen Movie Map's military application was to solve the problem of quickly familiarizing soldiers with new territory. The Department of Defense had been deeply impressed by the success of Operation Entebbe in 1976, where the Israeli commandos had quickly built a crude replica of the airport and practiced in it before attacking the real thing. DOD hoped that the Movie Map would show the way to a future, where computers could instantly create a three-dimensional simulation of a hostile environment at much lower cost and in less time.

CHARACTERISTICS OF HYPERMEDIA

Hypermedia is a network containing several inter-linked information units. The information units are called nodes, and the connections between the nodes are called links. Limited networks of nodes and links are called hyperdocuments or simply documents. Inside the node there are links and information objects. Links connect nodes, handling a natural transition from one node to another node or to other nodes. A link spot normally indicates links, so that the user may see where the links go. Users may follow the link by clicking on this link spot. A mouse cursor may often be sensitive to link spots, changing its shape when on a link spot.

There are three link categories: Organization links, Reference links and Function links. Organization links manage the hyperdocument structure, corresponding to chapters and paragraphs in ordinary printed text. Reference links are occasional links, which permit the user to follow references and other branching, which are independent of the text structure. Function links execute a function, e.g. initiate a query or start another application.

Based on the work of Bush, Nelson, Engelbart and Conclin we may list typical characteristics of hypermedia. These qualities largely agree with those of existing hypermedia systems:

- It must be possible to use hypermedia both for writing and reading information.
- The information comprises non-sequential structures, and may thus be followed along alternative paths.
- The information must follow natural associations from one information unit to another.
- The information may be hierarchically structured.
- Each information unit is presented in a separate on-screen window.
- It must be possible to share the information or parts of it among several users.
- It must be possible to have several people working with the database at the same time.
- The information resides in a database.

The literature on this occasionally appears to use the terms hypertext and hypermedia in a wider sense, so that the requirements above are not met. We will use "hypermedia" in the stricter sense of the term in rest of this chapter. Hypermedia is primarily a means for information exchange among persons.

At present, work is underway to develop a common reference work for hypermedia—"The Dexter Hypertext Reference Model"—which aims to standardize hypertext terms and concepts. A common standard, may clarify terminology, permitting various hypersystems to be considered more homogeneously. Furthermore, such standardization may form the basis for exchanging hyperdocuments among different hypersystems. However, it is so far uncertain whether this standard would be appropriate for describing existing systems, as it may set too strict requirements, thus excluding some existing systems. Because of the lack of standards, formal descriptions and methods, hypermedia must be regarded as an immature science. This would include both hypermedia itself as a technique and its applications. An important area for research is developing methods or models for hypermedia construction, and there is much work still to be done here. Initial work in this area suggests dividing these models into:

- Hypermedia design models
- Object-oriented hypermedia design models

From the first category three models are especially familiar: The Hypermedia Design Model—HDM, The Hypermedia Data Model—HM-data model, and The Relationship Management Design Model—RMD. Examining these more closely is beyond the scope of this book.

COMPONENTS OF HYPERMEDIA

Figure 36.2 is a general model of a typical advanced hypermedia system, divided into its component parts. The different components consist of nodes, links, hyperdocuments, diagrams, a search engine and a programming interface. The information itself in hypermedia consists of a number of hyperdocuments. The hyperdocuments again are built by a collection of nodes and links. Each hyperdocument comprises an independent, limited topic, and each node is an independent information unit. Links handle a natural switch from one node to another, thus structuring the hyperdocument.

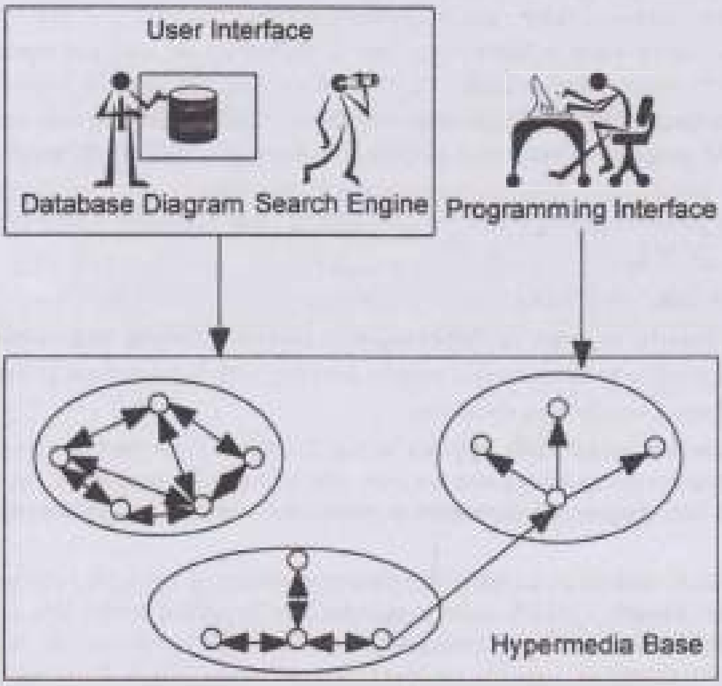


Figure 36.2 Model of a Typical Advanced Hypermedia System

A user's access to information primarily occurs directly via the hyperdocument nodes, by presenting each node in a screen window. This is suggested in Figure 36.2 by that part of the user interface box, which goes directly to the hyperbase. The user will then follow the links from node to node based on the information contained in each node.

For a number of reasons it is not always sufficient to follow links to access the desired information. For example, the user may have "lost his way" and is unable to locate what she/he wants in the hyperbase, or the structure in the document may be too difficult to understand. Therefore two alternatives exist for accessing information: using a database diagram, or simply diagram, and using a search engine.

A **database diagram** is a graphic overview of the hyperdocument. It allows the user to navigate directly between nodes in the hyperdocument, without following the links. Furthermore, such diagrams may help users navigate by allowing them to more easily understand the structure of the document. They thus simplify both navigation and orientation in the hypermedia database.

A **search engine** is a mechanism that allows a user to search directly for information in the hypermedia database. Search engines may find nodes of a certain type, or names or nodes containing specific information. Search engines therefore, will normally disregard the existing hyperdocument structure.

Advanced hypermedia systems may have search engines, which allow the formulation of direct queries in the hyperbase. Users may then describe precisely the information they want using a formal language. Using a structured query language may also be applied to filtering. The information found by the search engine may then be merged with the structure information of the hyperdocument, allowing the user to see only an excerpt of the hyperdocument. This permits the user to navigate in the usual way, via links and diagrams, but only accessing those parts of the hyperdocument which satisfy the formulated query.

Some hypermedia systems have special programming interfaces enabling the creation of special applications for the existing hypermedia system. Furthermore, the programming interface may be used to add new features to the system. It may, for example, be used to connect the hypermedia database to more advanced search routines, or to link it to other applications allowing these to access the information in the hypermedia database.

HYPERMEDIA APPLICATIONS

Accessing information is basically different when using hypermedia than when using traditional database technology. Typical traditional database access is via direct inquiry using unique keys or queries in the information database. In hypermedia, information access is handled through structuring the information. Users access new information by following links from existing information to new information.

Simply put, information in hypermedia databases has three typical features. Firstly, the information is not homogenous. Different forms of information objects such as text, audio and pictures may be used alone or together, and information, which is semantically different, is tied together. Secondly, hypermedia systems have a high degree of user interaction. Thirdly, hypermedia information is structured. If the hyperbase is to be built from information already possessing a structure, this structure may be retained, if so desired. Hypermedia may thus be employed to model existing structure. For example, a hyperdocument based on a book, may be structured in the same way as the original. Conversely, hypermedia may also be used to introduce a new structure in the information. An author writing about a hypermedia topic may use whatever structure he/she desires. Hypermedia, may thus also be used to structure information. Now, let us examine some typical applications for hypermedia. To place this in context, we shall start by describing a system, which probably would not lend itself to hypermedia.

A System Less Suited for Hypermedia

A vehicle register consists of a number of items, with each item (object) representing a vehicle. Each object is structured identically, with a fixed number of fields describing the object's attributes. The content of the information database thus has a high degree of homogeneity. There is little relation between the individual objects, as a vehicle does not have a direct link to another vehicle. Inquiries may be made using vehicle registration numbers or owner names. Directing inquiries to particular vehicles is rarely necessary; the typical transaction is periodically processing the entire database. One such process may be periodical printing of summons for technical checks. Such a system will not be able to utilize the special features offered by hypermedia. Hypermedia information databases are homogenous, and the ability of hypermedia to connect different information objects is not very interesting in this case. Each object is independent of other objects, and there is no way the vehicle register can utilize hypermedia's ability to structure information. Moreover, a vehicle register would have little need for user interaction.

Application Areas Well Suited for Hypermedia

Given below are some application areas that are well suited for hypermedia.

- **Literature systems**—Different types of literature require organizing the material, as well as references to other literature. Literature systems lend themselves well to the rich ways of structuring information afforded by hypermedia. Documents are kept together by means of organization links. This structure may be created by the author, or it may be the original structure of a document which has been converted from printed text to hypermedia. References to other parts of the document and to other documents are handled by reference links. This allows direct references to other documents, if the other documents are in the hyperbase.
- **Publishing**—Compared to traditional printed information media, hypermedia has the advantage of being able to present information other than text and pictures. Information objects such as audio and film may be included in the document. As this publishing is electronic, it will be easier to distribute than traditional printed matter.
- **Instruction systems**—Hypermedia is often employed in interactive instruction systems. The student can browse the information at will, hopefully learning while jumping from node to node. Instruction systems require the ability to guide the student through the material, creating recommended paths to follow. A simple way to add comments is also required.
- **Problem-solving systems**—This type of a system is used for inter-group communication. When using hypermedia's opportunities for allowing a number of users to access the same information set, a work group may seek solutions to different issues. Discussions, document sharing, and the ability to let work-group members comment on the work of other members are typical features of such systems.
- **Idea tools**—A number of experts have argued that the linear structure of traditional documents is inadequate for representing thoughts and ideas. As hypermedia offers a non-linear structure, it may well be an appropriate tool for structuring thoughts and ideas.

REVIEW QUESTIONS

Descriptive Type Questions

01. What is hypermedia?
02. What are the characteristics of hypermedia?
03. What are the components of hypermedia?
04. What are the areas well suited for hypermedia applications?
05. What are the benefits of using hypermedia?

Fill in the Blanks

01. The very first person to directly formulate the hypermedia concept was ______________.
02. The concept of hypertext, and later hypermedia was created by ______________.

03. ____________ created the hypermedia system Xanadu.
04. NLS stands for ____________.
05. WYSIWIS stands for ____________.

[**Answers:** (1) Vannevar Bush (2) Theodor Holm Nelson (3) Theodor Holm Nelson (4) Online System (5) What You See Is What I See]

True or False

01. The Memex was intended to structure information by association, in contrast to the traditional structuring by index.
02. Hypermedia is a network containing several inter-linked information units.
03. In a hypermedia system the mouse cursor is sensitive to link spots, changing its shape when on a link spot.
04. A database diagram is a graphic overview of the hyperdocument and allows the user to navigate directly between nodes in the hyperdocument, without following the links.
05. A search engine is a mechanism that allows a user to search directly for information in the hypermedia database.

[**Answers:** (1) True (2) True (3) True (4) True (5) True]

CHAPTER 37

Artificial Intelligence and Business Intelligence

TOPICS COVERED

- Artificial Intelligence (AI)
- Applications of AI
- AI in business and industry
- Business intelligence (BI)
- Reasons for BI
- Benefits of BI
- Factors influencing BI
- BI technology
- BI and ERP
- Future of BI

Key Points

- Artificial Intelligence (AI) is the area of computer [illegible] focusing on creating machines that can engage on behaviors [illegible] humans consider intelligent.
- The various application areas where AI is currently [illegible] used include game playing, speech recognition, natural [illegible] processing, computer vision, expert systems, neural [illegible] robotics, etc.
- Some of the business functions where AI is used are [illegible] medicine, manufacturing industry, transp[illegible] telecommunications, aviation, etc.
- Business Intelligence (BI) is a broad category of applica[illegible] and technologies for gathering, providing access [illegible] analyzing data for the purpose of helping enterprise users [illegible] better business decisions.
- The ultimate objective of BI is to improve the time[illegible] quality of information. Timely and good quality inform[illegible] like having a crystal ball that can give you an indication [illegible] is the best course to take.
- BI provides many benefits to companies utilizing [illegible] eliminate a lot of the guesswork within an organization, [illegible] communication among departments while coordinating [illegible] and enabling companies to respond quickly to [illegible] financial conditions, customer preferences and supply [illegible] operations. BI improves the overall performance of the [illegible] using it.
- The main factors that influence business intelligence [illegible] customers, competitors and competition, business partners [illegible] suppliers, business environment, and internal factors [illegible] efficiency, infrastructure, etc.
- The power and effectiveness of ERP can be enhanced [illegible] provide even greater value through the addition of [illegible] business intelligence systems.

ARTIFICIAL INTELLIGENCE (AI)

Artificial Intelligence (AI) is the area of computer science focusing on creating machines that can engage on behaviors that humans consider intelligent. The ability to create intelligent machines has intrigued humans since ancient times, and today with the advent of the computer and 50 years of research into AI programming techniques, the dream of smart machines is becoming a reality. Researchers are creating systems which can mimic human thought, understand speech, beat the best human chess player, and countless other feats never before possible. John McCarthy, regarded as the father of AI and who coined the term in 1956, defines AI as "the science and engineering of making intelligent machines."

AI is a combination of computer science, physiology, and philosophy. AI is a broad [illegible] consisting of different fields, from machine vision to expert systems. The element that the fields [illegible] have in common is the creation of machines that can "think". In order to classify machines as "thinking", it is necessary to define intelligence. To what degree does intelligence consist of, for example, solving complex problems, or making generalizations and relationships, perception and comprehension? Research into the areas of learning, of language, and of sensory perception has aided scientists in building intelligent machines.

One of the most challenging approaches facing experts is building systems that mimic the behavior of the human brain, made up of billions of neurons, and arguably the most complex matter in the universe. Perhaps the best way to gauge the intelligence of a machine is British computer scientist Alan Turing's test. The Turing test is a proposal for a test of a machine's ability to demonstrate intelligence. Described by Alan Turing in 1950 in the paper "*Computing Machinery and Intelligence*", it proceeds as follows: a human judge engages in a natural language conversation with one human and one machine, each of which tries to appear human. All participants are placed in isolated locations. If the judge cannot reliably tell the machine from the human, the machine is said to have passed the test. In order to test the machine's intelligence rather than its ability to render words into audio, the conversation is limited to a text-only channel such as a computer keyboard and screen.

Artificial Intelligence has come a long way from its early roots, driven by dedicated researchers. The beginnings of AI date back before electronics, to philosophers and mathematicians such as Boole and others, whose theories and principles were used as the foundation of AI Logic. AI really began to intrigue researchers with the invention of the computer in 1943. The technology was finally available, or so it seemed, to simulate intelligent behavior. Over the last four decades, despite many stumbling blocks, AI has grown from a dozen researchers, to thousands of engineers and specialists; and from programs capable of playing checkers, to systems designed to diagnose disease.

AI has always been on the pioneering end of computer science. Advanced-level computer languages, as well as computer interfaces and word-processors owe their existence to the research into artificial intelligence. The theory and insights brought about by AI research will set the trend in the future of computing. The products available today are only bits and pieces of what are soon to follow, but they are a movement towards the future of artificial intelligence. The advancements in the quest for artificial intelligence have, and will continue to affect our jobs, education, and lives.

APPLICATIONS OF AI

Artificial intelligence has been used in a wide range of fields including medical diagnosis, stock trading, robot control, law, scientific discovery and toys. However, many AI applications are not perceived as AI. A lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it is not labeled AI anymore. Many thousands of AI applications are deeply embedded in the infrastructure of every industry. The various application areas where AI is currently being used include game playing, speech recognition, natural language processing, computer vision, expert systems, neural networks, robotics, etc. As computers become smaller and less expensive, more and more intelligence is built into automobiles, appliances, and other machines, as well as computer software, in everyday use.

The greatest advancements in AI have been achieved in the field of **gaming**. Computer chess programs can now beat even the world champions. In 1997, IBM's supercomputer Deep Blue defeated then, the world chess champion Gary Kasparov.

Speech or voice recognition is the ability of a machine or program to recognize and carry out voice commands or take dictation. In general, speech recognition involves the ability to match a voice pattern against a provided or acquired vocabulary. Usually, a limited vocabulary is provided with a product and the user can record additional words. More sophisticated software has the ability to accept natural speech (meaning speech as we usually speak it, rather than carefully spoken speech).

Natural language processing is the analysis and generation of natural language text by the computer. The goal is to enable natural languages, such as English, French, or Japanese, to serve either as the medium through which users interact with computer systems such as database management systems and expert systems (natural language interaction), or as the object that a system processes into some more useful form such as in automatic text translation or text summarization (natural language text processing).

Computer vision is the technology concerned with computational understanding and use of the information present in visual images. The goal of computer vision is primarily to enable engineering systems to model and manipulate the environment by using visual sensing. In manufacturing, vision-based sensing and interpretation systems help in automatic inspection, such as identification of cracks, holes, and surface roughness, counting of objects, and alignment of parts. Computer vision helps in proper manipulation of an object, for example, in automatic assembly, automatic painting of a car, and automatic welding. Autonomous navigation, used for delivering material on a cluttered factory floor, has much to gain from vision to improve on the fixed, rigid path taken by vehicles which follow magnetic tracks pre-laid on the floor. Recognition of symptoms, for example, in a chest x-ray, is important for medical diagnosis. Classification of satellite pictures of the Earth's surface to identify vegetation, water, and crop types, is an important function. Automatic visual detection of storm formations and movements of weather patterns is crucial for analyzing the huge amounts of global weather data that constantly pour in from sensors.

An **expert system is** a computer program that simulates the judgment and behavior of a human or an organization that has expert knowledge and experience in a particular field. Typically, such a system contains a knowledge base containing accumulated experience and a set of rules for applying the knowledge base to each particular situation, which is described to the program. Sophisticated expert systems can be enhanced with additions to the knowledge base or to the set of rules. The best known expert systems have been those which play chess and that assist in medical diagnosis.

Neural networks are computer systems that are designed to mimic the human brain or some other biological system in its functioning. They were developed to deal with problems, like pattern recognition, that the brain does well, but that traditional computer systems cannot handle easily. The computers are programmed to simulate intelligence by attempting to reproduce the types of physical connections that occur in the human brain. Neural computing systems mimic the brain through a network of highly interconnected processing elements, which give them learning capabilities and enable then to recognize and understand subtle or complex patterns. Neural networks are also being widely deployed in security, speech and text recognition, data mining, oil exploration data analysis, weather prediction, the interpretation of nucleotide sequences in biology labs, exploration of models of thinking and consciousness, and e-mail spam filtering.

Robotics is a field of engineering concerned with the development and application of robots, and computer systems for their control, sensory feedback, and information processing. This field overlaps with electronics, computer science, artificial intelligence, mechatronics, nanotechnology, and bioengineering. The many types of robotic systems include robotic manipulators, robotic hands, mobile robots, walking robots, aids for disabled persons, telerobots, and micro electro-mechanical systems.

AI IN BUSINESS AND INDUSTRY

Some of the business functions where AI is used are finance, medicine, manufacturing industry, transportation, telecommunications, aviation, etc.

Banks use artificial intelligence systems to organize operations, invest in stocks, and manage properties. In August 2001, robots beat humans in a simulated financial trading competition. Financial institutions have long used artificial neural network systems to detect charges or claims outside of the norm, flagging these for human investigation. A medical clinic can use artificial intelligence systems to organize bed schedules, staff rotation, and provide medical information. They may also be used for medical diagnosis. Artificial neural networks are used for medical diagnosis (such as in Concept Processing technology in EMR software), functioning as machine differential diagnosis.

Robots have become common in many industries. They are often given jobs that are considered dangerous to humans. Robots have proven effective in jobs that are very repetitive, which may lead to mistakes or accidents due to a lapse in concentration and other jobs which humans may find degrading. General Motors uses around 16,000 robots for tasks such as painting, welding, and assembly. Japan is the leader in using and producing robots in the world. In 1995, about 700,000 robots were in use worldwide; over 500,000 of which were from Japan. Fuzzy logic controllers have been developed for automatic gearboxes in automobiles. Many telecommunications companies make use of heuristic search in the management of their workforces, for example BT Group has deployed heuristic search in a scheduling application that provides the work schedules of 20,000 engineers.

In aviation, rule based expert systems are used for a variety of purposes like fault diagnosis and maintenance. The aviation industry uses artificial intelligence for surrogate operators for combat and training simulators, mission management aids, support systems for tactical decision making, and post processing of the simulator data into symbolic summaries. The use of artificial intelligence in simulators is proving to be very useful for the aviation industry. Airplane simulators are using artificial intelligence in order to process the data taken from simulated flights. Other than simulated flying, there is also simulated aircraft warfare. The computers are able to come up with the best success scenarios in these situations. The computers can also create strategies based on the placement, size, speed, and strength of the forces and counter forces. Pilots may be given assistance in the air during combat by computers. The artificial intelligent programs can sort the information and provide the pilot with the best possible maneuvers, not to mention getting rid of certain maneuvers that would be impossible for a sentient being to perform. Multiple aircrafts are needed to get good approximations for some calculations so computer simulated pilots are used to gather data. These computer simulated pilots are also used to train future air traffic controllers.

BUSINESS INTELLIGENCE (BI)

Business intelligence (BI) is the intelligence of businesses and is a new field of investigation of the application of human cognitive faculties and artificial intelligence technologies to the management and decision support in different business problems. It relates to intelligence as information valued for its currency and relevance. It is expert information, knowledge and technologies efficient in the management of organizational and individual business. Therefore, business intelligence is a broad category of applications and technologies for gathering, providing access to, and analyzing data for the purpose of helping enterprise users make better business decisions. The term implies having a comprehensive knowledge of all of the factors that affect your business. It is imperative that you have in-depth knowledge about factors such as your customers, competitors, business partners, economic environment and internal operations to make effective and good quality business decisions. BI enables you to make these kinds of decisions. A specialized field of business intelligence known as compet intelligence focuses solely on the external competitive environment. Information is gathered on the actions of competitors and decisions are made based on this information. Little, if any, attention is pa to gathering internal information.

REASONS FOR BI

Business intelligence enables organizations to make well-informed business decisions and thus can be the source of competitive advantages. This is especially true when you are able to extrap information from indicators in the external environment and make accurate forecasts about fut trends or economic conditions. Once business intelligence is gathered effectively and used proac you can make decisions that benefit your organization before the competitor does.

The ultimate objective of business intelligence is to improve the timeliness and quality of information. Timely and good quality information is like having a crystal ball that can give you an indication of what is the best course to take. Business intelligence reveals to you:

- ▲ The position of your firm in comparison to its competitors
- ▲ Changes in customer behavior and spending patterns
- ▲ The capabilities of your firm
- ▲ Market conditions, future trends, demographic and economic information
- ▲ The social, regulatory and political environment
- ▲ What the other firms in the market are doing

You can then deduce from the information gathered what adjustments needs to be ma Businesses realize that in this very competitive, fast-paced and ever-changing business environment, key competitive quality is how quickly they respond and adapt to change. Business intellig enables them to use information gathered to quickly and constantly respond to changes.

BENEFITS OF BI

BI provides many benefits to companies utilizing it. It can eliminate a lot of the guesswork within organization, enhance communication among departments while coordinating activities and en companies to respond quickly to changes in financial conditions, customer preferences and su chain operations. BI improves the overall performance of the company using it. After people, the m valuable asset, organizations regard information as the most important resource. So when a comp can make decisions based on timely and accurate information, it can improve its performance. BI a expedites decision-making, as acting quickly and correctly on information before comp businesses do, can result in competitively superior performance. It can also improve cust experience, allowing for the timely and appropriate response to customers' problems and priorit

FACTORS INFLUENCING BI

The main factors that influence business intelligence are customers, competitors and compe business partners and suppliers, business environment, and internal factors like effic infrastructure, etc.

- ▲ **Customers** are the most critical aspect to a company's success. Without them a comp cannot exist. So it is very important that you have information on their preferences. You m quickly adapt to their changing demands. Business intelligence enables you to gat information on the trends in the marketplace and come up with innovative produ services in anticipation of customer's changing demands.

- ▲ **Competitors** can present a huge hurdle on your way to success. Their objectives are the same as yours and that is to maximize profits and customer satisfaction. In order to be successful you must stay one step ahead of your competitors. In business you do not want to play the catch up game because you would have lost valuable market share. Business intelligence tells you what actions your competitors are taking, so you can make better-informed decisions.
- ▲ **Business partners** must possess the same strategic information you have, so that there is no miscommunication that can lead to inefficiencies. For example, it is common now for businesses to allow their suppliers to see their inventory levels, performance metrics and other supply chain data in order to collaborate and to improve supply chain management. With business intelligence you and your business partners can share the same information.
- ▲ **Business environment** such as the state of the economy and other key economic indicators are important considerations when making business decisions. You do not want to roll out a new line of products during an economic recession. BI gives you information on the state of the economy so that you can make prudent decisions as to when it is the right time to maybe expand or scale back your business operations.
- ▲ **Internal operations** are the day-to-day activities that go on in your business. You need in-depth knowledge about the internal workings of your business from top to bottom. If you make an arbitrary decision without knowing how your entire organization works; it could have negative effects on your business. BI gives you information on how your entire organization works.

BI TECHNOLOGY

Business intelligence provides organizational data in such a way that the organizational knowledge filters can easily associate with this data and turn it into information for the organization. Persons involved in business intelligence processes may use application software and other technologies to gather, store, analyze and provide access to data, and present that data in a simple, useful manner. The software aids in business performance management and aims to help people make "better" business decisions by making accurate, current and relevant information available to them when they need it. Some businesses use data warehouses because they are a logical collection of information gathered from various operational databases for the purpose of creating business intelligence. For the BI system to work effectively, enterprises must address the following technical issues: security and specified user access to the warehouse, data volume (capacity), how long data will be stored (data retention), and performance targets.

BI AND ERP

ERP systems offer powerful tools for better measure and control of organizational operations. Many organizations have found that the power of ERP can be enhanced to provide even greater value through the addition of powerful business intelligence systems. BI systems store data (usually in a data warehouse) and then analyze this data (usually using data mining and OLAP techniques). One of the most popular forms of data mining in ERP systems is support of customer relationship management or CRM. Data warehouses and data marts are two of the most popular extensions of ERP systems. A data warehouse is an orderly and accessible repository of known facts and related data used as a basis of making better management decisions. Data marts are created with a subset of data warehouse information usually focusing on information needed by a specific set of users. We will see more about data warehouses and data marts in Chapter 39. ERP systems, as we have seen, use data mining and on-line transaction processing (OLAP), to derive the information from the data warehouses. The ERP systems use the business intelligence generated using data mining, OLAP, multi-dimensional analysis and other data analysis techniques for a variety of applications like demand forecasting, production planning, product design, retailing, customer relationship management, credit card management, etc.

FUTURE OF BI

In this rapidly changing world, consumers are now demanding quicker more efficient service from businesses. To stay competitive, companies must meet or exceed the expectations of consumers. Companies will have to rely more heavily on their business intelligence systems to stay ahead of trends and future events. Business intelligence users are beginning to demand real-time business intelligence or near real-time analysis relating to their business, particularly in frontline operations. They will come to expect up-to-date and fresh information in the same fashion as they monitor stock quotes on-line. Monthly and even weekly analysis will not suffice. Business users do not want to wait for information. Information needs to be always on and never out of date. In the not too distant future, companies will become dependent on real-time business information in much the same fashion as people come to expect to get information on the Internet in just one or two clicks. This instant "Internet experience" will create the new framework for business intelligence, but business processes will have to change to accommodate and exploit the real-time flows of business data. Also, in the near future business information will become more democratized where end users from throughout the organization will be able to view information on their particular segment to see how it is performing. So, in the future, the capability requirements of business intelligence will increase in the same way that consumer expectations increase. It is therefore imperative that companies increase at the same pace or even faster to stay competitive.

REVIEW QUESTIONS

Short Answer Questions

01. What is artificial intelligence?
02. What are the applications of AI?
03. What the applications of AI in business and industry?
04. Who is considered as the father of AI?
05. What is business intelligence?
06. What do you mean by competitive intelligence?
07. Why are customers considered as the most critical aspect to a company's success?
08. How does BI help in dealing with the competitors?
09. Why the knowledge of the business environment is important?
10. What are the two most popular extensions of ERP?

Descriptive Type Questions

01. What is the importance of AI?
02. What do you mean by speech recognition?
03. What is natural language processing and what are its applications?
04. What do you mean by computer vision?
05. What are expert systems and what are they used for?
06. Explain neural networks.
07. What do you mean by robotics?
08. What is the importance of BI?

09. What is the need for BI?
10. What does BI reveal to its users?
11. What are the benefits of BI?
12. How does BI help in managing the business environment?
13. How does BI help in managing the internal operations of the organization?
14. What are the technologies used by BI?
15. How are BI and ERP related?

Essay Questions

01. Explain the term business intelligence.
02. What are the factors that influence BI? Explain the significance of each.
03. What is the future of BI?

Fill in the Blanks

01. __________ coined the term AI.
02. __________ defeated Gary Kasparov in 1997.
03. __________ is the ability of a machine or program to recognize and carry out voice commands or take dictation.
04. __________ is the technology concerned with computational understanding and use of the information present in visual images.
05. __________ is a field of engineering concerned with the development and application of robots, and computer systems for their control, sensory feedback, and information processing.
06. BI relates to intelligence as information valued for its ________ and ________.
07. __________ focuses solely on the external competitive environment.
08. __________ enables them to use information gathered to quickly and constantly respond to changes.
09. __________ are the most critical aspect to a company's success.
10. __________ and __________ are two of the most popular extensions of ERP systems.

[Answers: (1) John McCarthy (2) IBM's Deep Blue (3) Speech or voice recognition (4) Computer vision (5) Robotics (6) Currency, relevance (7) Competitive intelligence (8) Business intelligence (9) Customers (10) Data warehouses and data marts]

True or False

01. Natural language processing is the analysis and generation of natural language text by the computer.
02. An expert system is a computer program that simulates the judgment and behavior of a human expert.
03. Neural networks are computer systems that are designed to mimic the human brain or some other biological system in its functioning.
04. BI is expert information, knowledge and technologies efficient in the management of organizations.
05. The ultimate objective of business intelligence is to improve the timeliness and quality of information.
06. BI improves the overall performance of the company using it because of its high cost.
07. OLAP stands for On-line Transaction Processing.
08. ERP stands for Enterprise Resource Preservation.

[Answers: (1) True (2) True (3) True (4) True (5) True (6) False (7) True (8) False]

Knowledge discovery uses artificial intelligence, machine learning, and neural network techniques to discover new relationships by sifting through an ocean of data to distil fresh answers to unstated questions. The insights from these discovered relationships and trends could result in quantum leaps in understanding the information hidden in the database.

On-line data continues to grow at an explosive pace, due to the Internet and the widespread use of database technology. This phenomenon has created an immense opportunity and the need for methodologies of knowledge discovery in databases (KDD). An interdisciplinary area, KDD focuses upon building automated techniques for extracting useful knowledge from data.

Research in this area draws principally upon methods from statistics, data management, pattern recognition, and machine learning to deliver advanced techniques for business intelligence. Key advances in robust and scalable data mining techniques, methods for fast pattern detection in very large databases, text and web mining, as well as innovative business-intelligence applications are some of the reasons that fuelled the growth of the KDD discipline.

KNOWLEDGE DISCOVERY IN DATABASES (KDD)

Knowledge discovery in databases (KDD) is the non-trivial extraction of implicit, previously unknown, and potentially useful information from databases. Many scientific and transactional business databases grow at a phenomenal rate. Both, the number and size of databases are rapidly growing. This growth by far exceeds the human capacities to analyze the databases in order to find implicit regularities, rules or clusters hidden in the data. Or in other words, the amount of data being collected in databases today far exceeds our ability to reduce and analyze data without the use of automated analysis techniques. Therefore, knowledge discovery becomes more and more important in databases and KDD is the field that is evolving to provide automated analysis solutions.

Typical tasks for KDD are the identification of classes (clustering), the prediction of new, unknown objects (classification), the discovery of associations or deviations in spatial databases. The term 'visual data mining' refers to the emphasis of integrating the user in the KDD process. Since these are challenging tasks, KDD algorithms should be incremental, i.e., when updating the database the algorithm does not have to be applied to the whole database. KDD is thus the process of discovering valuable information in large volumes of data by using pattern recognition technologies as well as statistical and machine learning techniques. KDD provides a means of extracting previously unknown information from the growing base of accessible data to create competitive advantages for organizations. KDD is often mentioned together with data warehouse, data mining, and OLAP.

A **Data warehouse** contains large amounts of data in a read-only database where data from several operational systems are integrated, aggregated, and historized. **OLAP (on-line analytical processing)** is the multidimensional analysis of data. Existing hypotheses are verified or disproved with queries against the database. OLAP is verification-driven. **Data Mining** is the discovery-driven analysis of databases. KDD addresses the complete business process involving data mining and OLAP, i.e. from data collection to the deployment of results. We will discuss these technologies in the next chapters.

BASIC FEATURES OF KDD

Although there are many approaches to KDD, six common and essential elements qualify each as a knowledge discovery technique. The following are basic features that all KDD techniques share:

- The approaches deal with large amounts of data
- Efficiency is required due to volume of data

- Accuracy is an essential element
- They require the use of a high-level language
- They approaches use some form of automated learning
- They produce some interesting results

Large amounts of data are required to provide sufficient information to derive additional knowledge. Since large amounts of data are required, processing efficiency is essential. Accuracy is required to assure that discovered knowledge is valid. The results should be presented in a manner that is understandable by humans. One of the major premises of KDD is that the knowledge is discovered using intelligent learning techniques that sift through the data in an automated process. For this technique to be considered useful in terms of knowledge discovery the discovered knowledge must be interesting; i.e., it must have potential value to the user.

ADVANTAGES OF KDD

KDD provides the capability to discover new and meaningful information by using existing data. KDD quickly exceeds the human capacity to analyze large data sets. The amount of data that requires processing and analysis in a large database exceeds human capabilities, and the difficulty of accurately transforming raw data into knowledge surpasses the limits of traditional databases. Therefore, the full utilization of stored data depends on the use of knowledge discovery techniques. The usefulness of future applications of KDD is far-reaching. KDD may be used as a means of information retrieval, in the same manner that intelligent agents perform information retrieval on the web. New patterns or trends in data may be discovered using these techniques. KDD may also be used as a basis for the intelligent interfaces of tomorrow, by adding a knowledge discovery component to a database engine or by integrating KDD with spreadsheets and visualizations.

PHASES OF KDD

Knowledge discovery, also known as data discovery, uses data warehouse technology as a starting point. To provide meaningful results, the knowledge discovery software needs extensive and detailed data. The basic steps of knowledge discovery are given below:

- **Selection** – Creating possible segmentation criteria for selecting data.
- **Preprocessing** – Normalize, rationalize and cleanse the data.
- **Transformation** – Create general representation and tables of metadata.
- **Extraction** – Extract patterns from the data warehouse, turning data into knowledge.
- **Interpretation and Evaluation** – Evaluate utility of extracted and identified patterns.

The first three steps (selection, preprocessing, and transformation) are usually done during the data warehousing stage. The fourth step, the extraction of patterns, is performed by applying artificial intelligence or statistical techniques based on initial patterns created from the metadata. Clearly the metadata and knowledge representation activities are important. The interpretation of the results, the fifth step, can be partially automated based on predefined criteria; but, for a major part, it is a manual evaluation process. If we could completely define the evaluation criteria, then the process would simply be a database lookup.

KDD TECHNIQUES

Learning algorithms are an integral part of KDD. Learning techniques may be supervised or unsupervised. In general, supervised learning techniques enjoy a better success rate as defined in terms of usefulness of discovered knowledge. Learning algorithms are complex and generally considered the hardest part of any KDD technique. Machine discovery is one of the earliest fields that have contributed to KDD. While machine discovery relies solely on an autonomous approach to information discovery, KDD typically combines automated approaches with human interaction to assure accurate, useful, and understandable results.

There are many different approaches that are classified as KDD techniques. There are quantitative approaches, such as the probabilistic and statistical approaches. There are approaches that utilize visualization techniques. There are classification approaches such as Bayesian classification, inductive logic, data cleaning or pattern discovery, and decision tree analysis. Other approaches include deviation and trend analysis, genetic algorithms, neural networks, and hybrid approaches that combine two or more techniques. Because of the ways that these techniques can be used and combined, there is a lack of agreement on how these techniques should be categorized. For example, the Bayesian approach may be logically grouped with probabilistic approaches, classification approaches, or visualization approaches. For the sake of organization, each approach described here is included in the group that it seemed to be the best fit. However, this selection is not intended to imply a strict categorization.

Probabilistic Approach

This family of KDD techniques utilize graphical representation models to compare different knowledge representations. These models are based on probabilities and data independencies. They are useful for applications involving uncertainty and applications structured such that a probability may be assigned to each "outcome" or bit of discovered knowledge. Probabilistic techniques may be used in diagnostic systems and in planning and control systems. Automated probabilistic tools are available both commercially and in the public domain.

Statistical Approach

The statistical approach uses rule discovery and is based on data relationships. An inductive learning algorithm can automatically select useful join paths and attributes to construct rules from a database with many relations. This type of induction is used to generalize patterns in the data and to construct rules from the noted patterns. OLAP is an example of a statistically oriented approach. Automated statistical tools are available both commercially and in the public domain. An example of a statistical application is determining that all transactions in a sales database that start with a specified transaction code are cash sales. The system would note that of all the transactions in the database, only 60 percent are cash sales. Therefore, the system may accurately conclude that 40 percent are collectibles.

Classification Approach

Classification is probably the oldest and most widely used of all the KDD approaches. This approach groups data according to similarities or classes. There are many types of classification techniques and numerous automated tools available.

The **Bayesian approach** to KDD is a graphical model that uses directed arcs exclusively to form a directed acyclic graph. Although the Bayesian approach uses probabilities and a graphical means of representation, it is also considered a type of classification. Bayesian networks are typically used when the uncertainty associated with an outcome can be expressed in terms of a probability. This approach relies on encoded domain knowledge and has been used for diagnostic systems. Other pattern recognition applications, including the Hidden Markov Model, can be modeled using a Bayesian approach. Automated tools are available both commercially and in the public domain.

Pattern discovery and **data cleaning** is another type of classification that systematically reduces a large database to a few pertinent and informative records. If redundant and uninteresting data is eliminated, the task of discovering patterns in the data is simplified. This approach works on the premise of the old adage, "less is more". The pattern discovery and data cleaning techniques are useful for reducing enormous volumes of application data, such as those encountered when analyzing automated sensor recordings. Once the sensor readings are reduced to a manageable size using a data cleaning technique, the patterns in the data may be more easily recognized. Automated tools using these techniques are available both commercially and in the public domain.

The **decision tree approach** uses production rules, builds a directed acyclical graph based on data premises, and classifies data according to its attributes. This method requires that data classes are discrete and predefined. The primary use of this approach is for predictive models that may be appropriate for either classification or regression techniques. Tools for decision tree analysis are available commercially and in the public domain.

Deviation and Trend Analysis

Pattern detection by filtering important trends is the basis for KDD approach. Deviation and trend analysis techniques are normally applied to temporal databases. A good application for this type of KDD is the analysis of traffic on large telecommunications networks. AT&T uses such a system to locate and identify circuits that exhibit deviation (faulty behavior). The sheer volume of data requiring analysis makes an automated technique imperative. Trend-type analysis might also prove useful for astronomical and oceanographic data, as they are time-based and voluminous. Public domain tools are available for this approach.

Other Approaches

Neural networks may be used as a method of knowledge discovery. Neural networks are particularly useful for pattern recognition and are sometimes grouped with the classification approaches. There are tools available commercially and in the public domain. Genetic algorithms, also used for classification, are similar to neural networks although they are typically considered more powerful. There are tools for the genetic approach available commercially.

Hybrid Approach

A hybrid approach to KDD combines more than one approach and is also called a **multi-paradigm approach**. Although implementation may be more difficult, hybrid tools are able to combine the strengths of various approaches. Some of the commonly used methods combine visualization techniques, induction, neural networks, and rule-based systems to achieve the desired knowledge discovery. Deductive databases and genetic algorithms have also been used in hybrid approaches. There are hybrid tools available commercially and in the public domain.

REVIEW QUESTIONS

Short Answer Questions

01. What are the techniques used for knowledge discovery?
02. What do you mean by the terms data warehouse, OLAP, and data mining?
03. What are the basic features of KDD?
04. Why is KDD important and what are its uses?
05. What are the typical tasks for KDD?

Descriptive Type Questions

01. What are the probabilistic KDD approaches?
02. What do you mean by the statistical KDD approach?
03. What is the Bayesian KDD approach?
04. What do you mean by the pattern discovery and data cleaning KDD approach?
05. What do you mean by the decision tree KDD approach?
06. What are the deviation and trend analysis KDD approaches?
07. What are the hybrid KDD approaches?
08. What is the future of KDD?

Essay Questions

01. What is knowledge discovery? Why is knowledge discovery important?
02. What is knowledge discovery in databases?
03. What are the advantages of KDD?
04. What are the different phases of KDD?
05. What are the different KDD techniques?

Fill in the Blanks

01. ___________ is defined as the non-trivial extraction of implicit, unknown, and potentially useful information from data.
02. ___________ is the non-trivial extraction of implicit, previously unknown, and potentially useful information from databases.
03. ___________ is the process of discovering valuable information in large volumes of data by using pattern recognition technologies as well as statistical and machine learning techniques.
04. A ___________ contains large amounts of data in a read-only database where data from several operational systems are integrated, aggregated and historized.
05. ___________ is the multidimensional analysis of data.
06. ___________ is the discovery-driven analysis of databases.
07. ___________ utilize graphical representation models to compare different knowledge representations.
08. The ___________ to KDD is a graphical model that uses directed arcs exclusively to form a directed acyclic graph.
09. The ___________ uses production rules, builds a directed acyclical graph based on data premises, and classifies data according to its attributes.
10. A ___________ to KDD combines more than one approach and is also called a multi-paradigmatic approach.

[**Answers:** (1) Knowledge discovery (2) Knowledge discovery in databases (KDD) (3) Knowledge discovery in databases (KDD) (4) Data warehouse (5) OLAP (6) Data mining (7) Probabilistic KDD techniques (8) Bayesian Approach (9) Decision tree approach (10) Hybrid approach]

True or False

01. Knowledge discovery is a new field that combines several techniques from computer science and artificial intelligence to search for relationships and global patterns in large databases.
02. The basic task of extracting knowledge from data is known as data warehousing.
03. KDD focuses upon building automated techniques for extracting useful knowledge from data.
04. KDD provides a means of extracting previously unknown information from the growing base of accessible data to create competitive advantages for organizations.

05. OLTP is verification-driven.
06. Probabilistic techniques may be used in diagnostic systems and in planning and control systems.
07. The statistical KDD approach uses rule discovery and is based on data relationships.
08. An inductive learning algorithm can automatically select useful join paths and attributes to construct rules from a database with many relations.
09. OLAP is an example of a probabilistic KDD approach.
10. Neural networks may be used as a method of knowledge discovery.

[**Answers:** (1) True (2) False (3) True (4) True (5) False (6) True (7) True (8) True (9) False (10) True]

CHAPTER 39

Data Warehouses and Data Marts

TOPICS COVERED

- Introduction
- Data in the data warehouse
- Data warehouse architecture
- Data warehousing system
- Advantages of a data warehouse
- Data marts
- Advantages of data marts

Key Points

▲ Data warehouse is a collection of data designed to support management decision-making. The primary goals of a Data Warehouse are providing access to the data of an organization, data consistency, capacity to separate and combine data, inclusion of tools set to query, analyze, and present information, publishing used data, driving business re-engineering, etc.

▲ The collection of data used by data warehouse may be characterized as subject-oriented, integrated, non-volatile, and time variant.

▲ The major components of a data warehouse are summarized data, operational systems of record, integration/transformation programs, current detail, data warehouse architecture or metadata, and archives.

▲ The main benefits of implementing a data warehouse are cost-effective decision-making, better business intelligence, enhanced customer service, business re-engineering, information system re-engineering, etc.

▲ A data mart stores only that information, which is needed to address a particular subject area and this can be translated as supporting the needs of a specific group of users. Compared with a data warehouse a data mart has a smaller data model, a shorter implementation curve, less data and fewer users.

NTRODUCTION

ata **warehouse** is a collection of data esigned to support management ecision-making. Data warehouses ntain a wide variety of data that esent a coherent picture of business nditions at a single point in time. evelopment of a data warehouse cludes development of systems to tract data from operating systems us installation of a warehouse tabase system that provides nagers flexible access to the data. e term 'data warehousing' generally ers to combine many different databases across an entire enterprise. The primary goals of a data rehouse are the following:

- Provide access to the data of an organization
- Data consistency
- Capacity to separate and combine data
- Inclusion of tools set to query, analyze, and present information
- Publish used data
- Drive business re-engineering

DATA IN THE DATA WAREHOUSE

The collection of data used by data warehouse may be characterized as subject-oriented, integrated, non-volatile, and time variant.

- **Subject-oriented** — The data warehouse is oriented toward those major subject areas of the organization, which have been defined in the data model. Examples of typical subject areas include the following: customer, product, transaction or activity, account, etc.
- **Integrated** — The data warehouse potentially can receive data from a number of sources. Each of these sources had an application designer(s), each freely encoding, naming conventions, physical attributes, and measurement of attributes. The filtering and translation necessary to transform the many sources into one consistent database is known as integration.
- **Nonvolatile** — While it is common in the operational environment for data to be updated and therefore changed, the same is not true in the data warehouse. Data is loaded and accessed but not changed.
- **Time variant** — Table 39.1 compares the time horizon, valuation and presence of the time element of an operational system to that of a data warehouse.

Table 39.1 Comparison between Time Horizon, Valuation and Presence

	Operational systems	Data warehouse
Time horizon	Less than 365 days	5 - 10 years
Time valuation	Current value date (changes)	Series of snapshots (no changes)
Element of time	May or may not contain year, month, day	Always contains some element of time

DATA WAREHOUSE ARCHITECTURE

In this section, we present an overview of the architecture and major components of a data warehouse. We describe each of the components of a data warehouse (see Figure 39.1). This description is based upon the work of W. H. Inmon, credited as the father of the data warehouse concept. The main components of a data warehouse are given below:

- Summarized data
- Operational systems of record
- Integration/Transformation programs
- Current detail
- Data warehouse architecture or metadata
- Archives

Summarized Data

Summarized data is classified into two—lightly summarized and highly summarized. Lightly summarized data are the hallmark of a data warehouse. All enterprise elements (department, region, function, etc.) do not have the same information requirements, so effective data warehouse design provides for customized, lightly summarized data for every enterprise element. An enterprise element may have access to both detailed and summarized data, but there will be much less than the [illegible]

[illegible]

summarized data can come from either the lightly summarized data used by [illegible] from current detail. Data volume at this level is much less than other levels and [illegible] collection supporting a wide variety of needs and interests. In addition to access to [illegible] data, executives also have the capability of accessing increasing levels of detail through a "drill down" process.

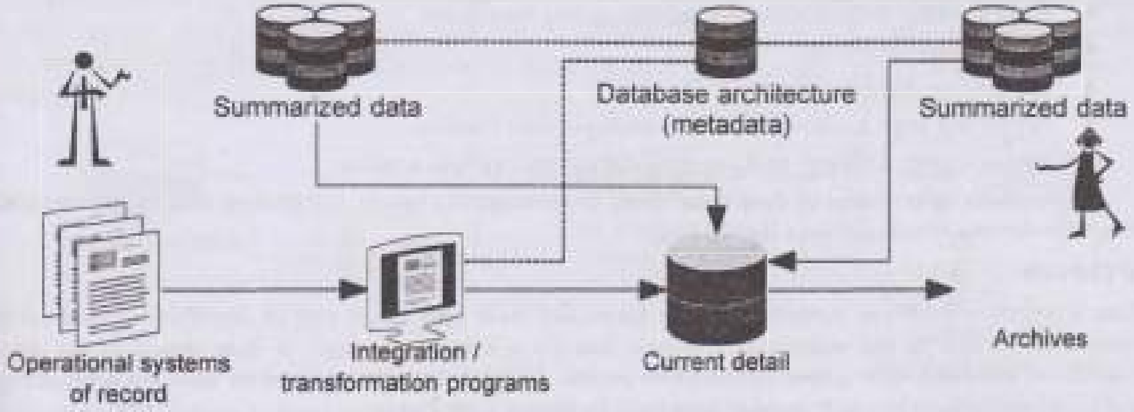


Figure 39.1 Components of a Data Warehouse

Current Detail

The heart of a data warehouse is its current detail, where the bulk of data resides. Current detail comes directly from operational systems and may be stored as raw data or as aggregations of raw data. Current detail, organized by subject area, represents the entire enterprise, rather than a given application. Current detail is the lowest level of data granularity in the data warehouse. Every data entity in current detail is a snapshot, at a moment in time, representing the instance when the data are accurate. Current detail is typically two to five years old. Current detail refreshment occurs as frequently as necessary to support enterprise requirements.

System of Record

A system of record is the source of the data that feed the data warehouse. Data in a data warehouse differ from operational systems data in that they can only be read, not modified. Thus, it is necessary that a data warehouse be populated with the highest quality data available, i.e., data that are most timely, complete, accurate, and have the best structural conformance to the data warehouse. Often these data are closest to the source of entry into the production environment. In other cases, a system of record may be one containing already summarized data.

Integration and Transformation Programs

Even the highest quality operational data cannot usually be copied, as it is, into a data warehouse. Raw operational data are virtually unintelligible to most information users. Additionally, operational data seldom conform to the logical, subject-oriented structure of a data warehouse. Further, different operational systems represent data differently, use different codes for the same thing, squeeze multiple pieces of information into one field, and more. Operational systems in most enterprises have been developed independently (no common enterprise data architecture), which means that most operational data are stored and managed redundantly and may even reside in many different physical sources—old mainframe files, non-relational databases, indexed flat files, even proprietary tape, and card-based systems. These operational data must be cleaned up, edited, and reformatted before being loaded into a data warehouse. As operational data items pass from their systems of record to a data

warehouse, integration and transformation programs convert them from application-specific data in
enterprise data. These integration and transformation programs perform functions such as:

- Reformatting, recalculating, or modifying key structures
- Adding time elements
- Identifying default values
- Supplying logic to choose between multiple data sources
- Summarizing, tallying, and merging data from multiple sources

When either operational or data warehouse environments change, integration and transformat programs are modified to reflect that change.

Archives

Data warehouse archives contain old data (normally over two years old) of significant, continu interest and value to the enterprise. There is usually a massive amount of data stored in the da warehouse archives, with a low incidence of access. Archive data are most often used for forecas and trend analysis. Although archive data may be stored with the same level of granularity as cur detail, it is more likely that archive data are aggregated as they are archived. Archives include not old data (in raw or summarized form); they also include the metadata that describes the old da characteristics.

Metadata

The physical implementation of a data warehouse is defined using a naming convention and sy rules which, while it may be convenient to IT staff, can be obscure and off-putting to business users s therefore a requirement that a separate data definition language is implemented, which provide meaningful description of the information contents. This is usually known as metadata—literally about data. Many products implement an effective metadata layer and users define their requireme n terms of the meaningful 'real-world' descriptions irrespective of the physical implementat Unfortunately, while attempts have been made to establish standards in this area, different vendors will use their own metadata repository. This makes it more time consuming to adopt a and match' approach to tool selection as the work of defining the metadata may have to be rep everal times.

The term may also be used in a different context. When data is to be extracted from a host or loading into the data warehouse the mapping between the two architectures is also somet nown as metadata—it is still a description of data but used in a different manner. The unfortunately' comment still applies—extraction and transformation products from different vill not use or understand the others' metadata. As we have seen, one of the most important pa lata warehouse is its metadata—or data about data. Also called data warehouse archit netadata is integral to all levels of the data warehouse, but exists and functions in a d limension from other warehouse data. Metadata that is used by data warehouse develope nanage and control data warehouse creation and maintenance resides outside the data wareho Metadata for data warehouse users is part of the data warehouse itself and controls access and f the data warehouse contents. To a data warehouse user, metadata is like a "card catalog" ubjects available.

DATA WAREHOUSING SYSTEM

he primary concept of data warehousing is that the data stored for business analysis can ffectively be accessed by separating it from the data in the operational systems. Many of the for this separation have evolved over the years. In the past, legacy systems archived data onto tapes as it became inactive and many analysis reports ran from these tapes or mirror data sources to minimize the performance impact on the operational systems. Much of the business analysis was done using batch reports that ran during off-peak hours without interfering with the operations of the applications. These reports were designed to run on a set schedule regardless of any specific need in any given period.

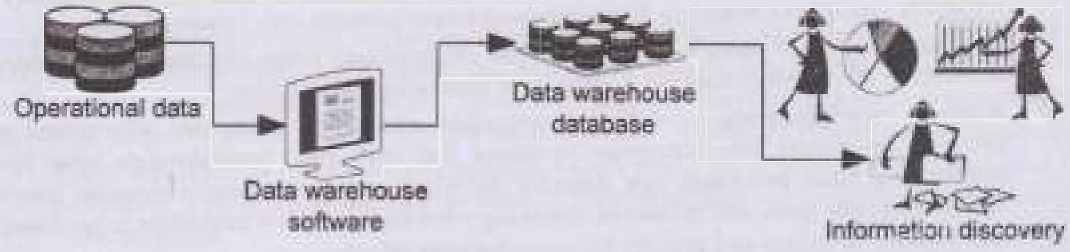


Figure 39.2 Data Warehousing System

The reasons to separate the operational data from analysis data have not significantly changed with the evolution of the data warehousing systems (see Figure 39.2), except that now they are considered more formally during the data warehouse building process. Advances in technology and changes in the nature of business have made many of the business analysis processes much more complex and sophisticated. In addition to producing standard reports, today's data warehousing systems support very sophisticated on-line analysis including multidimensional analysis.

A data warehouse is a collection of computer-based information that is critical to successful execution of enterprise initiatives. A data warehouse is more than an archive for corporate data and more than a new way of accessing corporate data. A data warehouse is a subject-oriented repository designed with enterprise-wide access in mind. It provides tools to satisfy the information needs of the employees at all organizational levels, not just for complex data queries, but as a general facility for getting quick, accurate, and often insightful information. A data warehouse is designed so that its users can recognize the information they want and access that information using simple tools.

One of the principal reasons for developing a data warehouse is to integrate operational data from various sources into a single and consistent architecture that supports analysis and decision-making within the enterprise. Operational (legacy) systems create, update and delete production data that "feed" the data warehouse. A data warehouse is analogous to a physical warehouse.

Operational systems create data "parts" that are loaded into the warehouse. Some of those parts are summarized into information "components" and stored in the warehouse. Data warehouse users make requests and are delivered information "products" that are created from the components and parts stored in the warehouse. A data warehouse is typically a blending of technologies, including relational and multidimensional databases, client/server architecture, extraction/transformation programs, graphical user interfaces, and more. A well-defined and properly implemented data warehouse can be an invaluable competitive tool.

ADVANTAGES OF A DATA WAREHOUSE

Implementing a data warehouse provides significant benefits—many tangible, some intangible. The benefits include the following:

- **More cost-effective decision-making** — A data warehouse allows reduction of staff and computer resources required to support queries and reports against operational and production databases. This typically offers significant savings. Having a data warehouse also eliminates the resource drain on production systems when executing long running, comp queries and reports.

▲ **Better enterprise intelligence** — Increased quality and flexibility of enterprise analysis ar from the multi-tiered data structures of a data warehouse that support data ranging fr detailed transactional level to high-level summary information. Guaranteed data accuracy a reliability result from ensuring that a data warehouse contains only "trusted" data.

▲ **Enhanced customer service** — An enterprise can maintain better customer relationships correlating all customer data via a single data warehouse architecture.

▲ **Business re-engineering** — Allowing unlimited analysis of enterprise information provides an insight into enterprise processes that may yield breakthrough ideas for engineering those processes. Just defining the requirements for data warehouse result better enterprise goals and measures. Knowing what information is important to an enterp will provide direction and priority for re-engineering efforts.

▲ **Information system re-engineering** — A data warehouse that is based upon enterprise- data requirements provides a cost-effective means of establishing both data standardiz and operational system inter-operability. Data warehouse development can be an effe first step in re-engineering the enterprise's legacy systems.

DATA MARTS

Data warehouse implies a single data architecture, which supports the entire information requir of an organization. In reality, most 'warehouses' constructed to date are in fact 'Data Marts'. A mart stores only that information which is needed to address a particular subject area and this translated as supporting the needs of a specific group of users. Compared with a data wareh data mart has a smaller data model, a shorter implementation curve, less data and fewer users. A mart will normally fit within the 'entry level' definition of less than 50 GB. It is therefore demanding on high-end hardware and easier to cost-justify.

The data that resides in the data warehouse is at a very granular level and the data in the mart is at a refined level. The different data marts contain different combinations and selections same detailed data found at the data warehouse. In some cases, data warehouse detailed data is differently across the different data marts. Yet, in other cases a data mart will structure detail differently from other data marts. But in every case, the data warehouse provides the foundation for all of the data found in all of the data marts. Because of the singular data war foundation that all data marts have, all of the data marts have a common heritage and are able reconciled at the most basic level.

Under normal conditions, the source of data that flows into the data mart is the current detail, or the data warehouse. Detailed data is customized, selected and summarized as it is into the data mart. In addition, the data mart can be fed data from external sources. The user data mart environment can be called the departmental DSS analyst. The departmental DSS an individual who does decision-making with a departmental bias. The departmental DSS not a technician, but is first and foremost a business person. The decisions the DSS analysts are are medium to long term, strategic decisions.

The departmental DSS analyst community can be divided into several categories. One categ a "farmer". A DSS farmer is someone who knows what they want and regularly and predicta to the same place to find it. Another category is the DSS "explorer." A DSS explorer is an ind who does not know what he/she wants. The DSS explorer looks at data in a random sporadic fashion. The DSS explorer is an individual who often finds nothing but occasionally finds spectacular results. Farmers and explorers are both found at the data mart level. However, there are many more farmers than explorers who are found here. The data mart environment has a very strong bias for farmers rather than explorers.

ADVANTAGES OF DATA MARTS

There are several factors that lead to the popularity of the data mart. As long as the data warehouse does not contain much data, it may serve the needs of different departments as a basis for DSS processing. But data warehouses do not stay small very long. For a variety of reasons, data warehouses quickly grow large and the motivation for data marts increases. As data warehouses grow large:

- ▲ The competition to get inside a warehouse grows fierce. More and more departmental DSS processing is done inside the data warehouse to the point that resource consumption becomes a real problem.
- ▲ Data becomes harder to customize. In the face of a small amount of data in a data warehouse, the DSS analyst can afford to customize and summarize data every time a DSS analysis is done. But in the face of lots of data in a data warehouse, the DSS analyst does not have the time and resources in order to summarize and customize the data.
- ▲ The cost of doing processing in the data warehouse increases as the volume of data increases.
- ▲ The software that is available for the access and analysis of large amounts of data (that is typical of the data warehouse) is not nearly as elegant as the software that can process smaller amounts of data (as is typical of the data mart).

The departmental DSS analyst discovers data marts and the analyst finds them to be very attractive. Data marts become a natural extension of the data warehouse. Data marts are attractive for the following reasons:

- ▲ When a department has its own data mart, it can customize the data as the data flows into the data mart from the data warehouse. There is no need for the data in the data mart to have to serve the entire corporation. Therefore, the department can summarize, sort, select, structure, etc., their own department's data to their heart's content with no consideration of any other department.
- ▲ The amount of historical data that is needed is a function of the department, not the corporation. In almost every case, the department can select a much smaller amount of historical data than that which is found in the data warehouse.
- ▲ The department can do whatever DSS processing they want whenever they want with no consideration of the impact for resource utilization on other departments.
- ▲ The department can select software for their data mart that is very elegant and is tailored to fit their needs.
- ▲ The department can select analytical software as they wish. There is a wealth of access and analysis software at the level of the processor that houses the data mart.
- ▲ The unit cost of processing and storage on the size machine that is appropriate to the data mart is significantly less than the unit cost of processing and storage for the machine that houses the data warehouse, and so forth.

There are many reasons as to why the data mart becomes attractive as the data warehouse grows in volume. There are organizational, technological, and economic reasons why the data mart is so beguiling and is a natural outgrowth of the data warehouse.

REVIEW QUESTIONS

Short Answer Questions

01. What is a data warehouse?
02. What are the goals of a data warehouse?
03. What are the characteristics of the data in a data warehouse?
04. How are data marts different from data warehouses?

Descriptive Type Questions

01. What do you mean by summarized data? Where is it used?
02. What is current detail? Why is it important?
03. What are operational systems of record? What is its use?
04. What are integration and transformation programs? What are their functions?
05. What are archives?
06. What is metadata?
07. What are the advantages of a data warehouse?

Essay Questions

01. What are the different components of a data warehouse? Explain with the help of a diagram.
02. What is a data warehousing system?
03. What are data marts?
04. What are the advantages of data marts?

Fill in the Blanks

01. ____________ is a collection of data designed to support management decision-making.
02. The bulk of data in a data warehouse resides in the ____________.
03. ____________ is the lowest level of data granularity in the data warehouse.
04. ____________ is part of the data warehouse that controls access and analysis of its contents.
05. ____________ is a subset of an enterprise-wide data warehouse, which supports an enterprise element.
06. A ____________ stores only that information which is needed to address a particular subject area supporting the needs of a specific group of users.

[Answers: (1) Data warehouse (2) Current detail (3) Current detail (4) Metadata (5) Data mart (6) Data mart].

True or False

01. In a data ware house the data once loaded is not changed.
02. A data warehouse is a collection of computer-based information that is critical to successful execution of enterprise initiatives.
03. Lightly summarized data are primarily for enterprise executives.
04. Current detail is the source of the data that feed the data warehouse.
05. Metadata is data about data.

[Answers: (1) True (2) True (3) False (4) False (5) True]

DATA MINING

We live in the age of information. The importance of collecting data that reflect your business or scientific activities to achieve competitive advantage is widely recognized now. Powerful systems for collecting data and managing it in large databases are already in place in most large and mid-range companies. However, the bottleneck of turning this data into your success is the difficulty of extracting knowledge about the system that you study from the collected data. Consider the following questions:

- ▲ What goods should be promoted to this customer?
- ▲ What is the probability that a certain customer will respond to a planned promotion?
- ▲ Can one predict the most profitable securities to buy/sell during the next trading session?
- ▲ Will this customer default on a loan or pay back on schedule?
- ▲ What medical diagnosis should be assigned to this patient?
- ▲ How large the peak loads of a telephone or energy network are going to be?
- ▲ Why the facility suddenly starts producing defective goods?

These are all the questions that can probably be answered if information hidden among megabytes of data in your database can be found explicitly and utilized. Modeling the investigated system and discovering relations that connect variables in a database is the objective of data mining. Modern data mining systems self learn from the previous history of the investigated system, formulating and testing hypotheses about the rules, which this system obeys. When concise and valuable knowledge about the system of interest had been discovered, it can and should be incorporated into some decision support system, which helps the manager to make wise and informed business decisions.

Why Use Data Mining?

Data might be one of the most valuable assets of your corporation, but only if you know how to reveal valuable knowledge hidden in raw data. Data mining allows you to extract diamonds of knowledge from your historical data and predict outcomes of future situations. It will help you optimize your business decisions, increase the value of each customer and communication, and improve satisfaction of customer with your services. Data that require analysis differ for companies in different industries. Examples include:

- ▲ Sales and contacts histories
- ▲ Call support data
- ▲ Demographic data on your customers and prospects
- ▲ Patient diagnoses and prescribed drugs data
- ▲ Traffic analysis and e-commerce analysis from your website

In all these cases data mining can help you reveal knowledge hidden in data and turn this knowledge into a crucial competitive advantage. Today increasingly more companies acknowledge the value of this new opportunity and turn to data mining tools and solutions that help optimizing their operations and increase profits.

What Can Data Mining Do for You?

The following are some areas where data mining can help business improve their operations and profits and increase customer goodwill:

- **Identify your best prospects and then retain them as customers** — By concentrating your marketing efforts only on your best prospects you will save time and money, thus increasing effectiveness of your marketing operation.
- **Predict cross-sell opportunities and make recommendations** — Whether you have a traditional or web-based operation, you can help your customers quickly locate products of interest to them and simultaneously increase the value of each communication with your customers.
- **Learn parameters influencing trends in sales and margins** — This is a task that could be solved by the OLAP tools. OLAP can help you prove a hypothesis only if you know what questions to ask in the first place. In the majority of cases you have no clue on what combination of parameters influences your operation. In these situations data mining is your only real option.
- **Segment markets and personalize communications** — There might be distinct groups of customers, patients, or natural phenomena that require different approaches in their handling. If you have a broad customer range, for example, you would need to address teenagers in Mumbai and senior citizens in Chennai with different products and messages in order to optimize your marketing campaign.

Evolution of Data Mining

Data mining techniques are the result of a long process of research and product development. This evolution began when business data was first stored on computers, continued with improvements in data access, and more recently, generated technologies that allow users to navigate through their data in real time. Data mining takes this evolutionary process beyond retrospective data access and navigation to prospective and proactive information delivery. Data mining is ready for application in the business community because it is supported by three technologies that are now sufficiently mature – massive data collection, powerful multiprocessor computers, and data mining algorithms.

Commercial databases are growing at unprecedented rates. The accompanying need for improved computational engines can now be met in a cost-effective manner with parallel multiprocessor computer technology. Data mining algorithms embody techniques that have existed for at least ten years, but have only recently been implemented as mature, reliable, understandable tools that consistently outperform older statistical methods. In the evolution from business data to business information, each new step is built upon the previous one. For example, dynamic data access is critical for drill-through in data navigation applications, and the ability to store large databases is critical to data mining. From the user's point of view, the four steps listed below were revolutionary because they allowed new business questions to be answered accurately and quickly.

- **Data collection (1960s)** — Answered questions like "What was my total revenue in the last five years?" This technology is characterized by its retrospective nature and static data delivery.
- **Data access (1980s)** — Answered business questions like "What were unit sales in New England last March?" Relational Database Management Systems (RDBMS), Structured Query Language (SQL), ODBC, etc., were used for querying and reporting. This phase is characterized by its retrospective nature and dynamic data delivery at record level.
- **Data warehousing and decision support (1990s)** — These technologies were capable of answering business questions like "What were unit sales in New Delhi last March?" The technologies used are OLAP, multidimensional databases, data warehouses, etc. The main characteristics are retrospective nature and dynamic data delivery at multiple levels.

- **Data mining (2000s)** – Capable of answering questions like "What's likely to happe... Southern region sales next month? Why?" Uses advanced algorithms, multipro... computers, massive databases, etc. The characteristics include prospective nature ... proactive information delivery.

The core components of data mining technology have been under development for decade... research areas such as statistics, artificial intelligence, and machine learning. Today, the matur... these techniques, coupled with high-performance relational database engines and broad ... integration efforts, make these technologies practical for current data warehouse environments.

Data Mining Process

Data mining uses a model that is different from the one used by Decision Support Systems (D... Executive Information Systems (EIS) for the creation of information about data. We call ... discovery model. Data mining uses methodologies that can sift through the data in ... frequently occurring patterns, can detect trends, produce generalizations about the data, etc. ... tools can discover these types of information with very little (or no) guidance from the user (see ... 40.1).

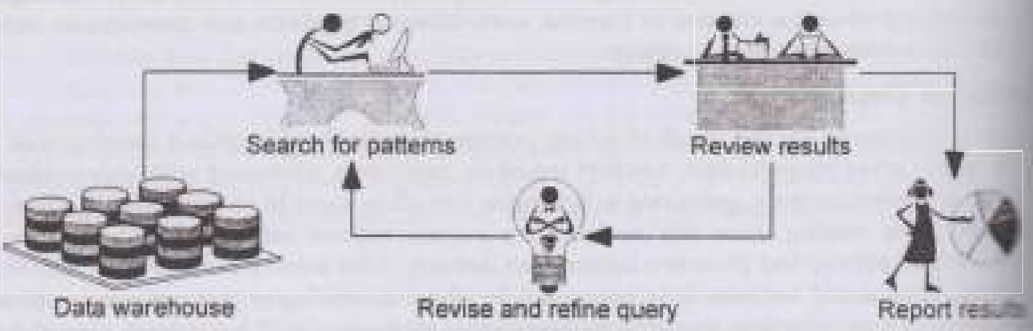


Figure 40.1 Data Mining Process

The discovery of these facts is not a consequence of a haphazard event. A well-designed data ... tool is one that is designed and built so that the exploration of the data is done in such a wa... yield as large a number of useful facts about the data as possible in the shortest amount ... Comparing the process of finding information in a collection of data to that of mining diam... diamond mine, we can say that **"verification"** is like drilling individual holes in a lode ... expectation of finding diamonds. Finding all (or many) diamonds in this way can be very ... **"Discovery"**, on the other hand, is similar to scooping out all the material in the lode and ... on a plain field so that all the glittering stones are thrown up into the open. Diamonds ... separated from the quartz by further inspection.

In data mining, large amounts of data are inspected, facts are discovered and brough... attention of the person doing the mining. Unlike diamonds, which are easily distinguishab... quartz, business judgment must be used to separate the useful facts from those that are ... useful. Because this last step does not involve sifting through the raw data, data mining ... efficient mode of finding useful facts about data.

Data Mining Methods

Data mining techniques are inspired from a variety of disciplines, ranging from machine ... statistical analysis, pattern recognition, signal processing, evolutionary computation, and ... visualization. The popular categories of data mining methods include:

Classification

Classification is probably the most widely used data mining approach. Classification is the task of finding a function that maps an example into one of several discrete classes. Most scoring models, such as credit scoring models, lending-risk scoring models, fraud scoring models, etc. are usually based upon classification methods. Classification methods (or classifiers) enable the categorization of records (or entities) into two or more pre-defined classes. The use of classification algorithms involves a training set consisting of pre-classified examples. In the tax audit domain, the two classes could be compliant filings versus non-compliant filings, and the training set would be assembled from historical audits. The classifier calibration algorithm uses the pre-classified examples to determine a set of parameters required for proper discrimination between the classes. The algorithm then encodes these parameters into a model called a classifier. Once such a classifier is calibrated, it can assign new filings to either of the classes. There are many algorithms that can be used for classification, such as decision trees, neural networks, logistic regression, etc.

Clustering

Clustering is an exploratory method used to discover natural groupings within records or entities. It is the task of identifying a finite set of categories or clusters that describe data. Clustering approaches are commonly used for segmentation – for example, identifying natural segments or groups within the taxpayer population. Clustering algorithms allow entities with a large number of attributes to be partitioned into a few distinct groups or "segments". It is different from the classification which pertains to a known number of classes. While the objective in classification is to assign new observations to one of the classes, cluster analysis makes no assumption about the number of underlying groups or any other structure.

Association Rules

Association rules are basic types of patterns or regularities that are found in transactional-type data. It has its origins in traditional retail marketing where it can discover affinities between items that occur within a particular shopping trip (for example, what items typically co-occur as contents of a shopping basket). Hence, an alternative name for this type of analysis is "market-basket analysis". From a set of transaction data (for example tax filings, or insurance claims), association rules can discover characteristics within a transaction that imply the presence of other characteristics in the same transaction. For two sets of characteristics X and Y, an association rule is usually denoted as $X \Rightarrow Y$ to convey that the presence of the characteristic X in a transaction frequently implies the presence of characteristic Y.

Sequential Pattern Detection

Sequential patterns involve mining frequently occurring patterns of activity over a period of time. In many situations, not only may the coexistence of items within a transaction be important (which could be discovered by association rules algorithms), but also the order in which those items appear across ordered transactions, and the amount of time between transactions (which would be discovered by sequential pattern detection algorithms). Thus, sequential pattern detection methods are similar to association rules, except that they look for patterns across time (as opposed to patterns within transactions). This could be a pattern that represents a sequence of tax filings over time, or a sequence of purchases over time, etc.

Change and Deviation Detection

Change and deviation detection is the task of determining the most significant changes in some key measures of data from previous or expected values. These techniques are useful for identifying significant changes in a data set from previously measured or normative values. Once a dev discovered, further analysis can be carried out to determine whether it is due to noise, or due to reasons. Deviation detection is typically carried out using simple linear projection of certain based on previous values, and comparing these projections against normative values.

Advantages of Data Mining

Data mining derives its name from the similarities between searching for valuable information in a large database and mining a mountain for a vein of valuable ore. Both require either sifting through an immense amount of material, or intelligently probing it to find where the value resides. Given databases of sufficient size and quality, data mining technology generate new business opportunities by providing capabilities such as automated prediction of and behaviors, automated discovery of previously unknown patterns and capability to use databases.

Automated Prediction of Trends

Data mining automates the process of finding predictive information in large databases. that traditionally required extensive hands-on analysis can now be answered directly from quickly. A typical example of a predictive problem is targeted marketing. Data mining uses past promotional mailings to identify the targets most likely to maximize return on investment future mailings. Other predictive problems include forecasting bankruptcy and other forms of and identifying segments of a population likely to respond similarly to given events.

Discovery of Unknown Patterns

Data mining tools sweep through databases and automatically identify previously hidden one step. An example of pattern discovery is the analysis of retail sales data to identify unrelated products that are often purchased together. Other pattern discovery problems detecting fraudulent credit card transactions and identifying anomalous data that could represent entry keying errors.

Larger Databases

The databases can have more columns and rows. Analysts must often limit the number of they examine when doing hands-on analysis due to time constraints. Yet, variables that are because they seem unimportant may carry information about unknown patterns. High performance data mining allows users to explore the full depth of a database, without pre-selecting a variables. The data mining databases contain larger samples (more rows) as they yield estimation errors and variance, and allow users to make inferences about small but segments of a population. Data mining techniques can yield the benefits of automation on software and hardware platforms, and can be implemented on new systems, as existing platforms upgraded and new products developed. When data mining tools are implemented on performance parallel processing systems, they can analyze massive databases in minutes. processing means that users can automatically experiment with more models to understand data. High speed makes it practical for users to analyze huge quantities of data. Larger databases turn, yield improved predictions.

Technologies Used in Data Mining

The most commonly used techniques in data mining are:

- **Neural networks** — They are non-linear predictive models that learn through training resemble biological neural networks in structure. In order to make meaningful predictions neural network first has to be trained on data describing previous situations for which both, input parameters and correct reactions to them are known. Training consists of selecting weights ascribed to intra-neural connections that provide the maximal closeness of reactions produced by the network to the known correct reactions.

- **Rule induction** – It is used in the extraction of useful if-then rules from data based on statistical significance.
- **Evolutionary programming** – At present this is the youngest and evidently the most promising branch of data mining. The underlying idea of the method is that the system automatically formulates hypotheses about the dependence of the target variable on other variables in the form of programs expressed in an internal programming language.
- **Case-based reasoning (CBR)** – The main idea underlying this method is very simple. To forecast a future situation, or to make a correct decision, such systems find the closest past analogs of the present situation and choose the same solution, which was the right one in those past situations. That is why this method is also called the nearest neighbor method.
- **Decision trees** – They are tree-shaped structures that represent sets of decisions. These decisions generate rules for the classification of a data set.
- **Genetic algorithms** – They are optimization techniques that use processes such as genetic combination, mutation, and natural selection in a design based on the concepts of evolution.
- **Non-linear regression methods** – These methods are based on searching for a dependency of the target variable on other variables. The obtained formula is more suitable for analysis and interpreting in principle (reality is usually still too complex for that). Thus, this method has better chances of providing reliable solutions in such involved applications as financial markets or medical diagnostics.

Many of these technologies have been in use for more than a decade in specialized analysis tools that work with relatively small volumes of data. These capabilities are now evolving to integrate directly with industry-standard data warehouse and OLAP platforms.

ON-LINE ANALYTICAL PROCESSING (OLAP)

OLAP is a method of analyzing data in a multidimensional format, often across multiple time periods, with the aim of uncovering the business information concealed within the data. OLAP enables business users to gain an insight into the business through interactive analysis of different views of the business data that have been built up from the operational systems. This approach facilitates a more intuitive and meaningful analysis of business information and assists in identifying important business trends.

OLAP is often confused with data warehousing. OLAP is not a data warehousing methodology. However, it is an integral part of a data warehousing solution. OLAP comes in many different shades, depending on the underlying database structure and the location of the majority of the analytical processing. Thus, the term OLAP has different meanings depending on the specific combination of these variables. This white paper examines the different options to support OLAP. It examines the strengths and weaknesses of each and recommends the analytical tasks for which each is most suitable. OLAP provides the facility to analyze the data held within the data warehouse in a flexible manner. It is an integral component of a successful data warehouse solution; it is not in itself a data warehousing methodology or system. However, the term OLAP has different meanings for different people, as there are many variants of OLAP. This article attempts to put the different OLAP scenarios into context.

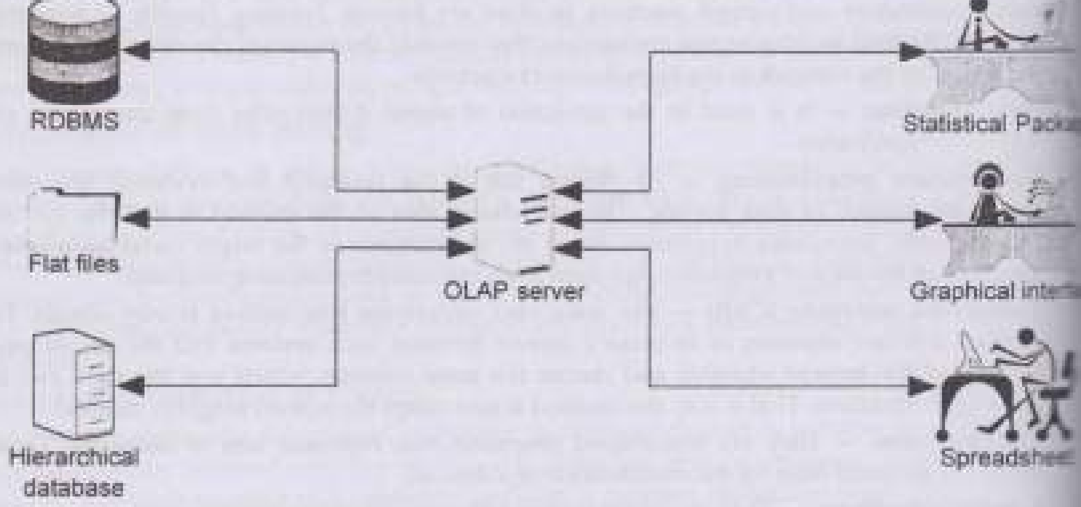


Figure 40.2 Mediating Role of the OLAP Server

OLAP can be defined as the process of converting raw data into business information th multidimensional analysis. This enables analysts to identify business strengths and weak business trends and the underlying causes of these trends. It provides an insight into the b through the interactive analysis of different views of business information that have been bu from raw operating data which reflect the business users understanding of the business.

The OLAP approach enables a more intuitive interactive analysis of business informat allows business users to understand the current business position, and the factors contributing position, through detailed analysis of the underlying information. It also helps business u identify important business trends and opportunities through the analysis of historical data and projections in various "what-if" scenarios.

The majority of the established OLAP products use multidimensional databases as oppo relational databases. The data consolidation process creates the physical multidimensional d structure and the indexing applied to it, storing pre-calculated and aggregated values in arrays, extensive indexing to facilitate rapid retrieval. However, this data structure does not o flexibility needed to easily modify the data warehouse dimensions (business area view of the b data) as the business processes change, as they undoubtedly will.

Some data warehousing experts advocate using a denormalized design on a relational data replace multidimensional databases. Denormalizing the relational data model should i response times for flexible analysis queries, i.e., those where the data has not been structu support a predetermined data access path. For a data warehouse application a well-designed me layer will provide a multidimensional view of the data. The use of relational database techn along with a well-designed metadata layer, will provide a greater degree of flexibility in the p design of the data warehouse than the use of a multidimensional database. The metadata layer the business view of the data (i.e. the multidimensional view) on to the physical database. It p details such as:

- The source(s) of each data item from the operating system(s)
- Business definitions for dimensions and measures

▲ Details of any data transformation rules applied
▲ Consolidation paths and any calculation formulas for data aggregations

The OLAP application contains logic, which includes:

▲ Multidimensional data selection
▲ Subsetting of data
▲ Retrieval of data, via the metadata layer
▲ Calculation formulas

The OLAP application layer is accessed via a front-end query tool, which uses tables and charts to "drill down" or navigate through dimensional data or aggregated measures. OLAP plays the role of a mediator to the various types of data sources and front-end interfaces. The Figure 40.2 illustrates the mediating role that an OLAP server provides with respect to the various types of databases and files in which data may be stored and the numerous types of front-end packages that the end users may need. These front-end packages (only 3 are shown) are placed at the top of the diagram, while the data organization types (only 3 are shown) are placed at the bottom. The OLAP Server is in the center of the diagram. This mediating role is a very important property that an OLAP Server should have.

OLAP and data warehouses are complementary. A data warehouse stores and manages data. OLAP transforms data warehouse data into strategic information. OLAP ranges from basic navigation and browsing (often known as "slice and dice"), to calculations, to more serious analysis such as time series and complex modeling. As decision-makers exercise more advanced OLAP capabilities, they move from data access to information to knowledge.

Benefits of OLAP

Successful OLAP applications increase the productivity of business managers, developers, and whole organizations. The inherent flexibility of OLAP systems means business users of OLAP applications can become more self-sufficient. Managers are no longer dependent on IT to make schema changes, to create joins, or worse. Perhaps more importantly, OLAP enables managers to model problems that would be impossible using less flexible systems with lengthy and inconsistent response times. More control and timely access to strategic information leading to more effective decision-making. IT developers also benefit from using the right OLAP software. Although it is possible to build an OLAP system using software designed for transaction processing or data collection, it is certainly not a very efficient use of developer time. By using software specifically designed for OLAP, developers can deliver applications to business users faster, providing better service. Faster delivery of applications also reduces the applications backlog.

OLAP reduces the applications backlog still further by making business users self-sufficient enough to build their own models. However, unlike stand-alone departmental applications running on PC networks, OLAP applications are dependent on data warehouses and transaction processing systems to refresh their source level data. As a result, IT gains more self-sufficient users without relinquishing control over the integrity of the data. IT also realizes more efficient operations through OLAP. By using software designed for OLAP, IT reduces the query drag and network traffic on transaction systems or the data warehouse. Lastly, by providing the ability to model real business problems and a more efficient use of people resources, OLAP enables the organization as a whole to respond more quickly to market demands. Market responsiveness, in turn, often yields improved revenue and profitability.

Different Styles of OLAP

Increasingly, companies are implementing OLAP architectures to support their analytical requirements within data warehouse implementations. Older OLAP applications have generally been implemented as stand-alone applications that do not allow easy sharing of data with other OLAP applications. They have also tended to use multidimensional database management technology, which imposes restrictions on the degree of flexibility of analysis. The newer OLAP tools are moving away from multidimensional database management technology and increasingly use relational database management technology. The four- major alternatives for implementing OLAP applications are multidimensional, hybrid, desktop, and relational. All four OLAP styles should implement all the data security requirements for confidentiality, possibly down to individual data item level. This is a major area of weakness in many current OLAP products, which implement only basic security controls.

REVIEW QUESTIONS

Short Answer Questions

01. What is data mining?
02. What do you mean by OLAP?
03. What are neural networks?
04. What is rule induction?
05. What do you mean by evolutionary programming?
06. What is case-based reasoning?
07. What are decision trees?
08. What are genetic algorithms?
09. What are non-linear regression methods?
10. How is OLAP different from data warehousing?
11. What are the different OLAP styles?

Descriptive Type Questions

01. What is data mining?
02. Why should one use data mining?
03. What are the tasks that data mining can do for you?
04. Explain the difference between verification and discovery.
05. What is classification?
06. What is clustering?
07. What are association rules?
08. What is sequential pattern detection?
09. What is change and deviation detection?
10. What are the benefits of OLAP?

Essay Questions

01. Explain the evolution of data mining techniques?
02. Explain the data mining process with a neat sketch.
03. Explain the different data mining methods.
04. What are the advantages of data mining?
05. Explain the mediating role of the OLAP server with the help of a neat sketch.

Fill in the Blanks

01. _______ is the extraction of hidden predictive information from large databases.
02. _______ technology is characterized by its retrospective nature and static data delivery.
03. _______ is characterized by its retrospective nature and dynamic data delivery at multiple levels.
04. The expansion of EIS is _______.
05. _______ is a task of learning a pattern from examples and using the developed model to predict future values of the target variable.
06. _______ is the task of finding a function that maps an example into one of several discrete classes.
07. _______ are non-linear predictive models that learn through training and resemble biological neural networks in structure.
08. _______ are optimization techniques that use processes such as genetic combination, mutation, and natural selection in a design based on the concepts of evolution.
09. The term On-line Analytical Processing was coined by _______.
10. _______ is a method of analyzing data in a multi-dimensional format, often across multiple time periods, with the aim of uncovering the business information concealed within the data.

[**Answers:** (1) Data mining (2) Data collection technology (3) Data warehousing and decision support technology (4) Executive information system (5) Predicting (6) Classification (7) Neural networks (8) Genetic algorithms (9) E. F. Codd (10) On-line Analytical Processing (OLAP)]

True or False

01. Modern data mining systems self learn from the previous history of the investigated system, formulating and testing hypotheses about the rules, which this system obeys.
02. The characteristics of data mining technology include prospective nature and proactive information delivery.
03. Detection of relations is the task of searching for the most influential independent variables for a selected target variable.
04. Explicit modeling is a task of identifying a finite set of categories or clusters that describe data.
05. Rule induction is the extraction of useful if-then rules from data based on statistical significance.
06. Evolutionary programming is not a data mining technology.
07. OLAP refers to a type of application that allows a user to interactively analyze data.
08. The majority of the established OLAP products use multidimensional databases as opposed to relational databases.

[**Answers:** (1) True (2) True (3) True (4) False (5) True (6) False (7) True (8) True] to the manufacturing department in Chennai. The lure of information integration struck a chord with CEOs and CFOs – ERP vendors' primary targets – and sales of ERP took off in the early 1990s.

BRIEF HISTORY OF ERP

In the manufacturing industry, MRP (Material Requirements Planning) became the fundamental concept of production management and control in mid-1970s. At this stage BOM (Bill of Materials), which is purchase order management that utilizes parts list management and parts development, was mainstream. And this concept unfolded from order inventory management of materials to plant and personnel planning and distribution planning, which in turn became MRP II (Manufacturing Resource Planning). This incorporated financial accounting, human resource management functions, distribution management functions and management accounting functions, and came to globally cover all areas of enterprise mainstay business and eventually came to be called ERP. We will trace the evolution of ERP in a little detail.

Material Requirements Planning (MRP)

Material requirements planning or MRP was an outgrowth of bill of material (BOM) processing. MRP began its life in the 1960s and became prominent in the 1970s. The manufacturing and production planning people were searching for better and more efficient methods of ordering materials and components. They found that MRP was a perfect answer for their needs. MRP asks the following questions:

- ▲ What products are we going to make?
- ▲ What are the materials need to make the products?
- ▲ What are the materials that we have in stock?
- ▲ What are the items that need to be purchased?

MRP uses the master production schedule (MPS) to find out the answer to the first question – what products are we going to make? It gets the details of the materials required to make the products from the bill of materials (BOM). It searches the inventory records to find out what items are in stock. It then calculates the items that need to be purchased for producing the goods. Thus, MRP solved the great manufacturing and production planning problems and made the manufacturing of goods easier.

Closed-loop MRP

MRP evolved into something more than merely a better way to order and the evolution was very fast as there were many followers for MRP and they wanted more. These MRP supporters realized that MRP had more capabilities than producing material reordering schedules. The MRP system maintained the order due dates and could be used to detect and warn when an item did not arrive on the due date. This new capability helped in reducing the uncertainty that is part of any production process.

Soon techniques for planning capacity requirements were merged with MRP. Tools were developed to support the planning of sales and production levels, development of production schedules, forecasting, sales planning, capacity planning, and order processing. Various plant, production, and supplier scheduling techniques for automating the processes inside and outside the organization were built into the MRP system. These developments resulted in the creation of closed-loop MRP.

Closed-loop MRP is not merely material requirements planning but, a series of functions for automating the production process. It contains tools and techniques to address both priority and capacity and supports both planning and execution. It has provisions for accepting feedback from the execution functions back to the planning function thus enabling the plans to be revised and [illegible] depending on the actual execution or changes in priorities.

Manufacturing Resource Planning (MRP II)

The third stage in the evolution of ERP is called MRP II. It is the next logical step of closed-loop [illegible] and contains the following additional capabilities—sales and operational planning, financial [illegible] and simulation capabilities (for better decision-making).

Thus, MRP II is a method for the effective planning of all the resources of a manufac[illegible] company. It addresses operational planning in units, financial planning in dollars, and [illegible] simulation capability to answer 'what if' questions. MRP II is made up of a variety of functions [illegible] linked together: business planning, sales & operations planning, demand management, [illegible] planning, master scheduling, material requirements planning, capacity requirements planning, [illegible] execution support systems for capacity and material. Output from these systems is integrat[illegible] financial reports such as the business plan, purchase commitment report, shipping budget, [illegible] projections in dollars, etc.

Enterprise Resource Planning (ERP)

The final step in the evolution is the emergence of ERP. The fundamentals of ERP are the same [illegible] of MRP II. However, the enterprise software makes ERP a set of business processes that is [illegible] scope, that is capable of dealing with more business functions and that has a better and [illegible] integration with the finance and accounting functions. The ERP system is also capable of [illegible] with other tools like customer relationship management, supply chain management, etc. [illegible] supporting businesses across company boundaries.

ERP predicts and balances demand and supply. It is an enterprise-wide set of [illegible] planning, and scheduling tools, which links customers and suppliers into a complete [illegible] employs proven processes for decision-making, and coordinates sales, marketing, operations, [illegible] purchasing, finance, product development, and human resources.

Its goals include high levels of customer service, productivity, cost reduction, and [illegible] turnover, and it provides the foundation for effective supply chain management and e-[illegible] does this by developing plans and schedules so that the right resources—manpower, [illegible] machinery, and money—are available in the right amount when needed. ERP is a direct [illegible] and extension of MRP and, as such, includes all of MRP II's capabilities. ERP is more powerful [illegible] it applies a single set of resource planning tools across the entire enterprise, provides [illegible] integration of sales, operating, and financial data, and connects resource planning appr[illegible] extended supply chain of customers and suppliers.

The primary purpose of implementing ERP is to run the business efficiently and effecti[illegible] brutally competitive and rapidly changing business environment. The goals of ERP include [illegible] of customer service, improved productivity, cost reduction, better inventory turnover [illegible] inventory), etc. It also provides a solid foundation for effective supply chain manage[illegible] commerce. It does this by developing plans and schedules so that the right resources—[illegible] materials, machinery and money—are available at the right amount at the right time.

ERP (Enterprise Resource Planning), as we have seen, is the evolution of [illegible] Requirements Planning (MRP) II. From business perspective, ERP has expanded from [illegible] manufacturing processes to the integration of enterprise-wide backend processes. From [illegible] aspect, ERP has evolved from legacy implementation to more flexible tiered client-server [illegible] Table 41.1 summarizes the evolution of ERP from 1960s to 1990s.

Table 41.1 Evolution of ERP

Timeline	System	Description
1960s	Inventory Management & Control	Inventory Management and control is the combination of information technology and business processes of maintaining the appropriate level of stock in a warehouse. The activities of inventory management include identifying inventory requirements, setting targets, providing replenishment techniques and options, monitoring item usages, reconciling the inventory balances, and reporting inventory status.
1970s	Material Requirement Planning (MRP)	Materials Requirement Planning (MRP) utilizes software applications for scheduling production processes. MRP generates schedules for the operations and raw material purchases based on the production requirements of finished goods, the structure of the production system, the current inventories levels and the lot sizing procedure for each operation.
1980s	Manufacturing Requirements Planning (MRP II)	Manufacturing Requirements Planning or MRP utilizes software applications for coordinating manufacturing processes, from product planning, parts purchasing, inventory control to product distribution.
1990s	Enterprise Resource Planning (ERP)	Enterprise Resource Planning or ERP uses multi-module application software for improving the performance of the internal business processes. ERP systems often integrate business activities across functional departments, from product planning, parts purchasing, inventory control, product distribution, fulfillment, to order tracking. ERP software systems may include application modules for supporting marketing, finance, accounting and human resources.

REASONS FOR THE GROWTH OF ERP

There is no question that the market for Enterprise Resource Planning (ERP) systems is very hot. Industry analysts are forecasting growth rates of more than 30 percent for at least the next five years. Why are so many companies replacing their key business systems? Here are some reasons:

- Enable improved business performance
  - Cycle time reduction
  - Increased business agility
  - Inventory reduction
  - Order fulfillment improvement
- Support business growth requirements
  - New products/product lines, new customers
  - Global requirements including multiple languages and currencies
- Provide flexible, integrated, real-time decision support

- Improve responsiveness across the organization
- Eliminate limitation in legacy systems
    - Century dating issues
    - Fragmentation of data and processing
    - Inflexibility to change
    - Insupportable technologies
- Take advantage of the untapped mid-market (medium size organizations)
    - Increased functionality at a reasonable cost
    - Client server/open systems technology
    - Vertical market solutions

These are some of the reasons of the explosive growth rate of the ERP markets and ERP vendors. As more and more companies are joining the race and as the ERP vendors are shifting their focus from big—Fortune 1000—companies to different market segments (medium size companies, small companies, etc.). So the future will see fierce battle for market share and mergers and acquisitions for strategic and competitive advantage. The ultimate winner in this race will be the customer, who will get better products and better service at affordable prices.

ADVANTAGES OF ERP

Installing an ERP system has many advantages—both direct and indirect. The direct advantages include the improved efficiency, information integration for better decision-making, faster response time to customer queries, etc. The indirect benefits include better corporate image, improved customer goodwill, customer satisfaction, etc. The following are some of the direct benefits of an ERP system:

- Business Integration
- Flexibility
- Better Analysis and Planning Capabilities
- Use of Latest Technology

Business Integration

The first and most important advantage lies in the promotion of integration. The reason ERP packages are called integrated is the automatic data updating (automatic data exchange among applications) between related business components. Since conventional company information systems were aimed at the optimization of independent business functions in business units, almost all were weak in terms of the communication and integration of information that transcended the different business functions. In case of large companies in particular, the timing of system construction and directives differ for each product and department/function and sometimes they are disconnected. For this reason, it has become an obstacle in the shift to new product and business classification. In case of ERP packages, the data of related business functions is also automatically updated at the time a transaction occurs. For this reason, one is able to grasp business details in real time, and carry out various types of management decisions in a timely manner based on that information.

Flexibility

The second advantage of ERP packages is their flexibility. Diverse multinational environments such as language, currency, accounting standards and so on are covered in one system, and functions that comprehensively manage multiple locations that span a company are packaged and can be implemented automatically. To cope with company globalization and system unification, this flexibility is essential, and one could say that it has major advantages, not simply for development and maintenance, but also in terms of management.

Better Analysis and Planning Capabilities

Yet another advantage is the boosting of planning functions. By enabling the comprehensive and unified management of related business and its data, it becomes possible to fully utilize many types of decision support systems and simulation functions. Furthermore, since it becomes possible to carry out flexibly and in real time the filing and analysis of data from a variety of dimensions, one is able to give the decision makers the information they want, thus enabling them to make better and informed decisions.

Use of Latest Technology

The fourth advantage is the utilization of the latest developments in Information Technology (IT). The ERP vendors were very quick to realize that in order to grow and to sustain that growth; they have to embrace the latest developments in the field of information technology. So the ERP vendors quickly adapted their systems to take advantage of the latest technologies like open systems, client/server technology, Internet/Intranet, CALS (Computer-Aided Acquisition and Logistics Support), electronic commerce, etc. It is this quick adaptation to the latest changes in information technology that makes the flexible adaptation to changes in future business environments possible. It is this flexibility that makes the incorporation of the latest technology possible during system customization, maintenance and expansion phases.

As stated above, ERP includes many of the functions that will be necessary for future systems. However, undertaking reforms to company structures and business processes so as to enable the full use of these major features is the greatest task for companies that will use them. It is necessary to take note that casually proceeding with the implementation of ERP merely for reasons of system reconstruction or migration to new hardware/software platforms is likely to result in turning the above mentioned advantages into disadvantages.

WHY ERP PACKAGES NOW?

In regard to the application packages, many products have been developed so far and are selling well. So, how do conventional application packages and ERP packages differ? The first answer to this question is that ERP packages have functions not only individual businesses have such as, accounts and inventory, but also the total range of main business necessary for company operation. The second difference is that ERP packages are targeted at everything from small businesses to the largest organizations, and that it can be composed of a highly flexible decentralized database and an information system cluster linked by a network. The third difference is global adaptation, represented by ERP packages' multilingual and multicurrency capacity. In the present day, when companies irrespective of their size and market share are manufacturing and selling in various areas of the world, the globalization of management platforms is being hastened, along with the global adaptation of enterprise information systems.

SUCCESSFUL ERP IMPLEMENTATION

The most important step of ERP implementation is the phase called Gap Analysis, which is the step of negotiation between the company requirements and the functions a package possesses.

In order for persons with differing viewpoints involved in a project to function as a team and to push ahead smoothly, it is effective to invite outside consultants with wide experience in package implementation to the user side, and assign such persons to the role of coordinator with package vendors and system integrators. This consultant can act from a neutral perso.ı to resolve conflicts and can push the project ahead while confirming direction on the whole.

The first important point is clearly defining company objectives and targets, and making these known and recognized throughout the company. Next, the manner in which the company management is involved in the project and the speed of decisions is important. Last is the selection of experienced (it is better not to limit this to package implementation) consultants and integrators. Unfortunately, in the present state of affairs, getting experienced experts could be difficult. This is because there are few experienced persons and too many projects. So the best way to solve this problem is to select employees with the right aptitude, commitment and functional knowledge and get them trained and make them work along with the external consultants. This will leave the company with enough in-house consultants and integrators when the vendor's staff and the external consultants leave the scene.

Most companies use the obsolete development models like waterfall model for the development of their information systems. EDP/IS professionals and system analysts have constructed systems that are tailor-made for the organization. These systems are usually designed to cater to the current needs of the company, leaving no scope for growth or scalability. The development periods are longer and there is lack of flexibility in respect to changes in business processes. However, the implementation processes in ERP packages are completely opposite. The core step is the Gap Analysis, and how to eliminate redundant business processes. Gaining the approval of the company management to eliminate the unwanted and redundant business process, to integrate the various business functions and to ensure effective information flow between the various business functions decides the success or failure of the ERP implementation.

Along with changes in development processes for a system that takes an ERP package as the platform, limits are also seen in the abilities of system analysts and system engineers. In the past, it was acceptable to design and concretize systems in line with existing or fixed business flows. However, in the future, the system analysts and system engineers must understand management targets; continue planning and suggesting towards their realization; and design and develop information systems that will help the managers to achieve the company's business objectives.

Put simply, information systems must become central—as a strategic weapon—designed from a managerial perspective and having persuasiveness in respect to business areas. For this to happen there should be a change in the attitude of all the people—managers and EDP professionals. They should come out of the traditional business functions and should work in tandem to make Information Technology and information resources work for them and to that end should develop systems that will deliver high quality information to all the decision-makers when they need it.

ERP TO ERP II— BRINGING ERP TO THE ENTERPRISE

ERP solutions were developed to deliver automation across multiple units of an organization, to help facilitate the manufacturing process. ERP addressed the issues of raw materials, inventory, order entry and distribution, but it was unable to extend to other functional areas of the company such as sales, marketing and services. ERP also failed to provide value for non-transactional relationships with external partners and vendors, and other non-inventory, non-order operations.

ERP did not tie in any customer relationship management (CRM) capabilities that would allow organizations to capture customer-specific information, nor did it work with websites or portals used for customer service or order fulfillment. Call center or quality assurance staff could not tap into the ERP solution, nor could ERP handle document management, such as cataloging contracts and purchase orders. All technologies adapt to changing business climates if they are to survive and prosper.

Table 41.2 Evolution ERP to ERP II

ERP (1990–1999)	Extended ERP (2000–2005)	ERP II (2005 Onwards)
▲ Materials Planning	▲ Scheduling	▲ Project Management
▲ Order Entry	▲ Forecasting	▲ Knowledge Management
▲ Distribution	▲ Capacity Planning	▲ Workflow Management
▲ General Ledger	▲ E-Commerce	▲ Customer Relationship Management
▲ Accounting	▲ Warehousing	▲ Human Resource Management
▲ Shop Floor Control	▲ Logistics	▲ Portal Capability
		▲ Integrated Financials
		▲ Internet and WWW Integration

The ERP market is no exception. As businesses entered the 21st century, they began to tinker with the idea of **extended ERP**—bringing functionality that existed outside of the ERP system into the mix. There were—and continue to be—issues with integrating such functionality, as businesses thus far have had to implement any "middleware" number of solutions to solve specific IT problems.

ERP II is the next step in extended ERP. It is a solution that includes the traditional materials planning, distribution, and order-entry functionality strengthened by capabilities like Customer Relationship Management (CRM), Human Resources Management (HRM), Document/Knowledge Management (KM) and Workflow Management. Such a system can quickly, accurately and consistently operate an entire organization. It delivers information instantly to the people who need it. It manages the access to that information by establishing security roles and ratings that define which employees can use certain pieces of information. It also addresses the issue of multiple office locations by making the solution **web-based**, so employees can access the system no matter where they may be.

Businesses are utilizing the **Internet** more and more. It is no longer just a tool for e-mail, research and single-transaction commerce. It is quickly becoming a tool for globalizing a business—a tool that allows an organization to tie together its employees, its suppliers and its customers. It enables the free flow of information, and the next generation of solutions will be built upon it.

With Web-enabled B2B, the ERP system can go much beyond the boundaries of your enterprise. You can integrate it with Business Intelligence to analyze your data; and you can couple it with CRM or SCM to increase your involvement with your customers and suppliers. Various enterprises are implementing these cross-functional changes.

Demand for more sophisticated processing capabilities to sharpen competitive edge has resulted in ERP II systems. Many businesses are looking to improve and extend processes, offering customers, suppliers and other trading partners access to integrated processing. This is done through concepts like self-service functionality, and aims to deliver more efficient and effective processes with reduced costs. Enabling technologies like ERP II has led to the advent of **Collaborative Commerce** (C-commerce). C-commerce is the electronic interaction of businesses, whether within the supply chain or an industry. The boundaries of the enterprise have shifted and now extend to customers and suppliers who are outside the organization. With ERP II the customer, the vendor, the supplier and the company all work in unison. The strongest features of ERP II are its **web-centricity** and **designed-to-integrate architectures**.

ERP II facilitated access to Internet and made it a part of the working component. Even though, ERP was a web friendly application it did not make full use of internet but they served as a means of support. This act equals possessing technology and not using it. However, ERP had its own reservations in using internet abundantly. ERP II worked on them and hence, became totally a web friendly application.

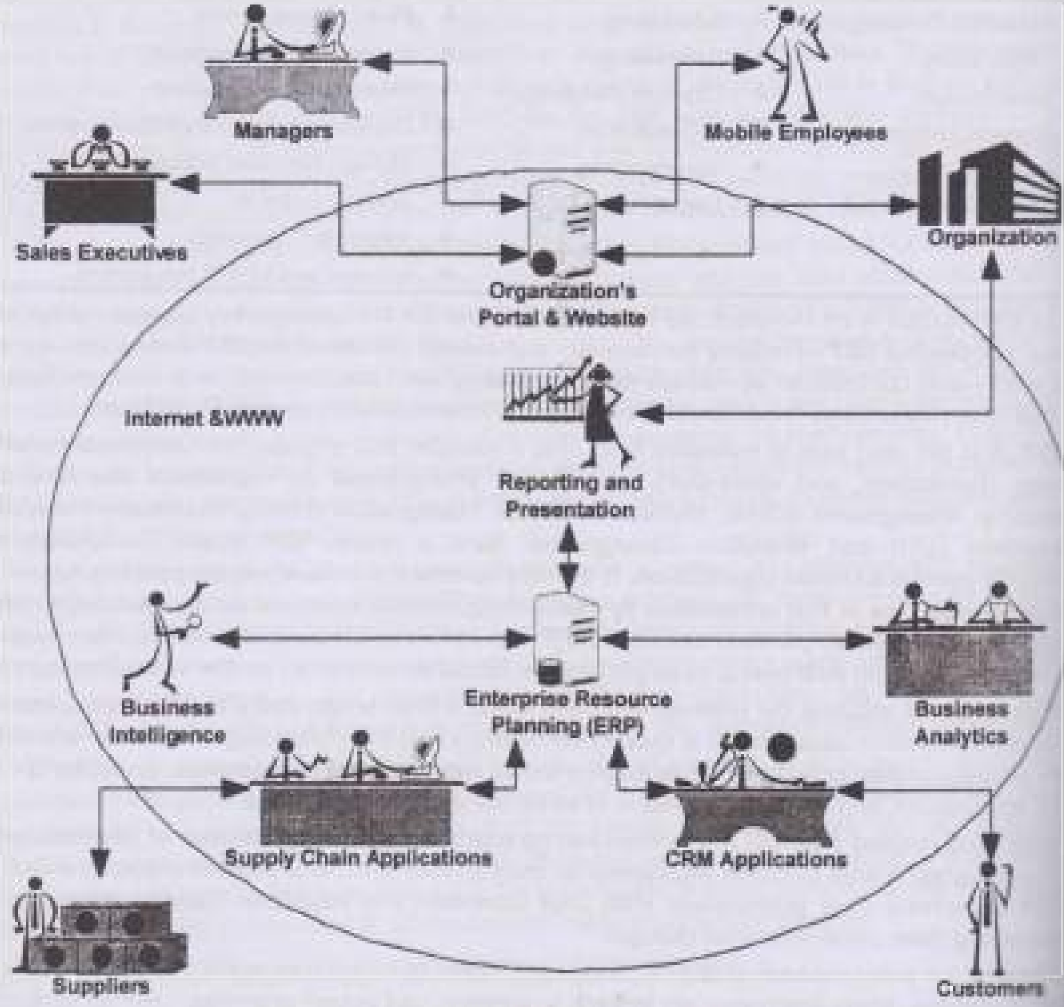


Figure 41.1 ERP, Related Technologies, Internet and WWW

C-commerce enables business partners from multiple companies to exchange information on e-commerce exchanges. For example, companies can develop new products with their supp sharing each other's data across online marketplaces. Collaborative commerce also organizations to find new partners to solve one-off design problems. In this scenario organization's competitive edge will be your ability to take good information and put it internet, and enable people to collaborate on it. Unlike old-style ERP, ERP II will cut across business processes, such as customer relationship management, as well as traditional including finance, and human resource management. ERP II will also be applicable to all not just the finance, manufacturing and distribution sectors that were the focus of ERP.

selling over the web is only a part of ERP II. The main focus is on business interaction and the questions asked are who are you working with and who is your focus. C-commerce is about intellectual capital.

To compete on a functional level today, businesses must adopt an enterprise-wide approach to ERP that utilizes the Internet and connect to every facet of the value chain. They must change their own internal processes and procedures to foster collaborative efforts both inside and outside the organization, and they must integrate technologies that allow their collaborative efforts to take full flight. Changing internal processes is not always easy. Corporations must abandon old methods that strived to preserve and protect data in individual fiefdoms. They need to allow data to be shared within an organization on a rules- and roles-based system. They must overhaul reporting structures that limit decision-making to a select few. They must open lines of communication and collaboration within the organization and to outside partners, suppliers and customers. Without open processes, the extension of ERP throughout an enterprise will fail.

Systems that leverage advanced levels of ERP II functionality integrate disparate software packages in a manner that is seamless and transparent to those using them. A single interface loads information from separate systems, allowing it to be modified and saved back. Actions can trigger events in individual systems, resulting in a chain of events across the enterprise and throughout the value chain.

Software providers need to provide vehicles to connect traditional ERP capabilities with front-office processes. They need to present companies with the means to unify the people, processes and knowledge that matter most to a business. By linking traditional ERP with advanced tools that help run a business, customers can create an accurate, up-to-the-moment view of the extended enterprise to enhance decision-making, analysis, scenario planning, and ongoing management of the value cycle. This approach also provides companies with the unique ability to see where processes intersect, how they impact each other, and the workflow that drives them to produce a clear picture of the business – leading to cost savings and operational efficiencies.

Solutions that bridge the gap between the back- and front-office worlds give organizations the ability to exchange information with the ERP solution. They also tie in additional functionality, such as giving designated individuals inside and outside the company easy access to information critical to their job function or role in the value cycle through a Web-based interface. The result: a substantive competitive advantage.

True enterprise-wide solutions create an environment in which companies can not only model, but also effectively streamline workflow and automate manual, unsecured processes into a secure centralized environment. Access to information and documents should be based on roles- and a rules-based schema, giving business managers the ability to control access to data on a need-to-know and need-to-access basis for projects and outside managed operations. This roles- and rules-based approach eliminates the "data islands" outcome inherent in most, if not all, ERP deployments. Such a model also allows for the involvement of outside stakeholders with the use of portal capabilities.

This enables all members of the value-chain to be included in the process. But most importantly, advanced ERP requires a powerful workflow component and integration with Internet and WWW. Workflow that provides each member of the value chain, based on their roles and responsibilities, with a process-centric view of the business. Workflow that does not depend upon a crude "send"-only model like e-mail, but on a business-rules system which automates the flow of communication and tasks. Workflow that can ensure that assigned tasks are completed, or elevated if need be. Workflow that can be used in conjunction with advanced alert management technology to make certain that potential problems in the production chain do not become crises. Because of the constant evolution of today's business requirements, workflow processes have to be updated as needs change.

REVIEW QUESTIONS

Short Answer Questions

01. What is ERP?
02. What is the connection between ERP and MRP?
03. How ERP is different from MRP II?
04. What do you mean by BOM? What is it used for?
05. What do you mean by MPS? What are its uses?
06. What are the differences between MRP and closed-loop MRP?
07. What are the developments that resulted in the creation of closed-loop MRP?
08. What are the additional capabilities that MRP II has over closed-loop MRP?

Descriptive Type Questions

01. What is the main goal while designing the ERP software?
02. Explain how ERP systems automate an organization's business processes with an example.
03. What do you mean by MRP? Explain
04. How did MRP solve the great manufacturing and production planning problems and made the manufacturing of goods easier?
05. What is closed-loop MRP?
06. Explain what you mean by MRP II.
07. What is ERP and how it is different from MRP, closed-loop MRP, and MRP II?
08. How do ERP systems achieve business integration?
09. How does ERP make organizations more flexible?
10. How does ERP provide better analysis and planning capabilities to organizations?
11. ERP uses the latest developments in the IT field. Explain with examples.
12. How do conventional application packages and ERP packages differ?

Essay Questions

01. Trace the evolution of ERP systems.
02. Summarize the evolution of ERP from 1960s to 1990s.
03. Explain the advantages of ERP over its predecessors.
04. What are the reasons for the growth of the ERP market?
05. What are the advantages of ERP?
06. How does ERP support businesses across company boundaries?
07. Explain the roadmap to a successful ERP implementation.
08. Explain the transition from ERP to ERP II with the help of a diagram.

Fill in the Blanks

01. ERP is an abbreviation for __________.
02. The most crucial factor in the successful implementation of an ERP system is __________.
03. ________ became the fundamental concept of production management and control in mid 1970s.
04. MRP stands for __________.
05. MRP II stands for __________.
06. BOM is the abbreviation of __________.

07. MPS stands for __________.
08. MRP uses the __________ to find out what products are going to be made.
09. MRP gets the details of the materials required to make the products from __________.
10. __________ is the step of negotiation between the company requirements and the functions a package possesses.

[Answers: (1) Enterprise Resource Planning (2) People (3) MRP (4) Material Requirements Planning (5) Manufacturing Resource Planning (6) Bill of Materials (7) Master Production Schedule (8) MPS (9) BOM (10) Gap Analysis]

True or False

01. ERP packages are integrated software packages that help in the effective use of management resources to improve the efficiency of enterprise management.
02. Originally, ERP packages were targeted at the service industry.
03. ERP software is a mirror image of the major business processes of an organization.
04. The fundamentals of ERP are not the same as that of MRP II.
05. ERP system is capable of integrating with other tools like customer relationship management, and supply chain management thereby supporting businesses across company boundaries.
06. The most important step of ERP implementation steps is the phase called Gap Analysis.

[Answers: (1) True (2) False (3) True (4) False (5) True (6) True]

CHAPTER 42

Supply Chain Management (SCM)

TOPICS COVERED

- ▲ Introduction
- ▲ Evolution of SCM
- ▲ Elements of a supply chain
- ▲ Sharing data and gut instincts electronically
- ▲ Battlefield to business
- ▲ Improvements in SCM
- ▲ SCM and retailers
- ▲ Advantages of SCM

Key Points

▲ Supply chain management (SCM) is the oversight of materials, information, and finances as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer. Supply chain management involves coordinating and integrating these flows both within and among companies. It is said that the ultimate goal of any effective supply chain management system is to reduce inventory with the assumption that products are available when needed.

▲ Supply chain management flows can be divided into three main flows: product flow, information flow, and finances flow.

▲ The product flow includes the movement of goods from a supplier to a customer, as well as any customer returns or service needs. The information flow involves transmitting orders and updating the status of delivery. The financial flow consists of credit terms, payment schedules, and consignment and title ownership arrangements.

▲ There are two main types of SCM software: planning applications and execution applications. Planning applications use advanced algorithms to determine the best way to fill an order. Execution applications track the physical status of goods, the management of materials, and financial information involving all parties.

▲ Supply chain management enables supply chain planning and collaboration, supply chain execution, supply chain visibility, design and analytics and creates a host of business benefits.

INTRODUCTION

Few concepts have revolutionized business more profoundly in recent years than supply chain management. The streamlining of communications and materials delivery from vendors to operations and on to customers can yield enormous business benefits—improved customer service, reduced inventory, shorter cycle time, increased agility and higher asset utilization levels, to name a few.

Supply Chain Management (SCM) is the oversight of materials, information, and finances as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer. Supply chain management involves coordinating and integrating these flows both within and among companies. It is said that the ultimate goal of any effective supply chain management system is to reduce inventory (with the assumption that products are available when needed). SCM is the management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers. SCM spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption (supply chain).

Figure 42.1 Organization's Supply Chain

After catching fire in the manufacturing and retail sectors, the principles of SCM are now heating up virtually every industry. As a solution for successful supply chain management, sophisticated software systems with web interfaces are competing with web-based application service providers (ASP) who promise to provide part or all of the SCM service to companies who rent their service. Supply chain management flows can be divided into three main flows:

- The product flow
- The information flow
- The finances flow

The product flow includes the movement of goods from a supplier to a customer, as well as any customer returns or service needs. The information flow involves transmitting orders and updating the status of delivery. The financial flow consists of credit terms, payment schedules, and consignment and title ownership arrangements.

There are two main types of SCM software: planning applications and execution applications. Planning applications use advanced algorithms to determine the best way to fill an order. Execution applications track the physical status of goods, the management of materials, and financial information involving all parties.

Some SCM applications are based on open data models that support the sharing of data both inside and outside the enterprise (this is called the extended enterprise, and includes key suppliers, manufacturers, and end customers of a specific company). This shared data may reside in diverse database systems, or data warehouses, at several different sites and companies.

By sharing this data "upstream" (with a company's suppliers) and "downstream" (with a company's clients), SCM applications have the potential to improve the time-to-market of products, reduce costs, and allow all parties in the supply chain to better manage current resources and plan for future needs.

Increasing numbers of companies are turning to websites and web-based applications as part of the SCM solution. A number of major websites offer e-procurement marketplaces where manufacturers can trade and even make auction bids with suppliers.

With shrinking product life cycles, shifting competitive landscapes and drastic changes to consumer buying patterns, supply chain management is no simple task. But, powerful new tools are helping to replace guesswork about planning, scheduling and execution, with systematic and scientific insight. Earlier waves of Enterprise Resource Planning (ERP) software that integrated financial and distribution functions with Distribution Requirements Planning (DRP), Master Production Scheduling (MPS) and Manufacturing Requirements Planning (MRP) have automated those tasks for many companies. The newest generation, which incorporates Advanced Planning and Scheduling (APS) goes beyond those discrete tasks by fine-tuning the entire supply flow for a company's unique needs.

EVOLUTION OF SCM

MRP grew out of the need to know **what to buy and when** it is to be delivered. But what to buy [illegible] when to deliver it, depends upon **the customer**. What does the customer want? When does he [illegible] Also, customers can change their minds, make last minute modifications, cancel the order or [illegible] totally different item. If several customers behave like this, then trying to match material [illegible] with production geared to meet customer **delivery dates** becomes a juggling nightmare.

Variables to consider include production capacity, machine availability, supplier, and [illegible] lead times, bill of materials, available raw material stock, and available finished product stock. [illegible] goal was always to minimize the level of inventory held yet meet customer demand. MRP, MRP [illegible] ERP provided only limited solutions.

In recognition of the problems of balancing supply with demand various practices [illegible] during 1980s. Sales and operations planning provided a high level overview of the match [illegible] supply and demand. Just-in-Time (JIT) deliveries were based on a card/bin system. This [illegible] what items were required and triggered the 'call-off' of the items from the supplier, who [illegible] agreement to have a stock of these items available for requirements. Product development [illegible] idea of collaboration between customer and supplier at the design stage. Expertise shared at [illegible] enabled the design out of costs and the development of standardized parts in order to reduce [illegible] of the component pool and to gain economies of scale when sourcing.

The fundamental task of dealing with the complexity of planning created an [illegible] vendors to develop specialized planning products. These integrate customer forecasts and [illegible] with operational constraints, including capacity and availability, to generate production [illegible] purchasing requirements. These powerful modeling tools are presented under the banners [illegible] Chain Planning (SCP) and advanced planning systems. Whether there is any distinction [illegible] two is open to debate. Despite all this sophistication, these planning tools are exposed to [illegible] in forecasts. An optimistic or pessimistic forecast passed from a retailer to his [illegible] magnified as it is transmitted back up the supply chain and could have an undesirable [illegible] inventory and availability.

Other functional developments have emerged. Maintenance, Repair and Overhaul [illegible] with the large number of parts, small quantities of each part and a myriad of suppliers [illegible] equipment maintenance. Different inventory requirements can be managed, whether these [illegible] multisite warehouses or different inventory accounts within one location. Replenishment [illegible] also be handled. Transport management includes transportation scheduling and real-time [illegible] and the tracking of items and/or vehicles in transit. The Internet has fuelled the [illegible] service malls and on-line auctions where buyers and sellers can engage in trade.

Collectively, the suite of functionality on offer provides fairly comprehensive [illegible] focused support to the practices associated with the concept of supply chain [illegible] However, one should beware of the interchangeable use of SCP and SCM in the [illegible] concerned with planning. The concept of supply chain management encompasses all [illegible] to the supply chain. This includes vendor selection, negotiation, relations and [illegible] accommodates the planning, procurement and delivery processes and personnel [illegible] training. It deals with vendor owned buffer stocks, on-site inventory levels, [illegible] management, the efficient use of transportation and the tracking of in-transit items. [illegible] include duty, import documentation and foreign currency management. A true [illegible] application package will support all these activities.

determine the core capabilities of a facility and outsourcing partnerships should grow from th decisions.

Inventory

Further strategic decisions focus on inventory and how much product should be in-house. A delica balance exists between too much inventory, which can cost anywhere between 20 and 40 percent their value, and not enough inventory to meet market demands. This is a critical issue in effecti supply chain management. Operational inventory decisions revolve around optimal levels of stock each location to ensure customer satisfaction as the market demands fluctuate. Control policies m be looked at to determine correct levels of supplies at order and reorder points. These levels are criti to the day to day operation of organizations and to keep customer satisfaction levels high.

Location

Location decisions depend on market demands and determination of customer satisfaction. Strateg decisions must focus on the placement of production plants, distribution and stocking facilities, a placing them in prime locations to the market served. Once customer markets are determined, lo term commitment must be made to locate production and stocking facilities as close to the consu as is practical. In industries, where components are lightweight and market driven, facilities shoul located close to the end-user. In heavier industries, careful consideration must be made to deter where plants should be located so as to be close to the raw material source. Decisions conce location should also take into consideration tax and tariff issues, especially in inter-state a worldwide distribution.

Transportation

Strategic transportation decisions are closely related to inventory decisions as well as m customer demands. Using air transport obviously gets the product out quicker and to the cu expediently, but the costs are high as opposed to shipping by boat or rail. Yet using sea or rail means having higher levels of inventory in-house to meet quick demands by the customer. It is keep in mind that since 30 percent of the cost of a product is encompassed by transportation, us correct transport mode is a critical strategic decision. Above all, customer service levels must b and this often determines the mode of transport used. Often this may be an operational decis strategically, an organization must have transport modes in place to ensure a smooth distrib goods.

Information

Effective supply chain management requires obtaining information from the point of end-us linking information resources throughout the chain for speed of exchange. Overwhelming pape and disparate computer systems are unacceptable in today's competitive world. Fostering in requires good organization of information. Linking computers through networks and the inter streamlining the information flow, consolidates knowledge and facilitates velocity of pro Account management software, product configurators, enterprise resource planning sys global communication are key components of effective supply chain management strategy.

SHARING DATA AND GUT INSTINCTS ELECTRONICALLY

An electronics manufacturer may put a premium on minimizing fast-obsolescing parts while a pizza franchiser cares more about faster delivery of foodstuffs to its stores. To tha tools monitor and optimize the supply chain from end to end—as a unified whole warehouses and retail sites—instead of as separate pieces. Thanks to The Internet and elec interchange (EDI) networks producers can now share operational data and even gut instincts systematically and instantly with wholesalers and retailors, and vice-versa, across time zones and geography. The result is more visibility throughout the supply chain, fewer surprises and less need to stock back up raw materials or finished goods. With better synchronization across the entire supply chain, each member achieves major benefits:

- Lower inventories and therefore, lower financing costs
- Shorter receivables cycles
- Optimal use of production resources, costly work forces and transportation fleets
- Faster response to market changes
- Greater satisfaction and loyalty among customers
- Greater profitability

The most successful companies maximize those benefits by selecting supply chain management solutions not on the basis of mere bells and whistles, but on how well they improve critical business processes such as procurement-to-pay cycles, demand forecasting, order-to-cash cycles. The secret to achieving improvement is a supply chain management system that ties all of the steps in the chain together, as well as into financial, production and other critical systems. A standalone APS system for example, is important but not sufficient to manage supply chain activities.

BATTLEFIELD TO BUSINESS

The military was one of the first organizations to recognize supply chains and how to manage them—during World War II. Strategists realized that delivering the right manpower and material on schedule to just the right spot was the key to battlefield supremacy. The digital computer brought new methods for scheduling the loading and movement of ships, planes and railcars. Thus was born modern supply chain management, and it was not long before automobile, chemical and electronics manufacturers picked up the new techniques. To improve forecasting, speed up material flows and synchronize production, they also found they needed to listen to customers and work more closely with suppliers. Supply chain management turned out to be mainly a matter of building new communications paths and interlocking feedback loops that help business partners share information and ultimately, more fully trust each other to maximize mutual benefit.

IMPROVEMENTS IN SCM

The supply chain discipline has taken a huge leap forward with APS's ability to simultaneously consider multiple constraints that affect production and delivery of goods. Making this possible is the tremendous increase in computer memory capacity now available at a reasonable cost from networked computers. It starts with constructing a detailed model of a given supply chain's elements—an enterprise's network of suppliers, distribution centers and factories, for example—with data on what each one can supply, the costs and time to re-tool, transfer costs between facilities and the inventories on hand at every stage. Next, it takes in details on current orders, forecasts of future demand, the costs and availability of every part and raw material, each customer's special requirements, etc.

Using specialized algorithms embodying artificial intelligence techniques, the APS software grinds through all of this data to come up with an enterprise-wide plan for production, distribution or both, tailored to the company's specific goals. For example, it may optimize production to make sure that orders from two customers get delivered on time at any cost, or that a specific plant of the company is kept as busy as possible. Or that inventory level at a particular distribution center does not fall dangerously low.

How does supply chain management apply to non-manufacturers? Think of hospitals, wh purchase of enormous volumes of surgical supplies and other materials account for some 23 perce their average annual budgets. Instead of blindly stocking a central storeroom and paying for inve while it sits for weeks before getting used, an ERP system with APS can schedule and manage freq delivery of supplies when and where they are needed. Leading healthcare companies are exte these efficiencies to entire networks of hospitals and clinics for even greater cost savings.

In fact, all businesses that involve complex flows of material can take advantage of this kin global optimization and efficient execution. Communications and power utilities deploy supply ch management to more efficiently purchase and schedule supplies for their network capital pr Suppliers can deliver telephone poles or power transformers directly to construction sites and by intermediate storage depots thus, eliminating inventory financing and reshipment costs.

SCM AND RETAILERS

The retail industry is another prime candidate for advancements in supply chain managemen heart is the ability to identify and then act upon fleeting fashion and other consumer trends whether for a single shop or a national chain, it is a daunting challenge, since sometimes thousa stocking units are delivered to multiple warehouses from hundreds of manufacturers. With visibility across the entire supply chain, buyers can make more informed decisions about every of their operations, from how to optimally allocate inventories among different stores and ware to what goods to order and reorder, and how to price and stock them on the sales floor. Tie it the retailer's financial accounting and human resources systems, and you have a model framew optimum efficiency.

ADVANTAGES OF SCM

Supply chain management enables:

- Supply chain planning and collaboration
- Supply chain execution
- Supply chain visibility design and analytics
- Business benefits

Supply Chain Planning and Collaboration

With SCM, you can model your existing supply chain: set goals and forecast, optimize, and time, materials and other resources. Supply chain planning functionality enables you to return on assets and ensures a profitable match of supply and demand.

Supply Chain Execution

SCM enables you to carry out supply chain planning and generate high efficiency at the possible cost. You can sense and respond to demand through an adaptive supply chain which distribution, transportation and logistics are integrated into real-time planning process

Supply Chain Visibility Design and Analytics

SCM gives you network-wide visibility across your extended supply chain to perform stra as day-to-day planning. The application also enables collaboration and analytics, so you can and analyze the performance of your extended supply chain using pre-defined Key Pe Indicators (KPIs).

Business Benefits

SCM can help you transform a traditional linear supply chain into an adaptive network with the following benefits.

- **Faster response to changes in supply and demand**—With increased visibility into the supply chain and adaptive supply chain networks, you can be more responsive. You can sense and respond quickly to changes and quickly capitalize on new opportunities.
- **Increased customer satisfaction**—By offering a common information framework that supports communication and collaboration, mySAP SCM enables you to adapt better to and meet customer demands.
- **Compliance with regulatory requirements**—You can track and monitor compliance in areas such as environment, health and safety.
- **Improved cash flow**—Information transparency and real-time business intelligence can lead to shorter cash-to-cash cycle times. Reduced inventory levels and increased inventory turns across the network can lower overall costs.
- **Higher margins**—With SCM, you can lower operational expenses with timely planning for procurement, manufacturing and transportation. Better order, product and execution tracking can lead to improvements in performance and quality—and lower costs. You can also improve margins through better coordination with business partners.
- **Greater synchronization with business priorities**—Tight connections with trading partners keep your supply chain aligned with current business strategies and priorities, improving your organization's overall performance and achievement of goals.

REVIEW QUESTIONS

Short Answer Questions

01. What do you mean by supply chain management?
02. What are the benefits of SCM?
03. Why supply chain management is not a simple task?
04. How does SCM improve supply chain planning and collaboration?
05. How does SCM improve supply chain execution?
06. How does SCM improve supply chain visibility, design, and analytics?

Descriptive Type Questions

01. What are the tools that help in effective and efficient management of the supply chain?
02. Why is trying to match material purchases with production geared to meet customer delivery dates is a juggling nightmare?
03. What is JIT and what are its advantages?
04. How do SCM solutions improve traditional supply chains?
05. How does supply chain management apply to non-manufacturers?
06. What are the advantages of sharing data with business partners?
07. How does SCM help retailer businesses?
08. What are the business benefits of SCM?

Essay Questions

01. Trace the evolution of SCM.
02. Explain the elements of a supply chain.

03. What are the improvements that happened to SCM over time?
04. What are the advaniages of SCM?

Fill in the Blanks

01. SCM stands for ___________.
02. DRP stands for ___________.
03. APS stands for ___________.
04. JIT stands for ___________.
05. MRO stands for ___________.
06. EDI stands for ___________.

[**Answers:** (1) Supply Chain Management (2) Distribution Requirements Planning (3) Advanced Planning and Scheduling (4) Just-in-Time (5) Maintenance, Repair and Overhaul (6) Electronic Data Interchange]

True or False

01. MRP grew out of the need to know what to buy and when it is to be delivered.
02. SCM enables collaboration, planning, execution and coordination of the entire supply chain.
03. The military was one of the first organizations to recognize supply chains and how to manage them.
04. All businesses that involve complex flows of material can take advantage of the SCM system.
05. KPI stands for Key Person's Information.

[**Answers:** (1) True (2) True (3) True (4) True (5) False]

CHAPTER 43

Customer Relationship Management (CRM)

TOPICS COVERED

- Introduction
- Functions of CRM
- Components of CRM system
- Uses of CRM
- Features and functions of CRM system
- Benefits of CRM

> **Key Points**
>
> ▲ Customer Relationship Management (CRM) consists of the processes a company uses to track and organize its contacts with its current and prospective customers. CRM software is used to support these processes, the software system can be accessed, and information about customers and customer interactions can be entered, stored and accessed by employees in different departments of the company. Typical CRM goals are to improve services provided to customers, and to use customer contact information for targeted marketing.
>
> ▲ The customers interacting with a company perceive the business as a single entity, despite often interacting with a number of employees in different roles and departments. CRM is a combination of policies, processes, and strategies implemented by an organization to unify its customer interactions and provide a means to track customer information.
>
> ▲ The three fundamental components in CRM are operational (automation of basic business processes such as marketing, sales, and service), analytical (analysis of customer data and behavior using business intelligence), and collaborative (communicating with clients).
>
> ▲ Many organizations turn to CRM software to help them manage their customer relationships.

INTRODUCTION

The need to manage customer relationships is not a new concept. Around 1998 a phrase emerged, which attempted to encapsulate everything relating to this. It was called, Customer Relationship Management (CRM). One significant feature of CRM was that it focused attention upon revenue generating activities. This contrasts with the more traditional focus of ERP, which is on operations, with improvements and benefits having an impact upon the cost aspects of doing business.

The emergence of CRM appears to be the outcome of several developments in the sales and marketing domains. On one hand, there were technological developments. It was increasingly recognized that MRPII and ERP systems which focused on manufacturing and related activities had failed to meet the growing needs of the sales and marketing functions. Customer contact management, product and price lists and direct mailing were among the first applications to be developed. Later, additions to this have included campaign management, call centre services and market intelligence management. One of the key technological issues has been the integration of the different technologies: databases, laptops, mobile phones, client/server and computer-telephony integration. The Internet has spawned new channels such as e-mail and portals. With the removal of technological barriers it becomes possible for information to be immediately available at any location globally. However, one of the main concerns is security. Unsecured channels present a threat of interception and intrusion. One of the solutions being developed is encryption.

There was a growing recognition of the need to be more customer-orientated. Enabled by the technological developments, the search was for better practices and greater efficiencies. Data analysis allows better customer profiling and hence more efficient customer targeting. On-line data entry from remote locations improves information about customer interactions and enables the development of more efficient ways of approaching customers. The development of call centers enables 24-hour customer support. On-line data access enables customers to be informed about the current status of their accounts and orders. Developments in logistics technology enable better tracking of products and early awareness of delivery problems. The assumption is that by being better informed, the customer can be better satisfied.

So what is CRM? Gartner Inc. defines CRM as follows: "A business strategy, the outcomes of which optimize profitability, revenue and customer satisfaction by organizing around customer segments, fostering customer-satisfying behaviors, and implementing customer-centric processes. By definition then CRM technologies enable greater customer insight, increased customer access, more effective interactions and integration throughout all customer channels and back-office enterprise functions."

While Gartner Inc. distinguishes between CRM and the enabling technologies, popular usage suggests that CRM appears to be all things to all people. CRM can be described as the development and implementation of a strategy for handling interactions with past, existing or future customers. It covers all customer-orientated activities from potential market identification through to customer loyalty retention. It is technology enabled and involves data capture and analysis, information generation and distribution, and customer-orientated activity. CRM has a central database and integrates with an ERP system and different channels of interaction. CRM involves different participants and has the facility to manage these participants. Finally, it distinguishes different emphasis in dealing with the customer, including account management and opportunity exploitation. CRM is about acquiring and retaining customers, improving customer loyalty, gaining customer insight and implementing customer-focused strategies. A true customer-centric enterprise helps a company drive new growth, maintain competitive agility and attain operational excellence.

Companies are increasingly waking up to the fact that they can create wealth (new value) by working creatively with business partners in the distribution chain and with consumers to reduce costs and cycle times of products, and to provide better order tracking information to customers. Customer delight is the key to enhancing revenue. Research has shown that only happy and satisfied customers are truly loyal and keep coming back. Using information technology (IT), nimble companies are strengthen customer relationships by integrating sales, product configuration, planning and design processes with customers through existing and new channels. Typically, a company has a set of preferred customers, but welcomes orders from any qualified buyer. Since the industrial revolution, companies have viewed orders as nothing more than a demand for their product or service. As the source of revenue, customers are treated with respect in hopes of getting repeat business.

With the popularity of the web and web-based business, companies operating in a mass production world were able to truly personalize relationships with customers. The ability to build strong relationships with customers is causing renewed efforts among businesses to achieve lifetime value from current customers and to put strategic plans in place to go after lifetime value for new customers in new markets. In the world of e-business, companies can replicate the personal customer relationship that existed prior to mass markets by using knowledge of the customer to personalize customer service while continuing to sell standard products.

There are a number of potential benefits in following the CRM route. These are increased automation facilitates, better use of existing resources, better quality of information, faster response time, improved customer targeting, better customer retention and increased sales. However, implementation of a CRM system has been described as 'not easy' with expectations often not being met. Reasons for failure include excessive expectations, lack of understanding of what CRM is, the misconception that CRM is a technical solution and not a business solution, poor requirements definition, required data not being captured or being inaccessible, lack of sponsorship, politics and inadequate attention to employees. Nevertheless, whilst the technology enables the supplier to know all about the customer, it remains to be seen whether this is at the expense of the old adage 'know your customer.'

Customer relationship management (CRM) helps companies achieve this objective. The CRM application enhances the company's "front office," focusing on sales, marketing and customer service. However, in order to be truly successful CRM must be seen as a combination of people, processes and systems rather than as a narrowly defined IT application. CRM is one piece of the new wave of ERP that focuses on outward facing processes, tying them together with the inside-the-enterprise transaction-processing engine of the original ERP systems.

FUNCTIONS OF CRM

Customer relationship management is a corporate level strategy, focusing on creating and maintaining relationships with customers. Several commercial CRM software packages are available which vary in their approach to CRM. However, CRM is not a technology by itself but, rather a holistic approach to an organization's philosophy, placing the emphasis firmly on the customer.

CRM governs an organization's philosophy at all levels, including policies and processes, front-of-house customer service, employee training, marketing, systems and information management. CRM systems are integrated end-to-end across marketing, sales and customer service. A CRM system should:

1. Identify factors important to clients
2. Promote a customer-oriented philosophy
3. Adopt customer based measures
4. Develop end-to-end processes to serve customers
5. Provide successful customer support
6. Handle customer complaints
7. Track all aspects of sales
8. Create a holistic view of customers' sales and services information

COMPONENTS OF CRM SYSTEM

There are three fundamental components in CRM:

- Operational—automation of basic business processes (marketing, sales, service)
- Analytical—analysis of customer data and behavior using business intelligence
- Collaborative—communicating with clients

Operational CRM

Operational CRM provides automated support to "front office" business processes (sales, marketing and service). Each interaction with a customer is generally added to a customer's history and staff can retrieve information on customers from the database as necessary. According to Gartner Group, operational CRM typically involves three general areas.

- Sales Force Automation (SFA)—SFA automates the organization's critical sales and sales force management tasks, such as forecasting, sales administration, tracking customer preferences and demographics, performance management, lead management, account management, contact management and quote management.
- Customer Service and Support (CSS)—CSS automates certain service requests, complaints, product returns and enquiries.
- Enterprise Marketing Automation (EMA)—EMA provides information about the business environment, including information on competitors, industry trends, and macro-environmental variables. EMA applications are used to improve marketing efficiency.

Integrated CRM software is often known as a "front office solution", as it deals directly with customers. Many call centers use CRM software to store customer information. When a call is received, the system displays the associated customer information (determined from the number of the caller). During and after the call, the call center agent dealing with the customer can add further information. Some customer services can be fully automated such as, allowing customers to access their bank account details on-line or via a WAP phone.

Analytical CRM

Analytical CRM analyses data (gathered as part of operational CRM or from other sources) in an attempt to identify means to enhance a company's relationship with its clients. The results of an analysis can be used to design targeted marketing campaigns, for example:

- Acquisition—Cross-selling, up-selling
- Retention—Retaining existing customers
- Information—Providing timely and regular information to customers

Other examples of the applications of analyses include contact optimization, evaluating and improving customer satisfaction, optimizing sales coverage, fraud detection, financial forecasts, price optimization, product development, program evaluation, risk assessment and management, strategic marketing, operational marketing, etc.

Data collection and analysis is viewed as a continuing and iterative process. Ideally, business decisions are refined over time, based on feedback from earlier analyses and decisions. Most analytical CRM projects use a data warehouse to manage data.

Collaborative CRM

Collaborative CRM focuses on the interaction with customers (personal interaction, letter, fax, phone, Internet, e-mail, etc.). Collaborative CRM includes:

- Providing efficient communication with customers across a variety of communication channels
- Providing on-line services to reduce customer service costs
- Providing access to customer information while interacting with customers

USES OF CRM

CRM covers all interaction and business with customers. A good CRM program allows a business to acquire customers, provide customer services and retain valued customers. Customer services can be improved by:

- Providing on-line access to product information and technical assistance around the clock

- Identifying what customers value and devising appropriate service strategies for each customer
- Providing mechanisms for managing and scheduling follow-up sales calls
- Tracking all contacts with a customer
- Identifying potential problems before they occur
- Providing a user-friendly mechanism for registering customer complaints
- Providing a mechanism for handling problems and complaints
- Providing a mechanism for correcting service deficiencies
- Storing customer interests in order to target customers selectively
- Providing mechanisms for managing and scheduling maintenance, repair and ongoing support

CRM applications often track customer interests and requirements, as well as their buying habits. This information can be used to target customers selectively. Furthermore, the products a customer has purchased can be tracked throughout the product's life cycle, allowing customers to receive information concerning a product or to target customers with information on alternative products once a product begins to be phased out.

Repeat purchases rely on customer satisfaction, which in turn comes from a deeper understanding of each customer and their individual needs. CRM is an alternative to the "one size fits all" approach. In industrial markets the technology can be used to coordinate the conflicting and changing purchase criteria of the sector.

The business benefits of a CRM system is that it provides the insight and analysis you need to anticipate customer needs and build lasting, profitable customer relationships. With CRM you benefit from:

- The ability to act immediately and grow strategically, without disruption
- End-to-end processes within the industry value chain by helping you drive customer value, loyalty and profitability across the entire value chain
- Real-time visibility into customer value by working with other business critical software and provision of a 360-degree view of customers, including all interactions with them and profitability at every point in the value chain. You can determine who your most profitable customers are and build lasting, loyal and profitable relationship with them.

FEATURES AND FUNCTIONS OF CRM SYSTEM

Customer relationship management (CRM) enables you to maximize the efficiencies of marketing resources and empower marketers to acquire and develop long-term customer relationships. Marketers can analyze, plan, execute and measure all marketing activities. With CRM you gain a flexible application to power marketing success. CRM supports critical marketing processes, including the following.

Technology-Enabled Selling

Technology-enabled selling (TES) goes beyond the blind application of raw technology and deals with understanding the ways technology benefits the bottom line. The changing face of sales is speeding the drive for TES. In consumer markets customers already expect a range of channels that offer consistent service. In the business-to-business (B2B) world the new focus on relationships and the rise of the consultant-salesperson have increased in complexity and diversity.

TES has three sets of component building blocks. The first is a foundation of customer information located in company databases and manipulated either by legacy or ERP systems. The second is an infrastructure of systems that allow the company to communicate and transact business with customers; these employ telephones, faxes, personal computers and other devices. The third is a set of advanced applications that are often specific to industries or sectors.

Marketing Resource Management

Analyze, plan, develop, implement and measure all marketing activities to maximize the efficiencies of your available resources and gain visibility and control into your marketing processes. CRM helps you control and manage your budget and marketing spend. The application also allows you to facilitate collaboration among team members and coordinate marketing activities across the enterprise, increasing the speed and effectiveness of your marketing processes.

Segment and List Management

Manage enterprise customer and prospect data without the need for IT support. With CRM you can create and capture customer profile data to target better and personalize marketing messages and you can view all relevant enterprise customer information from a central point. Using an interactive, drag-and-drop interface, the marketers can perform adhoc, high speed customer segmentation and segment analysis and quickly identify opportunities and gain insights into customer segments with data visualization features.

Call Center Management

Call centers are rapidly emerging as a means to provide service to customers, business partners and employees. Increasingly, they are the main point of contact for customers. Call centers perform the following five functions:

1. Resolve issues or refer problems to the next level of service provider
2. Provide more information about products and services
3. Make recommendations to customers about the product or service that best suits the customer's needs
4. Take calls and monitor progress on customer requests and problems
5. Generate reports for root-cause analysis

The best call centers link voice, video and data into a comprehensive system to provide cutting-edge "customer care." A call center system and process must be constructed with the customer in mind.

Campaign Management

Analyze, plan, execute and measure marketing activities through all inbound and outbound interaction channels to build long-term profitable relationships. With CRM you can make the most of dialog marketing by implementing inbound and outbound campaigns that are both multi-channel and multi-wave. You can develop and execute the best marketing strategy using constraint based optimization techniques to determine the optimum marketing mix.

Internet Protocol Telephony

Frequently integrated into a pre-existing call center, Internet protocol (IP) telephony in Internet call centers allows customers to speak directly with call center agents while using the browser to access the company's website. IP telephony can be used in call centers when, for example, a user is on a corporate website and requests technical support. The user clicks on a call button displayed on the web page

The call button is a hypertext link that activates the IP telephony software, which then connects the user with a call center agent. If the customer enters his or her customer identification number, the call center agent can access the customer's history—the products the customer is using and the problems the customer has encountered previously. Based on the customer's purchasing history, this access also enables the agent to sell upgrades or new products. This is enabled by computer-telephone integration (CTI) technology, which is available as a feature of high-end CRM software.

Field Service Management

E-business customer service also enhances field service, which is the part of customer service in which qualified representatives of a company are sent to the customer's site to resolve problems. A call center can forward an unsolved problem to an internal or external field service organization. E-enabled field service help sales representatives by providing them with up-to-date customer and product information (including design documents and repair manuals) via the Internet. Field service representatives can check on outstanding customer queries, view their active service calls and even update the status of accounts while traveling.

Trade Promotion Management

Effectively manage trade promotions that increase brand equity and achieve sales objectives. With the CRM tools you can gain complete visibility into trade programs at each stage of their life cycles—to reduce error, improve efficiency and control trade spend.

Lead Management

Generate highly qualified, prioritized leads and automate your lead distribution process to handle leads faster. CRM enables you to align marketing and sales organizations—and extend your lead management process to partner organizations—to increase conversion rates. The application provides full visibility into the lead management process enabling you to optimize all activities.

Marketing Analytics

Leverage a wide range of analytics such as customer values; and churn scores and satisfaction scores to make profitable decisions. Insights gained from CRM help you understand why marketing activities did or did not work. The application also helps you identify business challenges and opportunities, and predict customer behaviors, anticipate their needs and create more relevant, targeted messages.

BENEFITS OF CRM

With ERP systems in place in almost all organizations the backbone exists on which to build CRM systems. Where ERP itself with its focus on transaction processing, may have failed to deliver the anticipated benefits, CRM systems can provide tangible and measurable returns centered on customer sources of value creation.

Technology now exists that enables companies to conduct one-to-one marketing. These tools frequently available off the shelf are both powerful and inexpensive. They have transformed the selling and marketing landscape. Unlike some traditional forms of advertising, which are undirected and unspecified, CRM systems enable companies to communicate with customers on a personal level.

A company performing CRM provides a single corporate face to the customer wherever the customer may encounter the company: through different business units, regional offices or operational organizations within the company. Customers expect integrated, seamless, multichannel customer service that is transparent whether the service is being provided by the company or by a third-party service provider.

The "new marketing" hinges on four key technologies: technology-enabled selling, call centers, e-business and data warehousing/ mining. In many instances, these technologies are combined to provide a seamless customer service experience. Recognizing these emerging products, ERP vendors are now investing a great deal of money to catch up. But from the marketing world's perspective they have a long way to go. As a result, in many areas companies are using best-of-breed packages with bolt-on interfaces to their existing ERP systems.

CRM packages are available that bundle many existing sales and marketing functions, such as sales force automation, call center systems and data mining with a robust technical architecture resulting in integrated CRM with wide functionality.

REVIEW QUESTIONS

Short Answer Questions

01. What was the need for CRM?
02. What do you mean by CRM?
03. What do you mean by sales force automation?
04. What is customer service and support?
05. What do you mean by enterprise marketing automation?
06. What do you mean by marketing analytics?
07. What is lead management?
08. What is trade promotion management?
09. What do you mean by field service management?
10. What is Internet protocol telephony?

Descriptive Type Questions

01. What are the factors that led to the emergence of CRM?
02. What has the popularity of web and web-based businesses to do with CRM?
03. What are the potential benefits of CRM?
04. How does CRM help organizations to know their customers better?
05. What are the functions of CRM?
06. What do you mean by operational CRM? Explain its functions.
07. What do you mean by analytical CRM? Explain its functions.
08. What do you mean by collaborative CRM? Explain its functions.
09. What you mean by technology-enabled selling?
10. What is marketing resource management?
11. What do you mean by segment and list management?
12. What is call center management?
13. What do you mean by campaign management?
14. What are the benefits of CRM?

Essay Questions

01. Explain the different components of CRM.
02. Explain the uses of CRM.
03. What are the features and functions of a CRM system?

Fill in the Blanks

01. CRM stands for __________.

02. SFA stands for _________.
03. CSS stands for _________.
04. EMA stands for _________.
05. TES stands for _________.
06. CTI stands for _________.
07. _________ automates a company's critical sales and sales force management tasks, such as forecasting, sales administration, tracking customer preferences and demographics, performance management, etc.
08. _________ provides information about the business environment, including information on competitors, industry trends, and macro-environmental variables.

[**Answers:** (1) Customer Relationship Management (2)Sales Force Automation (3) Customer Service and Support (4) Enterprise Marketing Automation (5) Technology-Enabled Selling (6) Computer-Telephone Integration (7) SFA (8) EMA]

True or False

01. MRP II and ERP systems which focused on manufacturing and related activities failed to meet the growing needs of the sales and marketing functions.
02. Unsecured channels present a threat of interception and intrusion for internet transaction.
03. The development of call centers enables 24-hour customer support.
04. Analytical CRM provides automated support to "front office" business processes.
05. Integrated CRM software is often known as a "front office solution", as it deals directly with customers.
06. Collaborative CRM focuses on the interaction with customers.
07. CTI is available as a feature of high-end CRM software.
08. With CRM you can create and capture customer profile data to better target and personalize marketing messages.

[**Answers:** (1) True (2) True (3) True (4) False (5) True (6) True (7) True (8) True]

CHAPTER 44

Geographic Information System (GIS)

TOPICS COVERED

- Introduction
- How GIS works?
- Geographic references
- Vector and raster models
- Components of GIS
- Data for GIS
- GIS and related technologies
- What can GIS do for you?
- GIS in everyday life
- Global positioning system (GPS)

Key Points

▲ A Geographic Information System (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on earth.

▲ Mapmaking and geographic analysis are not new, but a GIS performs these tasks better and faster than the old manual methods. GIS stores information about the world as a collection of thematic layers that can be linked together by geography.

▲ A working GIS integrates five key components: hardware, software, data, people, and methods.

▲ GIS can be used to improve organizational integration, make better decisions, making maps, etc. GIS allows you to bring all types of data together based on the geographic and locational component of the data.

NTRODUCTION

Geographic Information System (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on arth. GIS technology integrates common database operations such as query and statistical analysis ith the unique visualization and geographic analysis benefits offered by maps. These abilities istinguish GIS from other information systems and make it valuable to a wide range of public and rivate enterprises for explaining events, predicting outcomes, and planning strategies.

The major challenges we face in the world today – overpopulation, pollution, deforestation, and atural disasters – have a critical geographic dimension. Whether it is locating a suitable site for a new usiness or finding the best soil for growing bananas or figuring out the best route for an emergency ehicle most problems also have a geographical component. GIS will give you the power to create aps, integrate information, visualize scenarios, solve complicated problems, present powerful ideas, id develop effective solutions like never before. GIS is a tool used by individuals and organizations, hools, governments, and businesses seeking innovative ways to solve their problems.

Mapmaking and geographic analysis are not new, but a GIS performs these tasks better and faster an the old manual methods. Before GIS technology came into existence, only a few people had the ills necessary to use geographic information to help with decision-making and problem solving.

Today, GIS is a multibillion dollar industry employing hundreds of thousands of people orldwide. GIS is taught in schools, colleges, and universities throughout the world. Professionals in ery field are increasingly aware of the advantages of thinking and working geographically.

HOW GIS WORKS?

GIS stores information about the world as a collection of thematic layers that can be linked together by geography (see Figure 44.1). This simple but extremely powerful and versatile concept has proven invaluable for solving many real-world problems from tracking delivery vehicles, to recording details of planning applications, to modeling global atmospheric circulation.

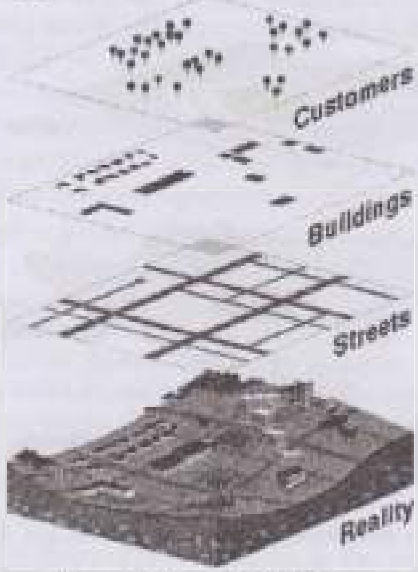


Figure 44.1 How GIS Works?

GEOGRAPHIC REFERENCES

Geographic information contains either an explicit geographic reference, such as a latitude and longitude or national grid coordinate, or an implicit reference such as an address, postal code, census tract name, forest stand identifier, or road name. An automated process called geocoding is used to create explicit geographic references (multiple locations) from implicit references (descriptions such as addresses). These geographic references allow you to locate features, such as a business or forest stand, and events, such as an earthquake, on the earth's surface for analysis.

VECTOR AND RASTER MODELS

Geographic information systems work with two fundamentally different types of geographic models—the "vector" model and the "raster" model. In the vector model, information about points, lines, and polygons is encoded and stored as a collection of x,y coordinates. The location of a point feature, such as a bore hole, can be described by a single x,y coordinate. Linear features, such as roads and rivers, can be stored as a collection of point coordinates. Polygonal features, such as sales territories and river catchments, can be stored as a closed loop of coordinates.

The vector model is extremely useful for describing discrete features, but less useful for describing continuously varying features such as soil type or accessibility costs for hospitals. The raster model has evolved to model such continuous features. A raster image comprises a collection of grid cells rather like a scanned map or picture. Both the vector and raster models for storing geographic data have unique advantages and disadvantages. Modern GISs are able to handle both models.

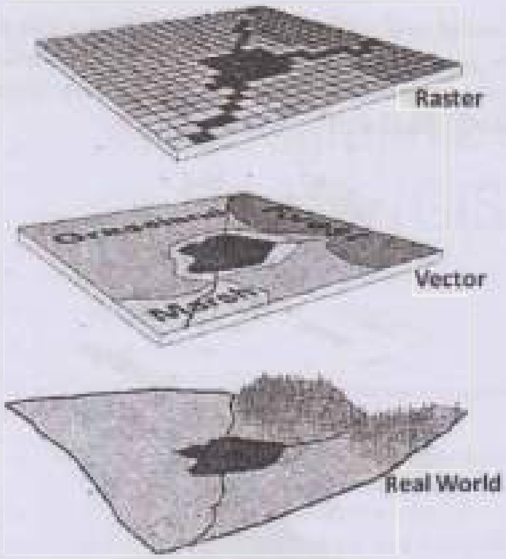


Figure 44.2 Raster and Vector Models

COMPONENTS OF GIS

A working GIS integrates five key components: hardware, software, data, people, and methods.

- **Hardware** – Hardware is the computer on which a GIS operates. Today, GIS software runs on a wide range of hardware types, from centralized computer servers to desktop computers used in stand-alone or networked configurations.
- **Software** – GIS software provides the functions and tools needed to store, analyze, and display geographic information. Key software components are:
    - Tools for the input and manipulation of geographic information
    - A database management system (DBMS)
    - Tools that support geographic query, analysis, and visualization
    - A graphical user interface (GUI) for easy access to tools
- **Data** – Possibly, the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organizations to organize and maintain their data, to manage spatial data.
- **People** – GIS technology is of limited value without the people who manage the system and develop plans for applying it to real-world problems. GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work.
- **Methods** – A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

DATA FOR GIS

If you are unfamiliar with map data, think first about how you want to use map data. The following are some of the common map data types:

- **Base Maps** – Include streets and highways; boundaries for census, postal, and political areas; rivers and lakes; parks and landmarks; place names; and geological survey raster maps.
- **Business Maps and Data** – Includes data related to census/demography, consumer products, financial services, health care, real estate, telecommunications, emergency preparedness, crime, advertising, business establishments, and transportation.
- **Environmental Maps and Data** – Includes data related to the environment, weather, environmental risk, satellite imagery, topography, and natural resources.
- **General Reference Maps** – World and country maps and data that can be a foundation for your database.

GIS AND RELATED TECHNOLOGIES

GISs are closely related to several other types of information systems, but it is the ability to manipulate and analyze geographic data that sets GIS technology apart. Although there are no hard and fast rules about how to classify information systems, the following discussion should help differentiate GIS from desktop mapping, Computer Aided Design (CAD), remote sensing, DBMS, and Global Positioning Systems (GPS) technologies.

- **Desktop Mapping** – A desktop mapping system uses the map metaphor to organize data and user interaction. The focus of such systems is the creation of maps: the map is the database. Most desktop mapping systems have more limited data management, spatial analysis, and customization capabilities. Desktop mapping systems operate on desktop computers such as PCs, Macintoshes, and smaller UNIX workstations.
- **CAD** – CAD systems evolved to create designs and plans of buildings and infrastructure. This activity required that components of fixed characteristics be assembled to create the whole structure. These systems require few rules to specify how components can be assembled and very limited analytical capabilities. CAD systems have been extended to support maps but typically have limited utility for managing and analyzing large geographic databases.
- **Remote Sensing and GPS** – Remote sensing is the art and science of making measurements of the earth using sensors such as cameras carried on airplanes, GPS receivers, or other devices. These sensors collect data in the form of images and provide specialized capabilities for manipulating, analyzing, and visualizing those images. Lacking strong geographic data management and analytical operations, they cannot be called true GISs.
- **Database Management Systems (DBMS)** – Database management systems specialize in the storage and management of all types of data including geographic data. DBMSs are optimized to store and retrieve data and many GISs rely on them for this purpose. They do not have the analytic and visualization tools common to GIS.

WHAT CAN GIS DO FOR YOU?

GIS can do a lot of things for you and your business. Given below are some examples:

Perform Geographic Queries and Analysis

The ability of GISs to search databases and perform geographic queries has saved many compa
literally millions of dollars. GISs have helped reduce costs by:

- ▲ Streamlining customer service.
- ▲ Reducing land acquisition costs through better analysis.
- ▲ Reducing fleet maintenance costs through better logistics.
- ▲ Analyzing data quickly.

Improve Organizational Integration

Many organizations that have implemented a GIS have found that one of its main benefits is impro management of their own organization and resources. Because GISs have the ability to link data together by geography, they facilitate interdepartmental information sharing and communication. creating a shared database, one department can benefit from the work of another—data can collected once and used many times. As communication increases among individuals departments, redundancy is reduced, productivity is enhanced, and overall organizational efficiency improved. Thus, in a utility company the customer and infrastructure databases can be integrated that when there is planned maintenance, affected customers can be sent a computer-generated lette

Make Better Decisions

The old adage "better information leads to better decisions" is as true for GIS as it is for information systems. A GIS, however, is not an automated decision making system but a tool to qu analyze, and map data in support of the decision-making process. GIS technology has been use assist in tasks such as presenting information at planning inquiries, helping resolve territorial disp and siting pylons in such a way as to minimize visual intrusion. GIS can be used to help re decision about the location of a new housing development that has minimal environmental impa located in a low-risk area, and is close to a population center. The information can be prese succinctly and clearly in the form of a map and accompanying report, allowing decision make focus on the real issues rather than trying to understand the data. Because GIS products can produced quickly, multiple scenarios can be evaluated efficiently and effectively.

Making Maps

Maps have a special place in GIS. The process of making maps with GIS is much more flexible tha traditional manual or automated cartography approaches. It begins with database creation. E paper maps can be digitized and computer-compatible information can be translated into the GIS. GIS-based cartographic database can be both continuous and scale free. Map products can th created centered on any location, at any scale, and showing selected information symbo effectively to highlight specific characteristics. The characteristics of atlases and map series can encoded in computer programs and compared with the database at the final production time. D products for use in other GISs can also be derived by simply copying data from the database. In a organization, topographic databases can be used as reference frameworks by other departments.

GIS IN EVERYDAY LIFE

In today's global community, the more information you have at your fingertips, the easier it is to an informed decision. In today's high-tech world, information comes in many different ways company reports and statistics, from down the hall to digital photos and multimedia from acros world. Information can be overwhelming and the need for timely decisions calls not only innovative ways to access accurate, up-to-the minute information, but also tools to help present the information in useful ways. Some of the typical applications of GIS are given in Figure 44.3.

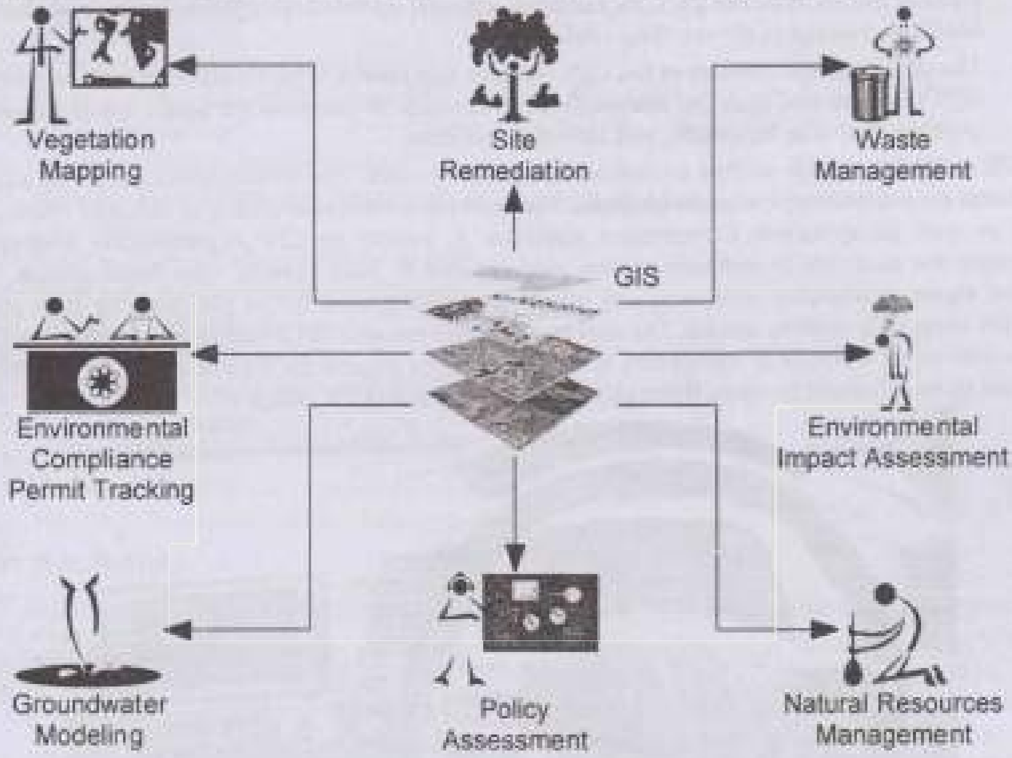


Figure 44.3 GIS in Everyday Life

A geographic information system or GIS allows you to bring all types of data together based on the geographic and locational component of the data. But unlike a static paper map, GIS can display many layers of information that is useful to you. You will be able to integrate, visualize, manage, solve, and present the information in a new way. Relationships between the data will become more apparent and your data will become more valuable. GIS will give you the power to create maps, integrate information, visualize scenarios, solve complicated problems, present powerful ideas, and develop effective solutions like never before. GIS is a tool used by individuals and organizations, schools, governments, and businesses seeking innovative ways to solve their problems.

GLOBAL POSITIONING SYSTEM (GPS)

The Global Positioning System (GPS) is a U.S. owned utility that provides users with positioning, navigation, and timing (PNT) services. GPS provides accurate location and time information for an unlimited number of people in all weather, day and night, anywhere in the world. The GPS consists of three segments – the space segment, the control segment, and the user segment. The U.S. Air Force develops, maintains, and operates the space and control segments.

- The space segment consists of a nominal constellation of 24 operating satellites that transmit one-way signals that give the current GPS satellite position and time.

- The control segment consists of worldwide monitor and control stations that maintain the satellites in their proper orbits through occasional command maneuvers, and adjust the satellite clocks. It tracks the GPS satellites, uploads updated navigational data, and maintains health and status of the satellite constellation.
- The user segment consists of the GPS receiver equipment, which receives the signals from the GPS satellites and uses the transmitted information to calculate the user's three-dimensional position (latitude, longitude, and altitude) and time.

GPS satellites provide service to civilian and military users. The civilian service is freely available to all users on a continuous, worldwide basis. The military service is available to U.S. and allied armed forces as well as approved Government agencies. A variety of GPS augmentation systems and techniques are available to enhance system performance to meet specific user requirements. These improve signal availability, accuracy, and integrity, allowing even better performance than possible using the basic GPS civilian service. The outstanding performance of GPS over many years has earned the confidence of millions of civil users worldwide. It has proven its dependability in the past and promises to be of benefit to users, throughout the world, far into the future.

Figure 44.4 GPS Navigation System in a Car

Individuals may purchase GPS handsets that are readily available through commercial retailers. Equipped with these GPS receivers, users can accurately locate where they are and easily navigate to where they want to go, whether walking, driving, flying, or boating. GPS has become a mainstay of transportation systems worldwide, providing navigation for aviation, ground, and maritime operations. Disaster relief and emergency services depend upon GPS for location and timing capabilities in their life-saving missions. Everyday activities such as banking, mobile phone operations, and even the control of power grids, are facilitated by the accurate timing provided by GPS. Farmers, surveyors, geologists and countless others perform their work more efficiently, safely, economically, and accurately using the free and open GPS signals.

REVIEW QUESTIONS

Descriptive Type Questions

01. What is GIS?
02. What are the components of a GIS?
03. What is the function of GIS software?
04. What is geocoding?
05. What are vector and raster models?
06. What are the different map data types?
07. How GIS works?
08. What are the technologies related to GIS?
09. What is the difference between GIS and GPS?
10. What is the difference between GIS and CAD?
11. What are the benefits of GIS?
12. How GIS can be used to improve organizational integration?
13. How does GIS help in making better decisions?
14. How can GIS be used to make better maps?
15. How does GIS help you in your everyday life?
16. What is GPS and what are its applications?

Fill in the Blanks

01. ______ is a computer-based tool for mapping and analyzing things that exist and events that happen on earth.
02. A working GIS integrates five key components: ______, ______, ______, ______ ,and ______.
03. An automated process called ________ is used to create explicit geographic references from implicit references.
04. GIS stands for ________.
05. Geographic information systems work with two fundamentally different types of geographic models: ______ and ______.
06. GPS stands for __________.

[**Answers:** (1) GIS (2) Hardware, software, data, people, and methods (3) Geocoding (4) Geographic Information System (5) Vector and Raster (6) Global Positioning System]

True or False

01. Mapmaking and geographic analysis are not new, but a GIS performs these tasks better and faster than do the old manual methods.
02. Today, GIS is a multibillion-dollar industry employing hundreds of thousands of people worldwide.
03. GIS stores information about the world as a collection of thematic layers that can be linked together by geography.
04. The raster model is extremely useful for describing discrete features, but less useful for describing continuously varying features such as soil type or accessibility costs for hospitals.
05. A desktop mapping system uses the map metaphor to organize data and user interaction.
06. GPS is a U.S. owned utility.

[**Answers:** (1) True (2) True (3) True (4) False (5) True (6) True]

CHAPTER 45

Computers in Business and Industry

TOPICS COVERED

- Introduction
- Office automation
- People
- Ergonomics
- Office automation technologies
- Office automation systems
- Transaction processing
- Centralized transaction processing
- Client/server systems
- Distributed computing
- Tools for management control

Key Points

▲ Office automation is defined as using computer and communications technology to help people better use and manage information. Office automation technology includes all types of computers, telephones, electronic mail, and other machines that use microprocessors or other high-technology components.

▲ The five primary technologies used in managing information in office automation are text, data, graphics, audio and video.

▲ Office automation systems comprise many distinct subsystems such as text management systems, business analysis systems, document management systems and network and communications systems.

▲ On-line transaction processing is a type of computer processing in which the computer responds immediately to user requests. Each request is considered to be a transaction. Automatic teller machines for banks are an example of transaction processing.

▲ The amount of information stored in the corporate database is often so vast that it is meaningless to managers. To make this information useful, it must be digested or summarized so that it can be used by managers and employees to analyze, direct, and plan their activities. The systems that make the data useful and help the employee's to make the right decisions are decision support systems, executive information systems, geographical information systems, on-line analytical processing, data warehousing and data mining.

INTRODUCTION

Since the dawn of the 1990s, genuine efficiencies in the office have occurred because there are better procedures to accompany the machines. Where the computer once simply replicated the previous manual tasks, it now automates more fully. The processes and the procedures have improved. In this chapter, we will see some of the fundamental business computing systems—management information systems, office automation, transaction processing, and management control.

OFFICE AUTOMATION

Office automation is defined as using computer and communications technology to help people better use and manage information. Office automation technology includes all types of computers, telephones, electronic mail, and office machines that use microprocessors or other high technology components.

With the advent of computers, ergonomics engineers became particularly interested in office automation systems, furniture and environments for the knowledge worker. Intensive studies determined the best designs for keyboards, set eye fatigue levels for monitors, and specified desk and seating designs that alleviate physical stress (see Figure 45.1). Office furniture companies soon introduced ergonomically designed chairs and equipment. Ergonomics has played a significant role in helping people use technology more effectively.

OFFICE AUTOMATION TECHNOLOGIES

There are five primary technologies used in managing information in office automation:

- Text or written words
- Data, as in numbers or other non-text forms
- Graphics, including drawings, charts and photographs
- Audio, as in telephone, voice mail, or voice recognition systems
- Video, such as captured images, videotapes or teleconferencing.

In the past, these forms of information were created using different technologies. Text was created using conventional typewriters or more recently, word processing. Data, such as sales reports, was provided by the central computer. Charts and graphs were either hand-drawn or created using 35 mm slide photography and videotapes were used for training. Audio was limited to the phone or tape recording. It was not possible to combine these various forms of information.

What made it possible to combine them was, the computer. What computer produces is called an electronic document, which is a self-contained work, conveying information that has been created by a knowledge worker and stored in a computer system. An electronic document may be a simple memo that may be printed on paper or transmitted via electronic mail. Or it may be a more complex document, with graphics or even video. Most computer systems can incorporate sound, so that an on-screen document can be annotated with comments spoken by the document creator.

Today, the computer integrates these media and others as well. Data, sound and images can all be entered into a computer, stored and translated into the kind of output we need. It is now common to see knowledge workers in workgroups using a special type of software designed specifically for them and their work. This application software, called groupware, lets networked PCs and workstations share information and electronic documents from both corporate and on-line sources. At the center of this integration are networking and communications systems.

OFFICE AUTOMATION SYSTEMS

Office automation uses computer-based systems to provide information to help knowledge workers make decisions that benefit the business. Office automation systems comprise many distinct subsystems: text management systems, business analysis systems, document management systems and network and communications systems.

Text Management

A text management system is a computer system designed to work with the written or typewritten word. It includes all kinds of typewriters, word processing systems, PCs with word processing, desktop publishing and text editing systems, and even computerized typesetting equipment. Text management systems are used for tasks like writing memos, notes, letters and other short documents, printing envelopes and labels, preparing pre-printed forms such as invoices, composing complex documents such as proposals and reports, retrieving and editing documents such as contracts, creating display documents like newsletters, etc.

Business Analysis

Managers need solid data from which to extract the information necessary to make good decisions for the business. In the past, these knowledge workers had to rely on their experience and other personal factors to make decisions. A business analysis system provides data that, when used with the proper software, helps its users better understand the business environment and make more effective decisions. Corporate users routinely use spreadsheets for analyzing cost and benefits and for creating budgets.

Other software tools for performing analysis that are commonly used in large companies are Decision Support Systems (DSS), expert systems and Executive Support Systems (ESS). A decision support system helps the knowledge worker to extract information from the various MIS database and reporting systems, analyze it, and then formulate a decision or a strategy for business planning. An expert system is a computer system that can store and retrieve data with special problem solving expertise. An executive support system is an information system that consolidates and summarizes ongoing transactions within the organization. It provides the management with all the information it requires at all times from internal as well as external sources.

Document Management

Document management systems aid in filing, tracking and managing documents, whether they are paper, computer based, micrographics, or purely electronic. Office automation demands that data be immediately accessible and instantaneously retrievable. For that reason, we are slowly moving away from paper and toward document forms that can be stored on the computer.

Network and Communication Management

Today, knowledge workers have many ways to communicate with one another, primarily by voice, fax, and e-mail. They can communicate in real time, via phone or computer. They can also communicate using computer controlled PBX telephone systems to record a digital message and leave it in the recipient's electronic mailbox. These systems are called network and communication management systems. The network and communication management systems include telephone, electronic mail, voice messaging systems, teleconferencing and fax machines.

TRANSACTION PROCESSING

Most organizations interact with the outside world. They take orders or reservations from customers and buy products and services from suppliers. Each of these contacts is a transaction. One of the key functions of the computer is to record and manage transactions. To do so, a procedure called On-Line Transaction Processing (OLTP) is used to enter and find data in real time.

Once you are aware of transaction processing, you suddenly see it everywhere. Buy something from a catalog, make a credit card charge, enroll in a fitness program, and you encounter these systems. Transaction processing is a type of computer processing in which the computer responds immediately to user requests. Each request is considered to be a transaction. Automatic teller machines for banks are an example of transaction processing. The opposite of transaction processing is batch processing, in which a batch of requests is stored and then executed all at one time. Transaction processing requires interaction with a user, whereas batch processing can take place without a user being present.

To understand how transaction processing works we will find out how the railway reservation system works. You want to book a ticket from say, Chennai to Delhi. You go to the reservation counter and tell the reservation clerk that you need a ticket from Chennai to Delhi. You will also give the date of journey, the class in which you want to travel, etc. The reservation clerk is sitting in front of a computer. When you inquire about the availability of the ticket, the clerk enters a query into the computer, which displays all the details about the trains that go from Chennai to Delhi. If the tickets are available on the train you want to travel, the reservation clerk confirms that availability and you can pay either by credit card or cash. If the train you want to travel in is full, then you can either change the date of journey, or the class in which you want to travel or the train. The availability of the tickets for all these different permutations and combinations can be verified by the reservation clerk by querying the computer. This can be done in seconds. While the reservation clerk is making the query, other clerks all around the country are doing the same, so you may find that a seat that was available suddenly becomes unavailable. This is because all the reservation clerks around the country are updating a central database and so while you were deciding on which train to go, another user reserved the seat. But once you have given confirmation, the reservation clerk, enters the details into the computer and the seat will be booked for you. All of your data is fed from the reservation clerk's computer back into a database, where it is accessible to people throughout the organization. So the same information is used to generate the names of the passengers and is later given to ticket examiners and which is also pasted on to the compartment.

CENTRALIZED TRANSACTION PROCESSING

The traditional information processing system was centralized around a mainframe computer; it still is, in many cases.

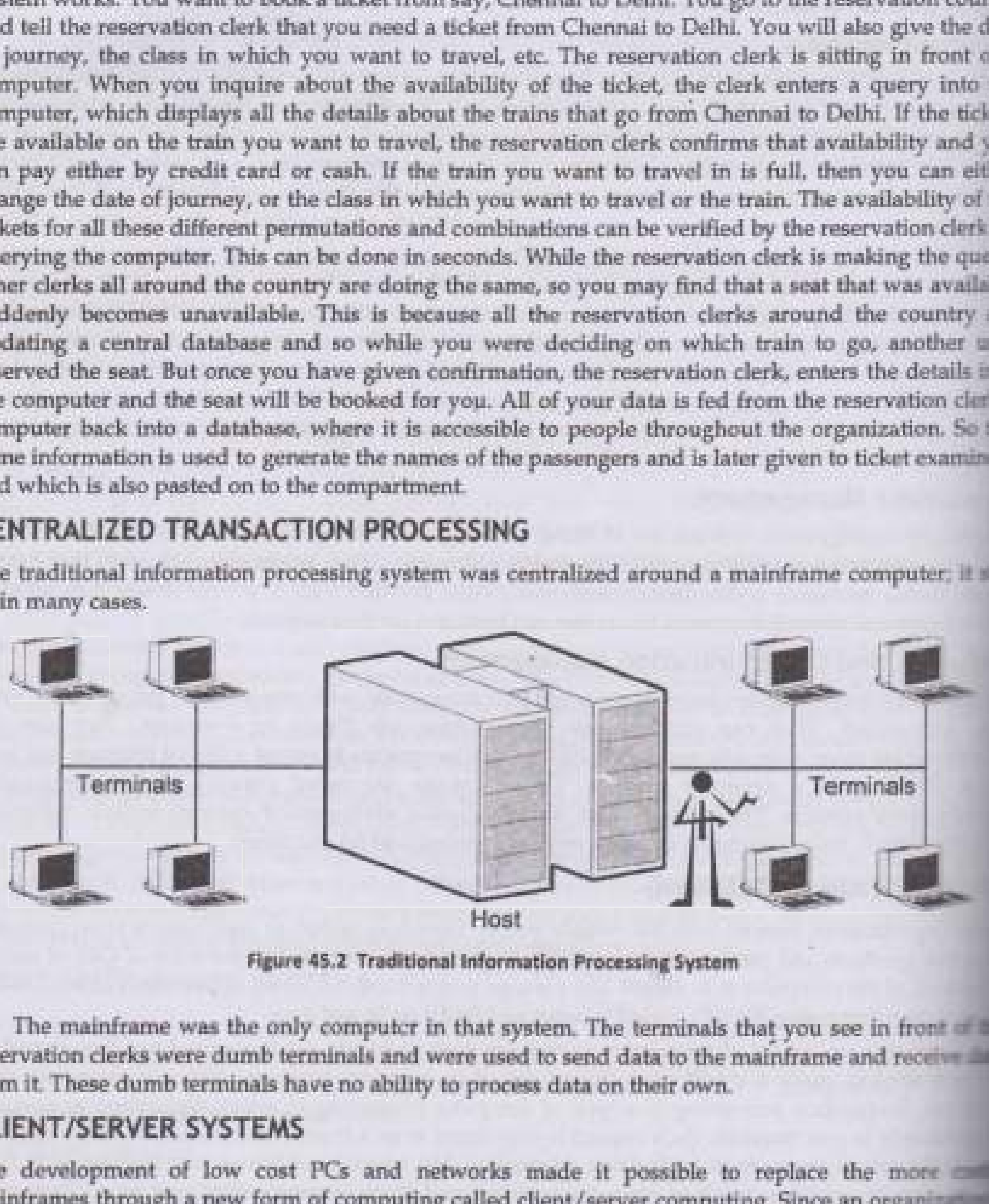


Figure 45.2 Traditional Information Processing System

The mainframe was the only computer in that system. The terminals that you see in front of the reservation clerks were dumb terminals and were used to send data to the mainframe and receive data from it. These dumb terminals have no ability to process data on their own.

CLIENT/SERVER SYSTEMS

The development of low cost PCs and networks made it possible to replace the more costly mainframes through a new form of computing called client/server computing. Since an organization's mission critical applications are very important, all the computers in the organization cannot be of the same type. For security, ease-of-use and management and for performance, many small computers are

TOOLS FOR MANAGEMENT CONTROL

The amount of information stored in the corporate database is often so vast that it is meaningless to managers. Just imagine the amount of data entered into computers each day by a major airline—information on hundreds of aircrafts, thousands of employees, and tens of thousands of passengers. To make this information useful, it must be digested or summarized so that it can be used by managers and employees to analyze, direct, and plan their activities.

Decision Support Systems (DSS)

Not all the information that a manager needs is provided on a routine basis in a structured way. Occasionally, new information must be gathered and analyzed, especially when a big decision must be made. The programs developed to help a manager integrate and analyze unstructured data from many sources are called decision support systems. For example, economic forecasts on inflation might be used to modify sales and expense forecasts over a ten-year period. The population growth projection for a metropolitan area might be used to adjust forecasted sales for a new store. The spreadsheet is a common decision support tool since changing numbers lets you ask "what if" questions. As decision support systems have evolved, a variety of tools have become available. In this chapter, we will discuss the major decision support tools. Keep in mind that many organizations use more than one approach and more than one tool.

Executive Information Systems (EIS)

Executive information systems provide up-to-date information to support decision-making by managers. Their emphasis is on interactive graphical displays and an easy-to-use interface that presents information from the corporate database. An EIS has a number of unique advantages over printed reports.

- It provides a top to bottom analysis instead of raw data.
- It runs on a computer so it is interactive. The manager can wander through it at his/her own pace looking for useful information.
- It presents data graphically as well as numerically, making it easier for the user to spot trends and relationships.

Geographic Information Systems (GIS)

Many types of data are easier to analyze when presented graphically. A GIS relates data to maps. Sales shown by country, state or region using colors for various ranges of sales, makes it easy to spot where sales are high and low. Management then has knowledge of where sales are lower than expected. Without a GIS this kind of analysis is so time consuming that it is not done on a regular basis. Problem areas will remain undiscovered, and actions will get delayed for months or even years.

On-Line Analytical Processing (OLAP)

On-line analytical processing allows users to view graphic and tabular presentations of their organization's data. Many people in organizations use their computers to enter basic queries and generate simple reports. A much smaller group called decision support specialists use much more complicated and complex queries to answer more complicated questions. The smallest group of all uses the costly executive information systems to analyze the database. All of these people work in discovery mode. This means that they are data explorers. Finding the answer to one question often leads to another question. OLAP is a decision support software that allows the user to quickly analyze information that has been summarized into multidimensional views and hierarchies. For example, OLAP tools are used to perform trend analysis on sales and financial information. They can enable users to drill down into masses of sales statistics in order to isolate the products that are the most volatile.

Data Warehousing

Since on-line transaction processing (OLTP) involves real-time transactions, data that is 6, 12, or 24 months old may not be needed and so can be stored elsewhere. Recently, it has been recognized that this data, combined with current data, contains an enormous amount of information from which one can discover trends that would never be seen on a day-to-day or month-to-month basis. To make this data more useful, it is now being stored in a separate database called a data warehouse. The database in a data warehouse is not the same as the database used for transaction processing. Databases used for transaction processing are designed to update thousands of records per second but are not designed for sophisticated querying. Data warehouse databases are designed to analyze terabytes of data and billions of records. They are organized to allow better analysis by using special techniques.

Data Mining

Once data warehouses are created, data stored here is mined. When you are data mining (also called knowledge discovery) you do not pose questions. Instead, you make the system look for past patterns that may predict future behavior. This approach can result in finding valuable previously unknown facts. By contrast, OLAP and DSS both depend on asking specific questions, which limits what you may find to only what you think it is worthwhile looking for. When you are using data mining, you process more general requests. For example, instead of asking how many people in each state bought a Hyundai i20 last year, you look for characteristics of the people who buy Hyundai i10s. The results may reveal things you have not even intended to look for. Perhaps, you will find a profile of the typical buyer—information you can use for targeted advertisement campaigns.

REVIEW QUESTIONS

Descriptive Type Questions

01. What is office automation?
02. What is ergonomics and what does it do?
03. What are text management systems?
04. What are business analysis systems?
05. What are document management systems?
06. What is transaction processing?
07. What is centralized transaction processing?
08. What is a client/server system?
09. What is client/server software?
10. What is distributed computing?
11. What are decision support systems?
12. What is an EIS?
13. What is a GIS?
14. What is OLAP?
15. What is data warehousing?

Fill in the Blanks

01. ____________ is defined as using computer and communications technology to help people better use and manage information.

02. People who use office automation are often called _____________.
03. In most offices, _____________ is the end product and is essential for conducting the company's business.
04. _____________ means a number of knowledge workers, each with different tasks, jobs or duties work together towards a common goal.
05. _____________ is the study of how to create safety, comfort and ease of use for people who use machines.
06. _____________ lets networked PCs and workstations share information and electronic documents from both corporate and on-line sources.
07. A procedure called _____________ is used to enter and find data in real time.
08. OLTP stands for _____________.
09. _____________ is a type of computer processing in which the computer responds immediately to user requests.
10. The traditional information processing system was centralized around a _____________.
11. The powerful central computer that stores the major databases and programs and performs complex computations and processing in a client/server system is called _____________.
12. DSS stands for _____________.
13. _____________ provide up-to-date information to support decision-making by managers.
14. The programs developed to help a manager integrate and analyze unstructured data from many sources are called _____________.
15. GIS is the abbreviation of _____________.
16. OLAP stands for _____________.

[**Answers:** (1) Office Automation (2) Knowledge Workers (3) Information (4) Workgroup computing (5) Ergonomics (6) Groupware (7) OLTP (8) On-line transaction Processing (9) Transaction processing (10) Mainframe (11) Server (12) Decision Support System (13) Executive Information Systems (14) Decision Support Systems (15) Geographical Information System (16) On-line Analytical Processing]

True or False

01. Office automation systems keep track of the information originating in various operations throughout the company, such as order processing, accounting, inventory, and manufacturing.
02. Ergonomics is not a new field of study, in fact it has existed for over a hundred years.
03. Ergonomics has played a significant role in helping people use technology more effectively.
04. A text management system is a computer system designed to work with the written or typewritten word.
05. A decision support system helps the knowledge worker to extract information from the various MIS database and reporting systems, analyze it, and then formulate a decision or a strategy for business planning.
06. The opposite of transaction processing is batch processing, in which a batch of requests is stored and then executed all at one time.
07. Automatic teller machines for banks are an example of transaction processing.
08. The development of low cost PCs and networks made it possible to replace the more costly mainframes through a new form of computing called client/server computing.
09. The large and powerful computer in a client/server system is called the server and can be a PC or workstation or even a mainframe.
10. Client/server applications are split into front-end and back-end.
11. To make this information useful, it must be digested or summarized so that it can be used by managers and employees to analyze, direct, and plan their activities.

12. The emphasis of EIS is on interactive graphical displays and an easy-to-use interface that presents information from the corporate database.
13. A GIS relates data to maps.
14. OLAP is a decision support software that allows the user to quickly analyze information that has been summarized into multidimensional views and hierarchies.
15. Data warehouse databases are designed to analyze terabytes of data and billions of records and are organized to allow better analysis by using special techniques.

[**Answers:** (1) True (2) True (3) True (4) True (5) True (6) True (7) True (8) True (9) True (10) True (11) True (12) True (13) True (14) True (15) True]

CHAPTER 46

Computers at Home

TOPICS COVERED

- ▲ Introduction
- ▲ Household business
- ▲ Business applications at home
- ▲ Smart cards
- ▲ Communication, education, and information
- ▲ Home entertainment redefined
- ▲ Creativity and leisure

Key Points

▲ Today, there are more computers in homes than in schools and the home computer market is still growing. Millions of people use home computers for education and information.

▲ Some of the applications that are used in homes are word processors, spreadsheets, database programs, personal information management systems, accounting and income tax programs, etc.

▲ Edutainment (Education and entertainment) programs specifically geared toward home markets combine education with entertainment so that they can compete with television and electronic games. Encyclopedias, dictionaries, atlases, almanacs, telephone directories, medical references, and other specialized references now come in low-cost CD-ROM versions—often with multimedia capability. More up-to-the-minute information is available from the Internet and other on-line application. Of course, Internet connections also provide electronic mail, discussion groups, and other communication options for home users.

▲ Home computers are mainly used for playing games. Computer games can simulate board games, card games, sporting events, intergalactic battles, street fights, corporate takeovers, or something else, real or imaginary. Many require strategy and puzzle solving; others depend only on eye-hand coordination. Many of the most popular games require some aspects of each.

INTRODUCTION

"There is no reason for any individual to have a computer in their home" —Ken Olson, President of Digital Equipment Corporation, 1977.

The same year Ken Olson made this statement, Apple Computers introduced the Apple II computer. In the years that followed, Apple, Commodore, Tandy, Atari, IBM, and dozens of other companies managed to sell computers to millions of individuals who had "no reason" to buy them. Today, there are more computers in homes than in schools, and the home computer market is still growing. While many of those computers gather dust, others are being put to work, and play, in a variety of ways. And new technologies are emerging that may soon put computers into the mainstream of modern home life. What are people using home computers for, and what kind of role will computers play in tomorrow's homes?

HOUSEHOLD BUSINESS

Frank Gilbreth, a turn-of-the-century pioneer of motion study in industry, applied "scientific management" techniques to his home. He required his 12 children to keep records on bathroom "work-and-process charts" of each hair combing, tooth brushing, and bathing. He gave them demonstrations on efficient bathing techniques to minimize "unavoidable delays." While it may have worked for Gilbreth, this "scientific management" approach to home life is not likely to catch on today. Still, certain aspects of family life are unavoidably businesslike, and a growing number of people turn to computers to help them take care of business.

BUSINESS APPLICATIONS AT HOME

Not everyone is convinced that computers are useful or practical at home. But those people who use home computers generally find that they can put the same applications to work at home as they do in their offices:

- **Word processors** — For letters, memos, and (especially) school papers, the word processor has replaced the typewriter for families with computers.
- **Spreadsheets** — "Can we afford a trip to Singapore this year?" "How much do we need to put away each year to pay for college?" "Should we refinance the house?" A spreadsheet program can frame answers to "What if?" questions involving numbers, provided somebody takes the time and effort to create a worksheet model of the problem.
- **Database programs** — Many people use database programs for address books, family record keeping, collections, and other data storage jobs. Others find that it's not worth the effort to type in all that data.
- **Personal information management programs** — Appointment calendars, to-do lists, addresses, phone numbers—they are part of home life, too, and an enthusiastic minority of people use home computers to keep their personal lives organized.
- **Accounting and income tax programs** — Many easy-to-use accounting programs are targeted at homes and small businesses. These programs can balance check books, write checks, keep financial records for tax time, and provide data for income tax calculation programs, provided somebody types in the relevant data.

SMART CARDS

For most people, the advantages of computerized home money management are not worth the time and effort required to enter every financial transaction into the computer. Some people strike a balance by only typing in "important" transactions; a few subscribe to home banking programs so they can download their summary statements directly from bank computers. But for most people computerized money management will not happen until there is an effortless way to record transactions—perhaps a device that, when inserted into the computer, can tell the software about each purchase and the paid bill. That device may turn out to be a smart card.

A smart card looks like a standard credit card, but instead of a magnetic strip it contains embedded microprocessors and memory. Some smart cards even contain touch-sensitive keypads for entering numbers. Whether it has a keypad or not, a smart card receives most of its input when it is slipped into a special slot on a computer. Data stored in smart cards can be password-protected. There are hundreds of millions of smart cards in use. Smart cards are obvious candidates to replace magnetic-stripe credit cards. In addition to storing critical ID information, a smart card can automatically record each transaction for later retrieval. But smart cards have other applications, too. College students use smart cards as meal tickets. Office workers use smart cards as keys to access sensitive data on computers. Many people in America and Europe use smart cards to pay highway tolls and unscramble cable TV broadcasts. In the future, it might be possible to use one card to buy groceries, check out library books, and store personal medical information in case of an emergency. Future smart cards will use pattern recognition techniques to verify signatures on checks or credit slips and help prevent millions of dollars in fraud and forgery.

COMMUNICATION, EDUCATION, AND INFORMATION

Millions of people use home computers for education and information. Many of the education[illegible] software programs are used by children and adults in homes. Edutainment (Education and entertainment) programs specifically geared toward home markets combine education with entertainment so they can compete with television and electronic games. Encyclopedias, dictionaries, atlases, almanacs, telephone directories, medical references, and other specialized references [illegible] come in low-cost CD-ROM versions—often with multimedia capability. More up-to-the-minute information is available from the Internet and other on-line applications. Of course, Internet connections also provide electronic mail, discussion groups, and other communication options [illegible] home users.

As computer technology and communication technology converge on the home market, they will produce services that will threaten television and newspapers as our main sources of information. Television is a broadcast medium—it transmits news and information to broad audiences. In the future we will see narrowcasting services—they will provide custom newscasts aimed at narrow groups or individuals. Personalized multimedia news programs will combine many of the [illegible] features of television news and newspapers. You will be able to request an index of available features and use it like a menu to build your own news program. Your personal newscast might include a [illegible] on the latest Middle Eastern crisis, the results of yesterday's election, highlights of the previous [illegible] cricket game, this weekend's weather forecast, a feature on your favorite local musician, and a reminder that there are only five more shopping days until your mother's birthday. You will be [illegible] train your news service to flag particular subjects so that even the menu is customized to [illegible] tastes. All of this is technologically possible now. Prototype systems have been running for [illegible] MIT's Media Lab, and a few pilot services are now offered through the Internet by private companies.

HOME ENTERTAINMENT REDEFINED

Regardless of how people say they use home computers, surveys suggest that they use them [illegible] play games. Computer games and video game machines (which are just special-purpose computers) represent a huge industry—one that is likely to evolve rapidly in the coming years.

Most computer games are simulations. Computer games can simulate board games, card games, sporting events, intergalactic battles, street fights, corporate takeovers, or something else, [illegible] imaginary. Many require strategy and puzzle solving; others depend only on eye-hand coordination. Many of the most popular games require some aspects of each. With dazzling graphics, [illegible] sound, and sophisticated effects, many of today's computer games represent state-of-the-art software. But in a few years these computer games are likely to look as primitive in a decade as those early [illegible] games look today.

The biggest changes in electronic games are likely to come as computers and communication technology converge on the home entertainment industry. As this happens, the line that [illegible] television programs and computer games will grow fuzzy. A few years ago, software shops [illegible] variety of interactive fiction games-stories with primitive natural-language interfaces that [illegible] some control over plot. Those non-graphic, not-very-intelligent programs have been squeezed [illegible] software shelves by interactive movie-animated features in which one or more of the characters [illegible] controlled by the viewers. Today's interactive movies are not Academy Award material; at [illegible] are like cartoons with controls. But as technology improves and the multimedia market grows, [illegible] expect to see all kinds of hybrid forms of entertainment.

CREATIVITY AND LEISURE

Interactive movies demand more involvement than television, but they are still a relatively passive pastime. Many people worry that television, computer games, and other media are replacing too many real-world activities. Instead of making up stories to share, we watch comedies on TV. Instead of playing music on guitars, we play music on boom boxes. Instead of playing one-on-one basketball, we play one-on-one video games.

Is electronic technology turning us into a couch-potato culture? Perhaps, but there is another possibility – the same technology that mesmerizes us can also unlock our creativity. There are many examples: Word processors help many of us to become writers, graphics software brings out the artists among us, desktop publishing systems put the power of the press in more hands, electronic music systems allow us to compose music even if we never mastered an instrument, and multimedia systems open doors to cable-access TV channels. Will computers drain our creativity or amplify it? In the end it is up to us....

REVIEW QUESTIONS

Descriptive Type Questions

01. What are the applications of computers in the home?
02. What are the uses of a spreadsheet program in the household?
03. What is a smart card and what is it used for?
04. How are home computers used for communication and education?
05. How are computers redefining home entertainment?

Fill in the Blanks

01. _____________ a pioneer of motion study in industry, applied "scientific management" techniques to his home.
02. _____________ program can frame answers to "What if? " questions involving numbers, provided somebody takes the time and effort to create a worksheet model of the problem.
03. _____________ looks like a standard credit card, but instead of a magnetic strip it contains embedded microprocessors and memory.
04. _____________ programs specifically geared toward home markets combine education with entertainment so they can compete with television and electronic games.
05. Regardless of how people say they use home computers, surveys suggest that they use them mostly to _____________.

[Answers: (1) Frank Gilberth (2) Spreadsheets (3) Smart card (4) Edutainment (5) Play games]

True or False

01. Word processor has replaced the typewriter for families with computers.
02. Many people use database programs for address books, family record keeping, collections, and other data storage jobs.
03. The accounting programs can balance check books, write checks, keep financial records for tax time, and provide data for income tax calculation programs.
04. Data stored in smart cards can be password-protected.
05. As computer technology and communication technology converge on the home market, they will produce services that will threaten television and newspapers as our main sources of information.

[Answers: (1) True (2) True (3) True (4) True (5) True] and other information utilities. But technological familiarity should not stop with learning how to work with tools. Students need to have a clear understanding of the limitations of the technology and the ability to assess the benefits and risks of applying technology to a problem. They need to be able to question technology.

Literacy

The industrial age may have passed, but the need for reading and writing has not. In fact, it is more important than ever, that today's students graduate with the ability to read and write. Many jobs that did not require reading and writing skills a generation ago now use high-tech equipment that demands literacy. A factory worker, who cannot read printouts, is not likely to survive the transition to an automated factory.

Mathematics

In the age of cheap calculators, many students think that learning mathematics is a waste of time. In fact, some educators argue that we spend too much time teaching students how to do things like division and calculating square roots—a skill that adults seldom do by hand. These arithmetic skills have little to do with being able to think mathematically. To survive in the high-tech, world students need to be able to see the mathematical systems in the world around them and apply mathematical concepts to solve problems. No calculator can do that.

Culture

An education is not complete without a strong cultural component. Liberal arts and social studies help us recognize the interconnections that turn information into knowledge. Culture gives us roots when the sands of time shift. It gives us a historical perspective that allows us to see trends and prepare for the future. Culture provides a human framework to view the impact of technology. It also gives us the global perspective to live in a world, where communication is determined more by technology than geography.

Communication

In the information age, communication is a survival skill. Isolated factory workers and desk-bound pencil pushers are vanishing from the workplace. Modern jobs involve interactions—between people and machines and between people and people. The fast-paced information-based society depends on our human ability to communicate, negotiate, cooperate, and collaborate, both locally and globally.

Learning How to Learn

Experts predict that most of the jobs that exist today will not be there ten years from now. With rapidly changing job descriptions and job markets it is unreasonable to assume that students can be trained once for lifelong jobs. Instead of holding a single job for 40 years, today's students are likely to change jobs several times. Those people who do keep the same jobs will have to deal with unprecedented change. The half-life of an engineer's specialized knowledge—the time it takes for half of that knowledge to be replaced by more current knowledge—is just over three years.

These facts suggest that we can longer afford to think of education as a one-time vaccination against illiteracy. In the information age, learning must be a lifelong process. To prepare students for a lifetime of learning, schools must teach students more than facts; they must make sure students learn how to think and learn.

COMPUTER IN SCHOOLS

The information age clearly makes new demands on the educational system, requiring radical changes in what and how people learn. Many educators believe that computers and information technology are essential parts of these changes. Many of the elementary and secondary schools are now introducing computers. Students and teachers are using these computers in a variety of ways to learn.

Computer-Aided Instruction (CAI)

Computers allow students to learn based on the drill-and-practice principle. The computer based training software allows students to learn at their own pace, in small steps and give feedback about how much they have learned. These are the same principles of the drill-and-practice methods—individualized rate, small steps and positive feedback. A traditional drill-and-practice program presents the student with a question and compares the student's answer with the correct answer. If the answers match, the program offers praise, possibly accompanied by music and animation. If the student's answer does not match with the correct answer, the program offers an explanation and presents another similar problem. The program may keep track of the student responses and tailor questions based on error patterns; it might also provide reports on student progress to the teacher. Today most drill-and-practice programs embed the lessons in animated games, but the underlying principles remain the same.

Pure drill-and-practice programs do not teach new material. Like fact cards and worksheets, they are designed to help students go over material they have already learnt to assimilate it better. Tutorial software provides direct instruction in a clearly specified skill or subject. Drill-and-practice software and tutorial software are often referred to as Computer-Aided Instruction (CAI) software. Most CAI programs combine tutorial material with drill-and-practice questions, in the same way a mathematics textbook alternates explanations with exercises. CAI software is one of the most common types of educational software for three reasons: it is relatively easy and inexpensive to produce, it can easily be combined with more traditional educational techniques, and it produces clear, demonstrable results. CAI offers many advantages over workbooks and worksheets:

- **Individualized learning** — Individual students can learn at their own pace. Teachers can spend their time working one-on-one with students—an important activity that is almost impossible in typical presentation-and-discussion classrooms.
- **Motivation** — CAI can turn practice into an entertaining game. It motivates students to practice arithmetic, spelling, touch-typing, piano playing and other skills that might otherwise be tedious to learn.
- **Confidence** — CAI can help timid children become comfortable with computers as well as with the subject matter being taught. A well-designed program is infinitely patient, and it allows students to make mistakes in private. Research has shown that younger children, disadvantaged children, and especially learning disabled students tend to respond positively to CAI.

Research also suggests that not all CAI software deserve praise. Many of the CAI software are flawed because they give inappropriate feedback, allow students to practice mistakes, and discourage students to moving into new material. Even the best CAI software can work only with tightly defined subjects, in which every question can have a single, clear, unambiguous answer. CAI presents information in the form of facts, leaving no room for questioning, creativity, or cooperation. In a sense, CAI programs students.

Programming Tools

With his colleagues at MIT, Seymour Papert developed a computer language called LOGO, so that children could program computers, rather than the other way round. Children can write LOGO programs as soon as they are old enough to read and write a few simple words.

Rather than teaching through lessons and tests, LOGO creates environments for learning. The most famous of these LOGO environments allow children to draw pictures using a technique called turtle graphics. With turtle graphics a child uses LOGO commands to make a turtle move, drag a 'pen' to draw lines as it moves. The turtle can be a small robot that moves around the floor or a graphical creature that lives in the middle of a computer screen. LOGO helps children learn advanced computer science concepts like recursion – the ability of a program or procedure to call or refer to itself. LOGO has other environments that go beyond geometry and graphics. LEGO LOGO allows children to use LOGO commands to control motorized machines and robots built out of LEGO building blocks.

Papert and many educators predicted that LOGO would help children become better at general problem solving and logical thinking. Research suggests that LOGO enhances creativity and originality in children, but there is no conclusive evidence that it improves their general thinking skills more than other teaching tools. Like a chalkboard, LOGO can be an effective tool in the hands of a good teacher.

Simulation and Games

When Papert developed LOGO, he based his educational philosophy on the work of the renowned Swiss developmental psychologist Jean Piaget. According to Piaget, children have a natural gift for learning on their own; they learn to talk, get around, and think without formal training. A child growing up in France learns French effortlessly, because the child's environment has the necessary materials. In Papert's vision the computer can provide an environment that makes learning mathematics, science, and the arts as effortless as learning French in France.

Many educational simulations today are based on the same idea: Children learn best through exploration and invention. These simulations allow students to explore artificial environments, imaginary or based on reality. Educational simulations are metaphors designed to focus student attention on the most important concepts. While most educational simulations have the look and feel of a game, they challenge students to learn through exploration, experimentation, and interaction with other students.

With a simulation, the students are in control of the learning environment. It is up to them to find and use information to draw conclusions. Students can experience the consequences of their actions without taking real-world risks. Simulations allow students to have experiences that would not be possible otherwise. Instead of simply spewing facts, simulations provide a context for knowledge.

Students love playing well-designed simulation games, but many schools do not use simulations because there is no room for them in the formal curriculum. It is difficult to prove the effectiveness of simulation games because they generally are not designed to teach simple, measurable facts. In spite of our culture's age-old tradition of learning through games, many educators question the educational value of games in the classroom. Of course, educational simulations, like all simulations, come up short as substitutes for reality. But when field trips are not possible, computer simulations can offer affordable alternatives.

Productivity Tools

Today, the trend in schools is clearly towards teaching children to use computers as tools. Word processors, spreadsheets, databases, graphics programs, desktop publishing software – the software tools used by adults are the tools students learn most often in schools. In some cases students use applications designed especially for children; others use standard "adult" applications. While only a few students take programming classes, classes in keyboarding and word processing are often required for everybody. Once students learn to use these general-purpose tools, they can put them to work in and out of school.

Some schools also provide special-purpose tools for classroom use, including:

- ▲ Laboratory sensing hardware and software that can be used to collect scientific data (such as temperature) and convert it into computer data to be analyzed by students.
- ▲ Collaborative writing groupware that allows students to work collectively on creative writing and editing projects.
- ▲ Music synthesizers with sequencing and notation software for teaching music composition.

Whether the computer is used as a tutor or a tool, the addition of multimedia adds a whole new dimension to the educational process.

Computer-Controlled Media

A typical child spends hours each day watching screens—television, video game, and computer—and listening to radio and recorded music. Traditional lectures cannot live up to the expectations created by the high-tech media input. A growing number of teachers are using computer graphics, videodiscs, CD-ROMS, and other digital media to convey information in a more dynamic form. Depending on the way these media are used, the student's role might be to observe, control, or to create the presentation.

Presentation Aids

In some cases, teachers use computers and multimedia technology to create in-class presentations. Here are some examples:

- ▲ A history teacher might outline the main points of a lecture using a set of bullet charts created with a presentation graphics program like PowerPoint.
- ▲ A science teacher might use a 3D graphics program to create models of molecules that can be displayed and manipulated during in-class demonstrations on a projection screen.
- ▲ An art teacher might illustrate an art history lecture with a series of images from a CD-ROM.
- ▲ A music teacher might guide a class through key passages of a Beethoven symphony using a commercial Hypercard stack that displays the score while the CD plays the composition.
- ▲ An English teacher might supplement lectures and discussions about the novel '*To Kill a Mockingbird*' by showing selected video clips that have been digitized into a presentation.

From the teacher's point of view, the advantage of computer technology is that the material can be customized to meet the needs of the class. Instead of using commercial transparencies and handouts designed for generic classrooms, a teacher can create custom visual aids for specific classes. Instead of being forced to move through videotapes and audiocassettes sequentially, the teacher can choose to present material in any order.

Hypermedia and Interactive Multimedia

From the student's point of view, teacher-controlled media presentations are still passive, linear affairs. To get students more involved in the learning process, many teachers use hypermedia and interactive multimedia software that put students in control. Sometimes these interactive lessons are created by teachers; more often they are purchased from software development companies. Some are simple tutorials with sound and/or video; others are multimedia reference tools with hypertext cross-references that allow students to jump quickly from one topic to another or change the way the information is displayed.

Authoring Tools for Students

To maximize student involvement, some teachers put multimedia-authoring tools in the hands of students. Instead of creating interactive lessons for students, teachers allow the students to create their own multimedia presentations. Clearly, the students are more involved in these projects than they are in teacher-made presentations. This kind of student involvement promotes learning, but it has drawbacks. One problem is economic: Few schools can afford the hardware, software, and floor space for multiple student media workstations. Another problem is both social and political: When students are creating or using interactive media, they are not conforming to the traditional factory model. Instead of sitting quietly listening to the teacher, they are taking control of the machinery and the learning process. The teacher becomes a supervisor and a mentor rather than a conveyor of information. This kind of restructuring of the educational process is threatening to many administrators, teachers, parents, and community members who are used to the old ways.

DISTANCE LEARNING: VIRTUAL SCHOOLS

For some students the most important application of computers in the schools is distance learning—using technology to extend the educational process beyond the walls of the school. Computers, modems, fax machines, satellite video transmissions, the Internet, and other communication technologies offer many promising possibilities. Students can network with kids in other parts of the world through the Internet. High-school correspondence courses can be completed by modem rather than by mail. Handicapped students can do course work without traveling to central sites. Two-way video links allow "visiting" experts to talk to students in outlying classrooms and answer their questions in real time. Networked school districts can offer multi-school videoconference courses in Chinese, college-level calculus, and other subjects that might have tiny enrollments if offered only at a single school. Teachers can receive additional education without leaving their schools.

Telecommunication technology is particularly important for students in remote locations. If a child in a small town develops an interest in a narrow subject, whether it is aboriginal anthropology or classical Russian ballet, that student may find pursuing that interest a discouraging process. Reference materials, adult experts, and classmates with similar interests are often hard to find. But now the Internet offers solutions: on-line reference materials on Web pages, special interest Usenet newsgroups, and like-minded modem pals are all within reach. In many areas rural interactive television networks keep remote schools and towns from fading away.

Distance learning also offers promise for workers whose jobs are changed or eliminated by a shifting economy. Many displaced workers cannot afford to relocate their families to college towns so that they can learn new skills. Others, who still have jobs, but want to go back to school, are faced with similar relocation problems. But if colleges and universities offer electronic outreach programs, these people can update their skills while remaining in their communities.

Since 1990 on-line degree programs have appeared at dozens of universities and colleges. Students use PCs and modems to do everything from ordering books to taking final exams. Many on-line students see their professors in person for the first time at graduation ceremonies. On-line schools are particularly attractive to older students whose work prevents them from attending more traditional colleges. On-line schools are an important step toward an educational system that encourages lifelong learning.

REVIEW QUESTIONS

scriptive Type Questions

01. What should education provide students in this information age?
02. What are the uses of computers in schools?
03. What is the drill-and-practice principle?
04. What is CAI and what are its advantages?
05. What are computer controlled media and how are they used?

l in the Blanks

01. ____________ is the fear of technology.
02. ____________ gives us roots when the sands of time shift and it gives us historical perspective that allows us to see trends and prepare for future.
03. Computers allow students to learn based on the ____________ principle.
04. CAI stands for ____________.
05. The most famous of the LOGO environments allow children to draw pictures using a technique called ____________.

[**Answers:** (1) Technophobia (2) Culture (3) Drill-and-practice (4) Computer-aided-instruction (5) Turtle graphics]

ue or False

01. The information age is changing the way we work.
02. Our educational system was developed more than a century ago to teach students the basic facts and survival skills they would need for jobs in industry and agriculture—jobs they would probably hold for their entire life.
03. To survive in the high-tech world students need to be able to see the mathematical systems in the world around them and apply mathematical concepts to solve problems.
04. In the information age communication is a survival skill.
05. The fast-paced information-based society depends on our human ability to communicate, negotiate, cooperate, and collaborate, both locally and globally.

[**Answers:** (1) True (2) True (3) True (4) True (5) True]

TOPIC

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CHAPTER 48

Computers in Entertainment, Science, Medicine, and Engineering

TOPICS COVERED

- Computers in entertainment
- Computers in medicine
- Computers in science
- Computers in engineering

Key Points

- Computers have now become an integral part of the entertainment industry. They are used in movies, music, advertising, art, etc.
- Computers are revolutionizing the medical field. In medicine, computers are used for everything from diagnosing illnesses and monitoring patients to controlling movements of robotic surgical assistants.
- Scientists use computers to develop theories, to collect and test data, and to exchange information electronically with colleagues around the world.
- Computers help in automating the design, production, and manufacturing processes of companies. Computers also help in securely exchanging business information, product data management, feature prototyping, project management, etc.

COMPUTERS IN ENTERTAINMENT

Computers have now become an integral part of the entertainment industry. They are used for creating dazzling special effects and also in editing movies. They are used to create full-length movies with cartoon characters. They are also used in multimedia presentations. They help in composing, editing, recoding and reproducing music and sound effects. Computers are used in sports to analyze the movements of sportspersons and to find faults in the movements and optimize them so that maximum efficiency is achieved. Computers are used by sports professionals to analyze their techniques and to find their strengths and weaknesses. Computers are used to simulate games and try out different game strategies. So the use of computers in the entertainment field—movies, music, presentations, sports and games—has increased over the last decade and now computers play a vital role in these fields.

Computers in Movies

Anybody who has seen science fiction movies like *'Star Wars'*, *'E.T.'* or *'Matrix'* or the special effects in movies like *'Titanic'* or *'Terminator'* or cartoon movies like *'A Bugs Life'*, *'Toy Story'* or *'Antz'* will know the importance of computers in the film industry. With the aid of sophisticated graphics and animation packages the special effects technicians can create the illusion of a locomotive flying through the air or a robot transforming into a human being, etc. At the theater, technicians use coordinated computer-controlled lighting cues to brighten or dim the stage. The performing artists might even use computers to control the images and sounds of the performance itself.

Computers help in improving productivity by automating time consuming, repetitive and monotonous processes. They give the movie makers a lot of options by giving them the power to create the kind of special effects they want—those that were not possible in the olden days. Astounding computerized special effects have been achieved in the motion-picture industry. Movies now contain many visual tricks and treats that could never be accomplished without the aid of computers. The computers can create outer space, alien characters, extinct animals, etc. without the need of creating their physical models. The filmmakers can then integrate these backgrounds and characters with the real characters seamlessly. These capabilities give the film industry the ability to create breathtaking and spellbinding sequences and special effects with the only limitation being the director's or the filmmaker's creativity and imagination. Thus computers and information technology have helped the film industry in reducing the cost of production as physical models and sets are no longer required. They also reduce the time taken to make movies. An animator can now create in a few hours any special effects, which used to take days with hand-drawing techniques. In the old days, when cartoon movies were made manually, it took years to complete a 30 minute movie, as each and every frame had to be drawn manually; but with today's computerized systems, the animation packages will take care of these monotonous and repetitive tasks, thus saving time and giving the filmmakers the time to concentrate on the creative aspects of the movie. Also, computer technology has given the ability to create special effects that were not possible in olden days. Now computers are used in almost all phases of movie making may it be writing scripts, creating special effects, editing, adding sound effects, etc.

Computers in Music

The use of technology in the world of music today is an inescapable fact. Any musical composition that we hear goes through a technological process at some point. This can be when the piece of music is created, when it is played or when it is reproduced. Thanks to the use of technology, musical information and communication have increased in scope over the past few decades to a remarkable extent.

How much do we interfere with computer music? As a matter of fact, most songs have some sort of electronic instrumentation. The same thing is in the music in TV commercials, cartoons, and popular movies. In fact, most of the music that surrounds us is electronic in nature. Musical instruments have always been machines, which are valuable only in the hands of people, not by themselves. And they always followed the evolutionary path of machines. It is only natural that computer applications are taking such an active part in the music of our age.

Everything started about fifty years ago. The first electronic devices for producing music—synthesizers—have been around since 1940s. A synthesizer can be defined as a musical instrument that generates music electronically. The first attempt to use a computer for synthesizing sounds was made in the mid-1950s. Bell Laboratories was working on the digital transmission of telephone conversations. The analog data was converted to digital form (sampling), transmitted digitally, and then, at the other end, converted back into analog form. During this project it became clear that the same approach could be used to create music electronically. This research resulted in MUSIC-I and MUSIC-II, two simple computerized music generation programs. Rock music quickly incorporated synthesizers, which gave the rock musicians the new opportunities to play with sound in their compositions.

One of the most significant developments in the history of electronic music came in 1983 when major electronic instruments manufacturers developed a communication standard called Musical Instrumental Digital Interface (MIDI). Before MIDI, synthesizers could send 'note' information to other synthesizers only if they were compatible and very often they were not. There were a lot of problems with interfacing electronic musical instruments manufactured by different companies. MIDI changed all this. All the compatibility problems were avoided by largely ignoring how a certain instrument generates a sound.

One of the largest and most popular applications is music notation software such as Finale for Mac, or Score for IBM PC. Music can be played on the keyboard or any MIDI instrument and immediately be displayed on the computer screen. The music score then can be edited in any way. It is especially helpful when a composer needs to change some part of the score before publication. Without the software, the author should rewrite everything by hand, while with music notation software, only the necessary part needs to be changed.

Computers are also very useful in creating Patch Librarians – programs that organize and store sounds. Synthesizers themselves have a small amount of memory, which could hold a finite number of patches (music sounds). However, with a librarian installed in a computer, one can store thousands of synthesized sounds in a file. This information can be downloaded via MIDI into the synthesizer and back.

Another very popular and helpful MIDI-oriented application is the Sequencer. A sequencer memorizes anything you play, and plays it back on command. The computer acts as a tape recorder, although, it records not just the sounds as air vibrations, but information as to how to create a certain sound. A sequencer allows to record and playback different parts of a composition in a multi-track manner. In this case we can add melody lines and different instruments to already existing pieces of music.

There are a lot of Music Composition Languages which resemble programming languages in the sense that they provide ways to create music on a computer – Music, Symbolic Composer, Fugue, SSSP, etc., which run on different platforms like Mac, IBM PC, UNIX, CP/M and others. There are a lot of different researches in computer music currently in progress. Some of them can really be beyond our imagination. A system called Biomuse consists of small electrodes, which are hidden underneath headbands and armbands sported by the musicians. These electrodes pick up signals from the musician's brain, eyes, arms, and hand muscles. The specially designed circuits would gather, filter, and process the bioelectric signals so they could control music synthesizers through the MIDI interface. With this system, a musician can just walk on stage and begin playing as every gesture made by hands, fingers, movement of eyes would generate sounds.

Another exciting research has been conducted in Fractal music. Fractal music is a result of a recursive process where an algorithm is applied multiple times to process its previous output. In a wider perspective, all musical forms can be simulated with this process. It is based on pure mathematical methods involving recursion, iteration, and complex mathematics.

Computers in Advertising

Advertising has been one of the key factors of growth and success in business. Smart businessmen always knew how important marketing was. All possible methods of promoting different products had been used, but before the late 1980s computers were something difficult for business people to use and understand. At the same time most of the people who worked with computers thought about computers as serious technical and science tools, and for many of them science and marketing were two things that cannot be together. In reality, only at the beginning of this decade computers really became considerably inexpensive, small in size, and freely available to many people. It was at this time that computers started to play a considerable role in marketing, and became a powerful tool in advertising and started to bring a lot of money to people who knew how to use them in real business.

There are many ways to use computers in advertising. We can divide them into two major groups. One of them is the use of multimedia in advertising and promoting products, and the other is the utilization of the Internet. Nowadays different applications of multimedia are used everywhere from a desktop presentation in a small travel agency to amazing multimedia exhibitions on computer shows. Modern computers are very user friendly. Many applications do not require sophisticated computer literacy. Animation, computer graphics, sound, and video make computer presentations attracting to all people. Demo floppies and CD-ROMs are often used to promote different types of products and services. Interaction is one of the major advantages of multimedia. In most cases a potential customer does not just observe the action like it works with TV commercials. He or she gets a response from the computer, has a choice of what to look for and when to start and finish. It is new, interesting, and attractive, therefore such an advertising strategy works. Another advantage of multimedia advertising is its considerable low cost. Many books and magazines are now shipped with some kind of demo or advertising material. Demo CDs and floppies are inexpensive, and of course it is difficult to imagine something that would fit so much information as we can put into a CD. More and more companies are using demo CDs as their free catalogs that they ship to their customers. These catalogs are user friendly and easy to use, so, usually, it takes only a few minutes to find any part or a product, print out an order form and order the item.

Computers in Art

A computer and an artist have a unique relationship, though the nature of the relationship has not yet been fully realized. Some artists embrace technology not only as a new tool but also as a new fine arts medium, capable of transforming art from visual experience to full emotional interaction with the work. Ironically, critics of computer art oppose the computer for the same reasons, claiming that the computer artist gets immersed in technology instead of the creative process. Technology itself is not the culprit instead the responsibility lies within the people who utilize those systems. But before we can discuss the effects of the computer we need to explore the age-old question of what is art?

Line drawings have been around almost as long as mankind. The first drawings date back to the Neolithic people. Drawing lines is one of the means that we use to record the appearance of objects in nature. A linear record of an object's appearance helps us to become familiar with the object itself, a purpose especially served by our childhood drawings. The visual arts are very much part of our daily lives. The clothes we wear, the chairs we sit on, and the plates we eat from are all products of attempts to present ideas in visual form.

Since the Stone Age, art has evolved along with mankind. As societies became more complex so did the art. In the age of discovery, the arts discovered the world around them, depicting scenes from everyday life. The impressionists fascinated themselves with the human sensory system. All these trends have one thing in common: a unique group of people with the ability and passion to make people see the mundane world in a new eye-opening way.

The tools and the medium have changed but the function of art remains the same—the transmutation of the mundane world into an imaginative created experience. The arts transform and transport viewers to alternate perceptions of reality. The computer revolution has touched every field, including the art world. First electronic art consisted of experiments in artificial intelligence and computational matrices. The computers of that time were not user friendly and there was no effective means of output. Computer art can be classified in two major categories—computer graphics and image processing. Computer graphics deals with the most fundamental aspects of image creation while image processing transforms existing images into a desired end product.

Computer graphics is predominately used in computer animation due to its precise and powerful data manipulation algorithms. People involved in computer graphics need programming knowledge as well as understanding of perspective, shading, hidden-line hidden-surface removal, shadowing, ray-tracing, anti-aliasing as well as more traditional aspects of image creation. Image processing on the other hand takes advantage of powerful easy to use software packages like Adobe Photoshop, Corel Paint Shop, Adobe Illustrator, Corel Painter, Fractal Painter, and others.

It is now accepted that the "new media", "multimedia", "electronic art", "hybrid arts", or simple computer art is rapidly changing the way we engage ourselves with issues of subjectivity, identity, nationality and interactivity. For pioneers, computers have opened a gateway to limitless forms of self-expression. The technology is changing at a rapid pace, and with each upgrade it offers a new form of self-expression. The viewer is no longer forced to absorb an image/idea in 'x' seconds. Interactive art allows the viewer to be the director and to experience the work in his own "time."

Each medium offers the artist new methods which lead to works unique to that medium. Just as the camera allowed the photographer to capture the tear of a crying child, new-media allows the artist to invoke emotions unreachable with a brush. Cyberspace will bring art to every home across social/political/geographical barriers. A well-designed web page is capable of enticing as much emotion, as the most exclusive art show.

COMPUTERS IN MEDICINE

Computers are revolutionizing the medical field. Computers are used in the medical field for performing a wide variety of tasks. In medicine, computers are used for everything from diagnosing illnesses and monitoring patients to controlling movements of robotic surgical assistants. This can be used for tasks that vary in complexity from recording of the patient's history and treatment details to monitoring the patients. Computers are also used in automating the hospital management systems, so that the information about the patient—the patient history, the treatment details, etc.—is available to the doctors. The advantage of the electronic patient records over the paper counterparts is that the electronic documents can be searched for specific keywords, can be sent via e-mail to other doctors for second opinions, can be stored and retrieved more effectively, etc. The computerized systems automate the billing, and other administrative processes, thus freeing the doctors and medical staff, so that they can spend more time on practicing medicine.

The advancements in digital and imaging technology have helped in better diagnosis as the images and outputs produced by the latest equipments are capable of delivering more information. Advancements in the field of biomedical engineering result in the development of laboratory and medical equipments that are better and more accurate. Several innovative medical applications use small, special-purpose computers. For example, pacemakers are computers that operate within the human body to help it function better. Another example is the cochlear implant, a special kind of hearing aid that allows profoundly deaf people to hear. Part of the device is a small computer that transforms sound into electrical impulses, which are then transmitted to the brain by a device implanted in the inner ear. Thus a cochlear implant helps a deaf person to hear sounds he/she would be unable to detect with a conventional hearing aid. In the case of cochlear implant, the signals travel over wires to an implant that directly stimulates the auditory nerves, bypassing damaged ear structures. In addition, tiny computers (computers so tiny, that could be swallowed by patients) are proving to be valuable diagnostic tools. Because these remotely controlled machines can navigate the twists and tight spaces in the body, they can take and transmit photographs of internal problems such as blood clots and tumors that previously could be seen only during exploratory surgery.

Computers play a vital role in patient monitoring and automated drug administration. In hospitals, bedside clinical information systems collect vital-sign measurements directly from patient monitors and automate the charting process. The modern drug administration systems automate the process of administrating medicines to patients.

Magnetic Resonance Imaging (MRI) uses radio waves and a strong magnetic field to scan a patient's body. A computer assembles this information into a picture that shows internal organs and certain types of diseased tissue. Another use of computers in the hospital is for automated imaging techniques, which produce a fully dimensional picture with much more detail and less risk than the standard X-ray films. The first widespread type of imaging to be used was Computerized Axial Tomography (CAT) scans. More recent techniques include Magnetic Resonance Imaging (MRI), and Positron Emission Tomography (PET). Using these techniques, doctors can look inside a person's body and study each organ in detail. As a result, conditions that might have been difficult to diagnose a few years ago can often be pinpointed at an early stage.

Video conferencing and other related technologies help in the collaboration of doctors from the different parts of the world. Advancements in telemedicine have made the life of patients easier and enabled them to get high-quality medical care irrespective of their physical location. Telemedicine uses technology to deliver medical services to the point of need. It is the use of electronic information and communications technologies to provide and support health care when distance separates the participants. It encompasses all of the health care, education, information and administrative services that can be transmitted over distances by telecommunications technologies.

Perhaps the most dramatic examples of computers improving people's lives involve physically challenged individuals. Before personal computers, people with physical disabilities often had great difficulty performing everyday tasks, and had limited opportunities for employment. Today, an astonishing array of software and devices are available to assist people who have a broad range of disabilities. Although by no means a panacea, the personal computer is helping thousands of people to manage their lives and to achieve greater independence. Someone who has only a single muscle under his voluntary control or who uses just one hand or foot to type can completely control a computer. A person can operate a joystick mounted on an adjustable extension arm with her lips, chin, cheek, shoulder, arm, hand, or foot to manipulate the cursor and, with an on-screen keyboard, to enter text. Using head wands or mouth sticks, a user can operate a computer by moving his head and puffing on a straw connected to a small headset to enter text on an on-screen keyboard. Optical pointing devices allow people to make selections by simply staring at an image-a word, character, or picture-for as little as 1/2 second. Because many of these input options are relatively time intensive, word-prediction capabilities are often included to help speed input. Using principles of artificial intelligence, these programs attempt to anticipate what the user is typing. As soon as the user enters the first character of a word, the program suggests possibilities. With each new character typed, the predicted list of words becomes shorter. Once the desired word appears, the user can select it, rather than type the remaining characters.

Voice-recognition systems allow users with many kinds of physical disabilities to speak commands to their computers. They may provide hundreds of preprogrammed selections for various types of applications, such as word processing, desktop publishing, and graphics. Individuals who are non-verbal or have speech difficulties can use speech synthesizers for digitized speech output. Assistive communication systems provide screens of messages, sometimes presented graphically. When the user points to or types a message, the computer speaks it. People with visual impairments can use screen magnifiers or large screen monitors, and can apply high-contrast labels to their keys. Optional Character Recognition (OCR) software can translate printed information into computer-networks to the supplier. At that end it is automatically processed and creates a list of the products to be shipped even before the normal workday begins.

Computer-Aided Design / Computer-Aided Manufacturing (CAD/CAM)

An increasingly popular tool for product design is Computer-aided Design (CAD). CAD systems are computer programs or integrated packages for workstation hardware and software that allow the user to draw and easily modify product designs on a computer screen. Advanced CAD systems provide designers with at least three major benefits.

- **Graphics capabilities** — CAD systems allow the designer to view a product from different perspectives, including three-dimensional rotations, and various cross-sections. The designer can also make proportional changes in scale, or change the angle of an arc with the click of a computer mouse rather than having to redraw the entire product.
- **Design, storage and retrieval** — Some CAD systems can store the design characteristics of existing products and components. Then, for example, if a company needs a gear for a new product, the designer can enter the relevant information about the gear, such as its diameter, tooth pattern and required hardness, into the CAD system. The CAD system determines whether the company is already using an identical or sufficiently similar gear, in which case a new one is unnecessary. If not, a gear which has similar properties may exist. The designer can then use the design of this similar gear as a starting point for the new gear. This capability not only promotes the use of common components but also reduces design time.
- **Automatic evaluation of specifications** — One of the most time-consuming aspects of design for highly technical products is calculating whether or not product specifications, such as strength, heat resistance or aerodynamic drag, are satisfied. These calculations can be programmed into some CAD systems so that whenever the designer changes the design (by altering the shape or material to be used), these performance characteristics are recalculated automatically and compared to the product requirements. This is sometimes called **Computer-aided-Engineering (CAE).**

The overall benefits of CAD systems can be substantial. The features described above reduce development time and cost, and they improve product quality because more design options can be evaluated in greater detail more quickly. For example, Motorola used three-dimensional CAD to produce its award-winning MicroTac pocket sized cellular phone two years ahead of the competition. It is not uncommon for CAD systems to reduce product cycle times by 10–50%.

Even greater time and cost reductions have resulted from recent advances whereby CAD-engineered designs are converted automatically into software programs for computerized production machines. These are called Computer-aided Design/Computer-aided Manufacturing (CAD/CAM) systems. This automatic conversion eliminates the costly and time consuming steps of having a person convert design drawings into a computer program for computer-controlled production equipment, such as robots or machine tools. CAD and CAD/CAM systems are not used by large automotive or electronics companies alone. Future Enterprises, the largest maker of wedding jewelry in the United States, reported that its CAD/CAM system reduces the time required to design and make jewelry from five months to one week.

Product Data Management (PDM)

One of the major manufacturing challenges is to maximize the time-to-market benefits of concurrent engineering while maintaining control of your data and distributing it automatically to the people who need it, when they need it. The way PDM systems cope with this challenge is that master data is held only once in a secure 'vault' where its integrity can be assured and all changes to it monitored, controlled and recorded.

Duplicate reference copies of the master data, on the other hand, can be distributed freely, to users in various departments for design, analysis and approval. The new data is then released back into the vault. When a 'change' is made to data, what actually happens is that a modified copy of the data, signed and dated, is stored in the vault alongside the old data which remains in its original form as permanent record. The following are some of the benefits of the PDM system:

- ▲ Reduced Time-to-Market
- ▲ Improved Design Productivity
- ▲ Better use of Creative Team Skills
- ▲ Data Integrity Safeguarded
- ▲ Better Management of Engineering Change

Feature Prototyping

One of the problems with product design is getting an intimate feel for the appearance and behavior potential of a product. Now there are software packages that can generate computer prototypes, which can be distributed and tested by actual customers. Usage data from these tests is collected automatically and used to refine product specifications until they precisely meet the customers' needs. This process helps in ensuring the market success of the new product before costly and time-consuming investments in engineering and manufacturing are made. Better than communicating with customers using written specifications, static drawings, flip charts, or multimedia authoring tools, feature prototyping using fully functional prototypes provide accurate and valuable feedback to the company based on customers' experience that can make the difference between a resounding market winner and an embarrassing product failure.

Project Management

When projects from marketing campaigns to construction projects are undertaken, keeping track of all the tasks is a big job and that is what project management programs have been developed to do. One concept they use is the critical path; the series of tasks that must follow one another in order and cannot be overlapped or begun until the previous one is completed. For example, a roof cannot be put on a house until the walls are up, and the walls cannot be built until the foundation is completed. When these dependent tasks are laid out end-to-end, they form the project's critical path. Any delays in the tasks on this path delay the entire project. Tasks not on the critical path like paving the driveway do not affect the project's completion date. Speeding up the project, called crashing the schedule can be done only by changing the dates on the critical path, but changing some dates on the critical path may result in another path becoming critical. Since this process is so interactive, it lets itself to computerization. Graphics are often used to show the complicated relationships in the timing and sequence of a project.

REVIEW QUESTIONS

Descriptive Type Questions

01. Briefly describe the role of computers in the film industry.
02. How do computers help musicians?
03. What is the role of computer in art?
04. How do computers help in advertising?

05. What is the role of computers in scientific research?
06. How do computers improve the quality of medical care?
07. What is telemedicine?
08. How does computer improve the engineering productivity?
09. What is EDI?
10. What is a CAD/CAM system?
11. What is Product Data Management?
12. What is feature prototyping?

Fill in the Blanks

01. MIDI is the abbreviation of ____________.
02. A ____________ allows to record and playback different parts of composition in a multi-track manner.
03. MRI stands for ____________.
04. CAT stands for ____________.
05. PET stands for ____________.
06. EDI stands for ____________.
07. CAD/CAM is the acronym for ____________.
08. ____________ is the computer-to-computer exchange of business documents in a standard format.
09. ____________ systems are computer programs or integrated packages for workstation hardware and software that allow the user to draw and easily modify product designs on a computer screen.
10. CAE stands for ____________.

[**Answers:** (1) Musical Instrumental Digital Interface (2) Sequencer (3) Magnetic Resonance Imaging (4) Computerized Axial Tomography (5) Positron Emission Tomography (6) Electronic Data Interchange (7) Computer-aided Design / Computer-aided Manufacturing (8) EDI (9) CAD (10) Computer-aided Engineering]

True or False

01. SSSP is a music composing software.
02. Fractal music is a result of a recursive process where an algorithm is applied multiple times to process its previous output.
03. Demo floppies and CD-ROMs are often used to promote different types of products and services.
04. Computer graphics is predominately used in computer animation due to its precise and powerful data manipulation algorithms.
05. Telemedicine encompasses all of the health care, education, information and administrative services that can be transmitted over distances by telecommunications technologies.
06. OCR is the abbreviation of optical character reproduction.
07. Using computers and sophisticated software, scientists can model complex molecules and can experiment with compounds that do not yet exist.
08. One widely used format of EDI is for purchase orders and consists of an outer digital 'envelope' with the addresses of both the sender and receiver.
09. CAD systems allow the designer to view a product from different perspectives, including three-dimensional rotations, and various cross-sections.
10. One of the most time-consuming aspects of design for highly technical products is calculating whether or not product specifications, such as strength, heat resistance or aerodynamic drag, are satisfied.

11. PDM stands for Production and Distribution Management.
12. Now there are software packages that can generate computer prototypes, which can be distributed and tested by actual customers.

[**Answers:** (1) False (2) True (3) True (4) True (5) True (6) False (7) True (8) True (9) True (10) True (11) False (12) True]

CHAPTER 49

Mobile Computing and Business on the Internet

TOPICS COVERED

- Mobile computing
- Business on the Internet

Key Points

- Mobile computing is a generic term describing one's ability to use technology while moving, as opposed to portable computers, which are only practical for use while deployed in a stationary configuration.
- Telecommuting and telework are synonyms for the use of telecommunication to work outside the traditional office or workplace, usually at home or in a mobile situation.
- Whiteboards are multimedia tools that allow cooperation among geographically dispersed people over a network or the Internet.
- Computers are making it increasingly easy for workers to roam outside the office while remaining in constant touch through e-mail, file transfer, or some form of conferencing.
- A virtual organization or company is one whose members are geographically apart, usually working by computer e-mail and groupware while appearing to others to be a single, unified organization with a real physical location.
- Companies' Web home pages that educate the public about their products and services are beginning to replace printed product catalogs that are expensive to produce and distribute and are soon out of date.
- Providing security for the information that is sent over the Internet is necessary for conducting business on the Internet. The Secure Socket Layer (SSL) protocol is used extensively on the web to protect credit card numbers and other sensitive data transmitted between a user's web browser and an Internet web server through the HTTP protocol.

MOBILE COMPUTING

As computers' ability to communicate with one another increases, information technology is beginning to have profound effects on many aspects of the organization, one of the most significant being how they make it much easier for people to move around while keeping in touch.

There are three basic genres of mobile computing. The first uses mobile computers. These are computers or similar devices that are designed for mobile use. They include notebooks, PDAs, and mobile phones. The second genre is remote connection. This type of mobility allows you to connect to your computer from remote locations and work as though you were sitting in front of it. The final type of technology is known as Desktop Virtualization. With this technology you take your software with you and recreate your computing experience on any available hardware.

Mobile Newspaper

Many newspapers offer on-line versions of their editions, some free and some others requiring a subscription. Some lets you to customize your newspaper by selecting the topics that interests you the most. When you are mobile, or out of town on a trip, you can still read your favorite newspaper via the Internet.

Telecommuting

It is estimated that millions of people all over the world are employed in part- or full-time telecommuting programs. Millions more work from home informally or operate home-based businesses. This is seen by many as being more productive and also better for the environment. In certain circumstances, telecommuting may even be required such as in the case of an organization that does not have enough room for all its employees. But there are many technological hurdles to overcome before workers can have the same functionality at home that they do in the office.

- Desktop videoconferencing is at this point harder to do with people not at central locations; it adds so much to interpersonal business communications that it has become almost a necessity.
- Telephone-to-PC integration technology needs to be simplified and improved.
- ISDN services are sometimes not available and are always too complex and costly.
- Telecommuters must have access to the proper tools. For example, they might need whiteboard collaborative tools.
- Security must be improved perhaps with dial-back services to ensure it is really an employee logging in and not just someone who stole or guessed a password.

Figure 49.1 Telecommuting Helps People to Work from Anywhere

There are also some problems with telecommuting to be addressed on the personal side as well as on the technical side.

- Telecommuters must be 10–15% more productive because of the high cost of the equipment.
- It is difficult for managers to measure productivity and performance and they need to see a gain. New developments brought about by information technology cannot be

'productivity-neutral' for them. Bosses may view telecommuting as losing control over their employees.

Whiteboards

Whiteboards are multimedia tools that allow cooperation among geographically dispersed people over a network or the Internet. Whiteboards allow a document or an image to be viewed simultaneously by all participants in a conference so they can share ideas interactively by voice or by drawing comments or sketches that everyone can see. It is the electronic equivalent of physical whiteboards. Why are they called whiteboards? The chalk dust associated with blackboards or chalkboards was a problem in the electronic industry. It contaminated equipment. The solution was the whiteboard as a surface on which people could write or draw using erasable marker pens. The name has been carried over to the digital version.

Wireless Mobile Computing

Computers are making it increasingly easy for workers to roam outside the office while remaining in constant touch through e-mail, file transfer, or some form of conferencing.

Figure 49.2 Mobile Worker

With a radio modem, a roaming employee can use Radio Frequency (RF) communications in most major cities to send and receive e-mails without searching for a phone jack. Cellular Digital Packet Data (CDPD), which will soon be available on the same radio frequency used by cellular phones, transmits digital data as packets as well as voice. With the mobile facilities, the employees working in the field will have access to the company's network computers and data from wherever they are just as if they were at their desks in their office. So armed with a cellular phone (or in some case Satellite

Phones), and a portable computer, the mobile worker of today can be anywhere in the world and still be in touch with the office.

Enabling Technologies

There are many technological developments that have made mobile computing possible. Some of them are Bluetooth, Wi-Fi, USB, FireWire etc. We will see these in some detail in the following sections:

- **Bluetooth** – Bluetooth refers to a wireless technology which allows digital devices to easily transfer files at high speed, bluetooth is common in many portable devices such as laptops, PDAs, and mobile phones. Bluetooth wireless technology is a short-range communications technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. The key features of Bluetooth technology are robustness, low power, and low cost. The Bluetooth specification defines a uniform structure for a wide range of devices to connect and communicate with each other. The amount of products that utilize Bluetooth technology is growing rapidly in all sectors of the tech market, some other devices that use Bluetooth technology include gaming devices, medical instruments, printers, audio and visual devices, automotive systems, GPS, and many more.
- **Wi-Fi** – Wi-Fi is the name of a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections. The Wi-Fi Alliance, the organization that owns the Wi-Fi term specifically defines Wi-Fi as any wireless local area network (WLAN) products that are based on the IEEE 802.11 standards.
- **USB** – USB is a high-performance serial bus communication technology. Most new computers and associated peripheral devices like printers and scanners contain built-in support for this technology. USB hubs for file and printer sharing also exist. USB and FireWire are the most popular, competing standards for networking computer peripherals. To build a USB network, simply connect USB cables to the USB ports on those devices. USB is plug and play compatible, meaning that the operating system's USB driver software automatically detects and configures device connections. One USB network supports up to 127 devices.
- **FireWire** – FireWire is a high performance networking standard based on serial bus architecture similar to USB. FireWire is also known as the IEEE 1394 standard, created in 1995. People typically use FireWire to network their digital video cameras with their computers, using special cables. However, FireWire theoretically supports direct networking of any two computers / computer peripherals that support the standard.

Virtual Organizations

With the growth of networks and easy connections, a new virtual corporation is possible. The **company-in-a-box** is a dream of many engineers and planners who envision businesses operating in cyberspace to coordinate employees and provide services on-line.

A virtual organization or company is one whose members are geographically apart, usually working by computer e-mail and groupware while appearing to others to be a single, unified organization with a real physical location. It is possible to bring people together at the same place to work or be educated. These groupings take place electronically, with everyone home or wherever they want to be. The virtual office setup can be at a low cost. It allows managers and others to spend more time with customers; improve employee satisfaction and productivity by working with fewer interruptions; alleviate traffic congestion; improve air quality; and gradually reduce real estate cost. It reduces or eliminates commuting so that there is more time after hours for family and friends.

BUSINESS ON THE INTERNET

The new wave of popularity of the World Wide Web (WWW) has turned attention to its possibilities for commerce. And this means not only promoting products or services, but also selling them and getting payment via the web.

Electronic Catalogs

Companies' Web home pages that educate the public about their products and services are beginning to replace printed product catalogs that are expensive to produce and distribute and are soon out of date. Business-to-business electronic catalogs is a rapidly growing business. Once electronic catalogs replace the printed ones, huge savings is possible. Customers benefit because printed catalogs are hard to file and search through for the right product. Search engines built into electronic catalogs allow potential buyers to search an entire product line using various keywords or other characteristics.

Web Advertising

As you browse the Web, you find many pages adorned with company's names, medallions, and icons. These companies have paid the websites to put these elements in their pages, and the hope is that someone visiting the page will click one of the ornaments to visit the advertiser's website. To help advertisers measure the effectiveness of their ads and to develop leads to follow, software has been created that lets the companies know who is clicking and what they are viewing. This raises some serious privacy issues and a lot of people object to this capturing of information about them. The wonderful thing about the world of computers is that creative minds are also developing software that conceals your identity from these advertisers. These programs will become popular defenses as web users start getting unsolicited sales calls.

Secure Transactions

One of the early struggles with the Internet was finding a way to safely buy and sell goods or transfer funds over it. But eventually this has been achieved. Since messages go through many computers between a buyer and a seller, no transaction was secure. Credit card numbers and other sensitive information could easily be captured. The goal was to enable electronic commerce by providing a safe, convenient, and immediate payment system on the Internet for transactions between customers, merchants and their banks by processing them in real time and passing authentication codes back to merchants. One of the mechanisms, which provide this kind of security, is called the Secure Socket Layer or SSL.

The **Secure Socket Layer (SSL)** protocol is used extensively on the web to protect credit card numbers and other sensitive data transmitted between a user's web browser and an Internet web server through the HTTP protocol. SSL supports different encryption systems and key lengths. The protocol is bundled into the web browsers, so it does not depend on the host computer to support encryption. With SSL, a credit card number is encrypted by the customer's computer and decrypted by the merchant's. With the number in hand, the merchant then charges the purchase against the account. This process has a weakness. Insiders and intruders with access to the merchant's customer records can potentially compromise the card number. The **Secure Electronic Transaction (SET)** protocol addresses this vulnerability in SSL by providing an encrypted channel between the customer and the bank. Upon receipt of an order, the merchant forwards the encrypted payment information to the bank. The bank decrypts the message, validates the payment information, and informs the merchant whether to go ahead with the sale. With this approach, a customer's credit card number is never made available to the merchant.

REVIEW QUESTIONS

Descriptive Type Questions

01. What is a mobile newspaper?
02. What is telecommuting?
03. What are the advantages and problems with telecommuting?
04. What are whiteboards?
05. What is wireless mobile computing?
06. What do you mean by Bluetooth and what are its uses?
07. What is Wi-Fi and what are its applications?
08. What is USB and what are its uses?
09. What is FireWire and where is it used?
10. What are electronic catalogs?
11. What is web advertising and what are its advantages?
12. What are secure transactions?
13. What is SSL and how does it work?
14. What is SET technology?

Fill in the Blanks

01. ____________ are making it increasingly easy for workers to roam outside the office while remaining in constant touch through e-mail, file transfer or some form of conferencing.
02. ____________ are multimedia tools that allow cooperation among geographically dispersed people over a network or the Internet.
03. With a ____________, a roaming employee can use radio frequency communications in most major cities.
04. CDPD stands for ____________.
05. Businesses operating in cyberspace to coordinate employees and provide services on-line are called ____________.
06. WWW stands for ____________.
07. One of the mechanisms that provide security for on-line business transactions is ____________.
08. ____________ electronic catalogs is a rapidly growing business.
09. SSL stands for ____________.
10. SET stands for ____________.

[**Answers:** (1) Computers (2) Whiteboards (3) Radio modem (4) Cellular digital packet data (5) Virtual organizations (6) World Wide Web (7) Secure Socket Layer (8) Business-to-Business (9) Secure Socket Layer (10) Secure Electronic Transaction]

True or False

01. Many newspapers offer on-line versions of their editions, some free and some others requiring a subscription.
02. It is estimated that millions of people all over the world are employed in part or full-time telecommuting programs.
03. Telecommuters must be 10-15% more productive because of the high cost of the equipment.
04. Whiteboards allow a document or an image to be viewed simultaneously by all participants in a conference so that they can share ideas interactively by voice or by drawing comments or sketches that everyone can see.

05. The company-in-a-box is a dream of many engineers and planners who envision businesses operating in cyberspace to coordinate employees and provide services on-line.
06. Companies' Web home pages that educate the public about their products and services are beginning to replace printed product catalogs that are expensive to produce and distribute and are soon out of date.
07. Search engines built into electronic catalogs allow potential buyers to search an entire product line using various keywords or other characteristics.
08. To help advertisers measure the effectiveness of their ads and to develop leads to follow software has been created that lets the companies know who is clicking and what they are viewing.
09. SSL supports only a single encryption system and key length.
10. SET provides an encrypted channel between the customer and the bank.

[**Answers:** (1) True (2) True (3) True (4) True (5) True (6) True (7) True (8) True (9) False (10) True]

APPENDIX A

History of Computing

INTRODUCTION (TILL 1975)

The start of modern science that we call **Computer Science** can be traced back to long ago when man still dwelled in caves or in forests, and lived in groups for protection and survival from the harsh elements on the Earth. Many of these groups possessed some primitive form of animistic religion; they worshipped the sun, moon, trees, or sacred animals. Within the tribal group was one individual who took the responsibility of the tribe's spiritual welfare. It was he or she who decided when to hold both the secret and public religious ceremonies, and interceded with the spirits on behalf of the tribe. In order to correctly conduct the ceremonies and thus ensure good harvest in the fall and fertility in the spring, the cavemen needed to count the days or to keep track of the seasons. From this tradition, man developed the first primitive counting mechanisms—counting notches on sticks or marks on walls. The *Antikythera* mechanism used for registering and predicting the motion of stars and planets dates to the first century BC. It was discovered off the coast of Greece in 1901.

Figure 1 Stonehenge

From the caves and forests, man slowly evolved and built structures such as *Stonehenge*. Stonehenge, which lies 13 Km north of Salisbury, England, is believed to have been an ancient form of calendar designed to capture the light from the summer solstice in a specific fashion. The solstices have long been special days for various religious groups and cults. Archeologists and anthropologists today are not quite certain how the structure, believed to have been built about 2800 BC, was erected since the technology required to join together the giant stones and raise them upright seems to be beyond the technological level of the Britons at that time. It is widely believed that the enormous edifice of stones may have been erected by the Druids. Regardless of the identity of the builders, it remains today a monument to man's intense desire to count and to track the occurrences of the physical world around him.

Meanwhile, in Asia, the Chinese were becoming very much involved in commerce with the Japanese, Indians and Koreans. Businessmen needed a way to tally accounts and bills. Somehow, out of this need, the abacus was born. The abacus is the first true precursor to the adding machines and computers, which would follow. It worked using by assigning values to the beads or pebbles. The value assigned to each pebble (or bead, shell or stick) is determined not by its shape but by its position: one pebble on a particular line or one bead on a particular wire has the value of 1; two together have the value of 2. A pebble on the next line, however, might have the value of 10, and a pebble on the third line would have the value of 100. Therefore, three properly placed pebbles—two with values of 1 and one with the value of 10—could signify 12, and the addition of a fourth pebble with the value of 100 could signify 112, using place-value notational system with multiples of 10.

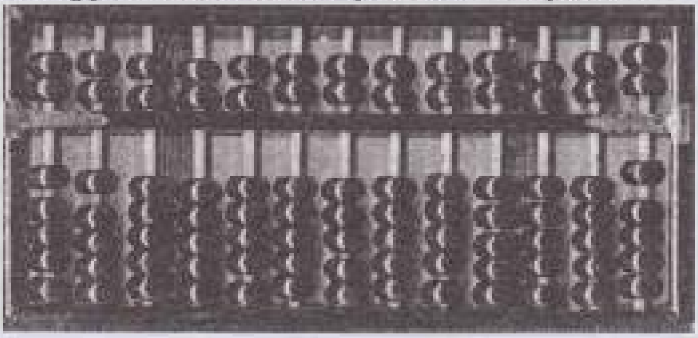

Figure 2 Abacus

Thus, the abacus works on the principle of place-value notation: the location of the bead determines its value. In this way, relatively few beads are required to depict large numbers. The beads are counted, or given numerical values, by shifting them in one direction. The values are erased (freeing the counters for reuse) by shifting the beads in the other direction. An abacus is really a memory aid for the user making mental calculations, as opposed to the true mechanical calculating machines, which were still to come.

For over a thousand years after the Chinese invented the abacus, not much progress was made to automate counting or in mathematics. The Greeks came up with numerous mathematical formulae and theorems, but the newly discovered math had to be worked out by hand. A mathematician was often a person who sat in the back room of an establishment with several others and worked on the same problem. The redundant personnel working on the same problem were there to ensure the correctness of the answer. It could take weeks or months of laborious work by hand to verify the correctness of a proposed theorem. Most of the tables of integrals, logarithms, and trigonometric values were worked out this way, their accuracy unchecked until machines could generate the tables in far less time and with more accuracy than a team of humans could ever hope to achieve.

John Napier (1550-1617) brought about the next great step towards today's computers. He was born in Merchiston, Edinburgh and studied at St. Salvatore's College, University of St. Andrews. He also studied in Paris and traveled to Italy and Germany before returning to Scotland to marry in 1571. John Napier is commonly known as the inventor of logarithms. While important steps had been taken in the 16th century, particularly by Burgi, it was Napier who brought the theory to the attention of Mathematicians. His '*Mirifici Logarithmorum Canonis Descripto*' (1614), was the first important work on mathematics produced in Great Britain, and one which inspired Briggs, the professor of geometry at Gresham College, London, to develop the system of common logarithms with the decimal base.

Figure 3 John Napier

Napier is also known for something called *Napier's Bones* for use in Multiplication. This apparently was an interpretation of the abacus. It has also been claimed, with some validity that Napier introduced the decimal point into common usage and eliminated the use of notation to indicate fractional position.

William Oughtred (1575-1660), born in Edin, Buckinhamshire was an Anglican cleric and a schoolmaster. He is credited for two discoveries, both of which were forms of a slide rule. He invented the circular slide rule and the rectangular slide rule. Each of these instruments had a common accuracy of three digits. He wrote the '*Circles of Proportion and Horizontal Instrument*' in 1632. In this book he describes both the slide rules and the various uses of the sundial. Wilhelm Schickard, a professor at the University of Tubingen, Germany, built the first mechanical calculator in 1623. It could work with six digits, and carried digits across columns. It worked, but never made beyond the prototype stage.

Blaise Pascal (1623-1662), born in Clermont (now Clermont-Ferrand), Auvergne, France was a mathematician and the son of a mathematician and tax collector, Etienne Pascal. His father wanted Blaise to be innovative, to push the envelope of mathematics; so he decided that Blaise must learn first from him alone. He removed all mathematical texts from his home and would not allow Blaise to study mathematics at all until the age of 15. He felt that by then he would have enough maturity to see mathematics for the marvelous tool that it was rather than simply as another lesson to be memorized and despised. Blaise had his curiosity aroused by this odd prohibition and started to work on geometry himself at the age of 12. He discovered that the sum of the angles of a triangle is 2 right angles. When his father discovered this he finally allowed him a copy of Euclid. At the age of 14, Blaise began to attend the meetings of another great scholar Marin Mersenne. Attending these meetings were luminaries such as Fermat (Law of Probabilities), Gassendi author of the famous '*Philosophical Treatise*', Gilles Personne de Roberval, one of the pioneers of Calculus, among others. At the age of 16, he presented a single paper to one of these prestigious meetings, which contained a number of projective geometry theorems, including Pascal's *Mystic Hexagon*.

Pascal is most remembered among the Computer Scientists as the inventor of the calculator. In 1642 he presented this to his father to assist him. This calculator, called the *Pascaline*, resembled the mechanical calculators used in the 1940's. These were not his only contributions by far. He also invented the syringe, the hydraulic press, and Pascal's law of pressure. Pascal built Pascaline based on a design described by Hero of Alexandria (AD 2) to add up the distance travelled by a carriage. The basic principle of his calculator is still used today in water meters and modern-day odometers.

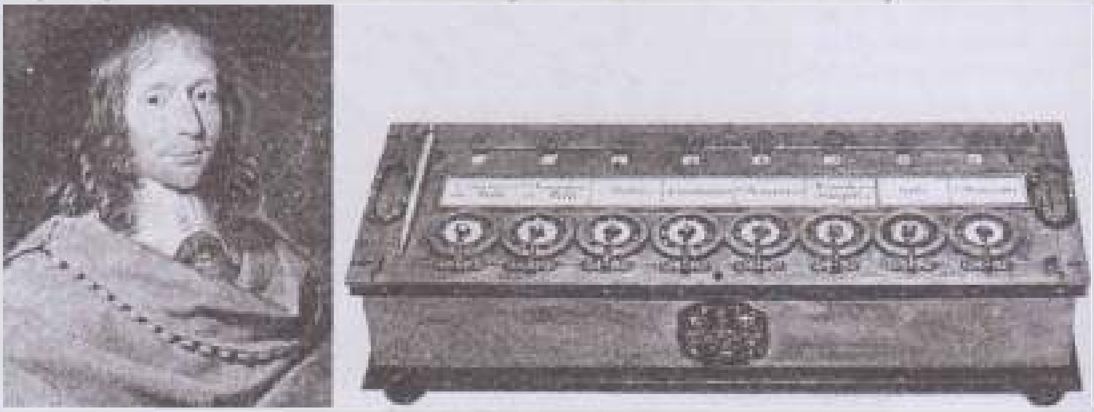

Figure 4 Blaise Pascal and Pascaline

Gottfried Wilhelm von Leibniz (1646-1716) was born in Liepzig, Saxony (now Germany). He is most associated with his contributions to Integral Calculus. In 1694, he invented the *Stepped Reckoner*. This was another calculator similar in intent to that of the Pascaline, except that this device used stepped cylinders, like a music box, rather than gears. Based on the decimal system this device could multiply and divide as well as add and subtract. Unfortunately, both this and the Pascaline were simply too complicated for mass production and so they remained one-of-a-kind.

Joseph-Marie Jacquard (1752-1834) was born in Lyon, France. He was a stone mason and later a weaver. He created the *Punched Card Loom* in 1801. This device was a new type of loom for weaving cloth. Punched cards controlled its operation. Needles could pull threads through cards where there were holes and not where there were none. Thus patterns were stored on punched cards. This device never gained him the riches that he should have received as the labor union of the silk weavers was very strong at that time and they recognized the threat it posed from unemployment. They prevented its mass production with massive demonstrations and riots against the replacement of people with machines.

Thomas de Colmar (1785-1870), invented his first *Arithmometer* in 1820. This was the first mass produced calculator. It did multiplication in much the same fashion as the *Stepped Reckoner* but at the size of about a desktop was much smaller and easier to produce. With some assistance from the user it could do division as well. This device was widely used, but the importance of it was the inspiration that it later caused.

While Thomas de Colmar was developing the first successful commercial calculator, Charles Babbage (1792-1871), realized as early as 1812 that many long computations consisted of operations that were regularly repeated. He theorized that it must be possible to design a calculating machine which could do these operations automatically. He produced a prototype of this "*difference engine*" by 1822 and with the help of the British government started work on the full machine in 1823. It was intended to be steam-powered; fully automatic, even to the printing of the resulting tables; and commanded by a fixed instruction program.

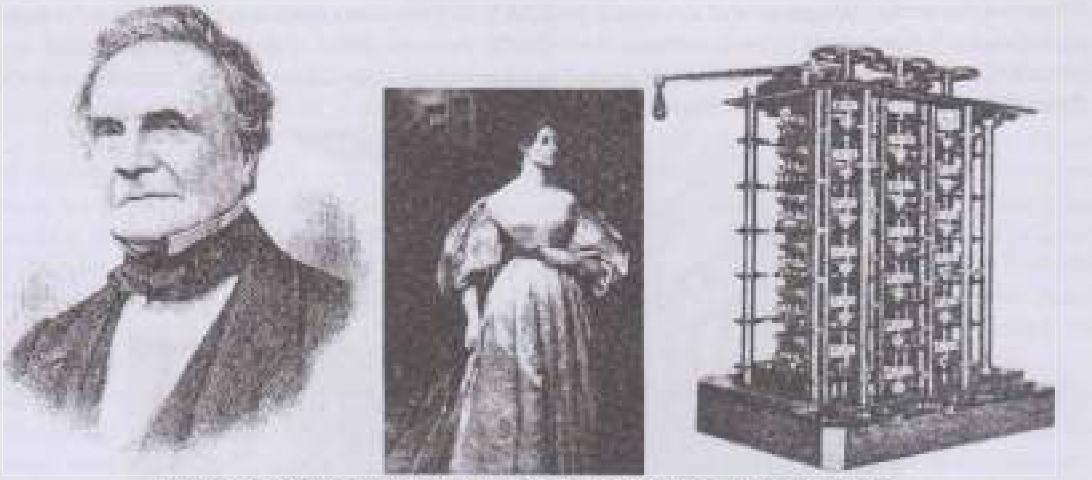

Figure 5 Charles Babbage, Augusta Ada Byron and The Difference Engine

In 1833, Babbage ceased working on the difference engine because he had a better idea. His new idea was to build an *"analytical engine."* The analytical engine was a real parallel decimal computer which would operate on words of 50 decimals and was able to store 1000 such numbers. The machine would include a number of built-in operations such as conditional control, which allowed the instructions for the machine to be executed in a specific order rather than in numerical order. The instructions for the machine were to be stored on punched cards, similar to those used on a Jacquard loom.

Ada Byron, Lady Lovelace (1815–1852) was one of the more picturesque characters of the early history of computers. Ada met Babbage in 1833. She described the Analytical Engine as weaving "algebraic patterns just as the Jacquard loom weaves flowers and leaves." Her published analysis of the Analytical Engine is our best record of its programming potential. In it, she outlines the fundamentals of computer programming including data analysis, looping and memory addressing. Published in 1843, Ada's prescient comments included her predictions that such a machine might be used to compose complex music, to produce graphics, and would be used for both practical and scientific use. She was correct. When inspired, Ada could be very focused and a mathematical taskmaster. Ada suggested to Babbage writing a plan for how the engine might calculate Bernoulli numbers. This plan, is now regarded as the first *"computer program."* A software language developed by the US Department of Defense was named *"Ada"* in her honor in 1979.

Konrad Zuse, a German engineer, completed the first general-purpose programmable calculator in 1941. He pioneered the use of binary math and Boolean logic in electronic calculation. During World War II, a group of scientists led by Max Newman, a mathematician from Cambridge University, and including Alan Turing and several thousand others, attacked the German high command coded messages to decrypt their contents and to produce intelligence that became known as *"Ultra"*. Located at Bletchley Park, England, these scientists achieved their goal, even though complicated by an ever more complex encryption device, through the development of a series of computer-like machines culminating in an electronic marvel known as *Colossus*. The first prototype began operating in February 1944.

The next major breakthrough was funded by the US Defense Department. They needed a better system of computing the firing and ballistic tables for their missiles. J. Presper Eckert and William Mauchley at the Moore school for Engineering of the University of Pennsylvania developed the

Electronic Numerical Integrator and Calculator (ENIAC), in 1946. This machine filled a 30 x 50 foot room and weighed thirty tons. The computer had 18,000 vacuum tubes. Programs were stored on plug boards that had wires wrapped around pins. Numbers were entered by turning a series of dials until they corresponded to the proper digit.

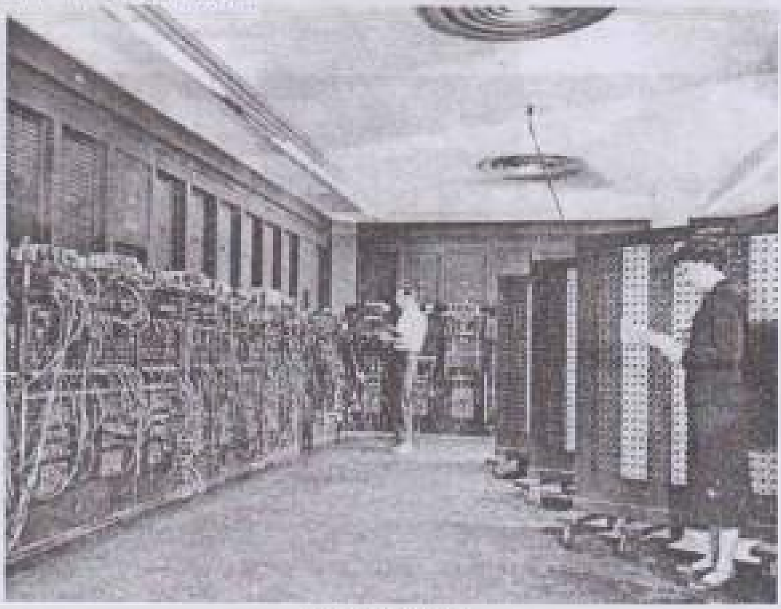

Figure 6 ENIAC

In 1945 John Von Neumann wrote a paper describing how a binary program could be electronically stored in a computer. It was entitled *'First Draft of a Report on the EDVAC'*. Eckert, Mauchley, and Konrad Zuse all claimed to have had the same thought in the 1930's but since Von Neumann was the first to write it on paper he is given the credit for the architecture that so changed the world.

Figure 7 John Von Neumann

As odd as it might seem, the work of this one man, particularly this one paper, would form the basis of the design for the first Intel chip for microprocessors, *the 8088*. He described a mechanism whereby a computer chip would have a single point at which any other device could place values. The chip would then read the values at that point, act upon them, and clear them. This would continue until something meaningful was done. The manner in which the chip would act upon those values would depend upon the values and the order in which they were placed at this location. Placing a particular binary value at this location might mean, 'add the next two numbers.' The chip would clear the location (today known as the bus), and move the next value that arrived at the bus to a location inside its domain. Today, these places are called registers. It would then clear the bus again. It would read the next value, the second number, and place it in another register. Then it would add the value in the first register to that in the second and leave the sum in a place that is today called the accumulator. It would then clear the bus again.

Neumann in his paper demonstrated that a computer could have a simple, fixed structure, yet be able to execute any kind of computation given properly programmed control without the need for hardware modification. He contributed a new understanding of how practical and fast computers should be organized and built; these ideas, often referred to as the stored-program technique, became fundamental for future generations of high-speed digital computers and were universally adopted. The primary advance was the provision of a special type of machine instruction called *conditional control transfer*. This permitted the program sequence to be interrupted and reinitiated at any point, similar to the system suggested by Babbage for his analytical engine. By storing all instruction programs together with the data in the same memory unit, the instructions could be arithmetically modified in the same way as data, as and when desired. Thus, data was the same as program.

As a result of these techniques and several others, computing and programming became faster, more flexible, and more efficient, with the instructions in subroutines performing far more computational work. Frequently used subroutines did not have to be reprogrammed for each new problem but could be kept intact in "libraries" and read into memory when needed. Thus, much of a given program could be assembled from the subroutine library. The all-purpose computer memory became the assembly place in which parts of a long computation were stored, worked on piecewise, and assembled to form the final results. The computer control served as an errand runner for the overall process. As soon as the advantages of these techniques became clear, the techniques became standard practice.

The first generation of modern programmed electronic computers, which took advantage of these improvements, appeared in 1947. This group included computers using Random Access Memory (RAM), which is a memory designed to give almost constant access to any particular piece of information. These machines had punched card or punched-tape input and output devices and RAMs of 1,000 words. Physically, they were much more compact than the ENIAC: some were about the size of a grand piano and required 2,500 small electron tubes, far fewer than was required by the earlier machines. The first-generation stored-program computers required considerable maintenance, attained perhaps 70–80% reliable operation, and were used for 8–12 years. Typically, they were programmed directly in machine language, although by the mid-1950s progress was made in several aspects of advanced programming. This group of machines included EDVAC and UNIVAC, the first commercially available computers.

The term *bit* for a binary digit was first used in 1946 by John Tukey. In 1947, William Shockley, John Bardeen, and Walter Brattain invented the "*transfer resistance*" device at Bell Laboratories which later came to be known as the *transistor*. In 1950, Maurice V. Wilkes at Cambridge University first started using the *assembler* (symbolic assembly language) on the EDSAC. Remington-Rand bought

Ecker-Mauchley Computer Corp., and the SEAC (Standards Eastern Automatic Computer) was delivered to the National Bureau of Standards (USA).

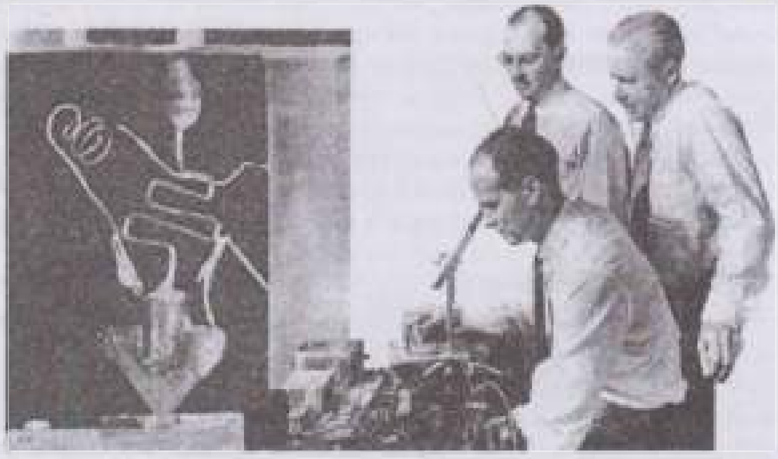

Figure 8 The First Transistor with its Inventors

In 1951, Eckert and Mauchley built the UNIVAC for the Census Bureau. This machine is certainly a fully functional computer. Some mark the beginning of the computer age with this device. It most certainly was the first commercially produced computer for the business world. It stored input/output on magnetic tape. Forty-six of these computers were sold. The first Joint Computer Conference was held this year and the IEEE Computer Society was formed.

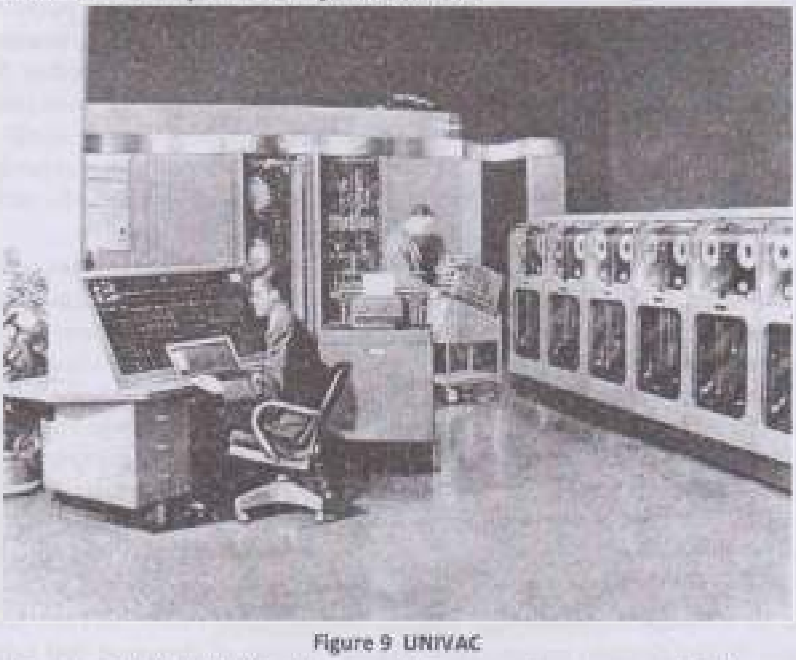

Figure 9 UNIVAC

The UNIVAC was installed at the Bureau of Census using a magnetic tape unit as a buffer memory. Wang Laboratories, Inc was founded by An Wang in Boston, MA., and the Whirlwind computer became operational at MIT. This was the first real-time computer and was designed by Jay Forrester and Ken Olsen. Also in 1951, Grace Murray Hopper invented the notion of a compiler. She detailed it in a report entitled *'The Education of a Computer.'* In this report she described the techniques by which a computer could be used to select (or compile) pre-written code segments to be assembled into programs in correspondence with codes written in a high level language—thus describing the concept of a compiler, and the general concept of language translation. For the next forty years, Hopper was to champion the development of easier ways of solving problems and taking no notice of the doubters who said that "it can't be done." The idea of *"automatic programming"* was born. To that point, all programming had been done in *machine language*, the native language of the computer.

Figure 10 IBM 701

1952 was another significant year for computer history. The first computer manual was written by Fred Gruenberger. IBM introduced the 701 as its first electronic stored-program computer. The Nixdorf Computer was founded in Germany. Remington-Rand bought Engineering Research Associates. RCA developed *Bizmac* with iron-core memory and a magnetic drum. This marked the very first database.It could store 12,000 digits in random access mercury-delay lines. EDVAC, for *Electronic Discrete Variable Computer*, was completed under contract for the Ordinance Department in 1952. Harlan Herrick ran the first successful FORTRAN program in 1954. In the same year Gene Amdahl developed the first operating system which ran on the IBM 704. Kenneth Olsen founded the Digital Equipment Corporation in 1957. In 1958, at Texas Instruments, Jack Kilby completed the building of the first integrated circuit, containing five components on a piece of germanium half an inch long and thinner than a toothpick.

Texas Instruments and Fairchild Semiconductor (constructed by Robert Noyce) both announced the integrated circuit in 1959. In the same year, COBOL (COmmon Business Oriented Language) was invented which was defined by the Conference on Data System Languages (CODASYL). It was based on Grace Hopper's *Flow-Matic*. IBM developed the first automatic mass-production facility for transistors in New York in 1960. In 1961, Fairchild Semiconductor released the first commercial integrated circuit. In 1963, Douglas Engelbart received a patent on mouse, the pointing device for computers.

Timesharing, the concept of linking a large numbers of users to a single computer via remote terminals, was developed at MIT in the late 50s and early 60s. In 1962, Paul Baran of RAND developed the idea of distributed, packet-switching networks. In 1964, Gordon Moore suggested that integrated circuits would double in complexity every year. This later came to be known as the *Moore's Law*. Also in the same year, John Kemeny and Thomas Kurtz developed the BASIC programming language at Dartmouth College. The IBM 360 was introduced in April 1964 and quickly became the standard institutional mainframe computer. By the mid-80s, IBM 360 and its descendents had generated more than $100 billion in revenue for IBM.

In 1968, Douglas C. Engelbart, of the Stanford Research Institute demonstrated his system of keyboard, keypad, mouse, and windows at the Joint Computer Conference in San Francisco's Civic Center. He demonstrated the use of a word processor, a hypertext system, and remote collaborative work with colleagues. Also, in the same year Robert Noyce and Gordon Moore founded the Intel Corporation.

Xerox created its Palo Alto Research Center - Xerox PARC in 1969. Also, in 1969, ARPANET went online. Its mission was to explore the "*architecture of information.*" Fairchild Semiconductor introduced a 256-bit RAM chip in 1970. In the late 1970 Intel introduced a 1K RAM chip and the 4004, a 4-bit microprocessor. Two years later came the 8008, an 8-bit microprocessor.

Figure 11 Bill Gates and Paul Allen

Bill Gates and Paul Allen formed the *Traf-O-Data* in 1971 to sell their computer traffic-analysis system. Steve Jobs and Steve Wozniak were building and selling "*blue boxes*" in Southern California in 1971. In 1972, Gary Kildall wrote PL/M, the first high-level programming language for the Intel microprocessor. In April 1972, Intel introduced the 8008, the first 8-bit microprocessor. Bob Kahn and Vint Cerf developed the basic ideas of the Internet in 1973.

Jonathan A. Titus designed the Mark-8, "*Your Personal Minicomputer,*" according to the July, 1974 cover of *Radio-Electronics*. Also in 1974, Brian Kernighan and Dennis Ritchie developed the C programming language. BBN opened the first public packet-switched network—*Telenet*—in the same year. Popular Electronics featured the MITS Altair 8800 on its cover in January 1975. It was hailed as the first "*personal computer.*" Thousands of orders for the 8800 rescued MITS from bankruptcy. Paul Allen and Bill Gates developed BASIC for the Altair 8800 and Microsoft was born.

1976

Steve Jobs and Steve Wozniak form the Apple Computer Company, on April Fool's Day. Also in the same year, Michael Shrayer completes writing *Electric Pencil*, the first popular word-processing program for microcomputers and Shugart announces its 5.25 inch "minifloppy" disk drive for US$390.

1977

The Apple Computer Company is incorporated. Bill Gates and Paul Allen sign a partnership agreement to officially create the Microsoft Company. Apple Computer delivers its first Apple II system. Microsoft ships "Microsoft FORTRAN" for CP/M-based computers. Apple Computer releases Applesoft, a version of BASIC with floating-point capabilities. It is licensed from Microsoft. Dan Bricklin conceives the idea for the VisiCalc spreadsheet program.

1978

Intel introduces the 4.77 MHz 8086 microprocessor. Microsoft ships Microsoft COBOL. Apple Computer introduces the Disk II, a 5.25" floppy disk drive linked to the Apple II by cable. Epson announces the MX-80 dot matrix printer, which established a new standard in high performance with low price for printers. Taito develops the Space Invaders arcade game in Japan. Commodore introduces the CBM 2020 dot-matrix printer.

1979

Bob Metcalfe founds 3Com Corporation. CompuServe begins a service to computer hobbyists called MicroNET, offering bulletin boards, databases, and games. Microsoft releases its Assembler language for 8080/Z80 microprocessors. Wayne Ratliff develops the Vulcan database program (Ashton- Tate later markets it as dBase II). Personal Software releases VisiCalc for the Apple II, for US$100. The first Comdex show is held, in Las Vegas. Approximately 150 companies show their products to some 4,000 visitors. Alan Shugart founds Seagate Technologies (hard disk maker), in Scotts Valley, California. Apple Computer releases the word processing program AppleWriter 1.0. IBM introduces the IBM 3800 laser printer, capable of printing 20,000 lines per minute. A UUCP link between the University of North Carolina at Chapel Hill and Duke University establishes USENET. The first MUD is also developed at the University of Essex.

1981

MS-DOS runs for the first time on IBM's prototype microcomputer. Microsoft buys all rights to DOS from Seattle Computer Products, and the name MS-DOS is adopted. The first IBM PCs roll off the assembly lines. IBM announces the CGA graphics card for the PC, giving 640 x 200 resolution with 16 colors. Microsoft, Incorporated becomes Microsoft Corporation. Hayes Microcomputer Products advertises the Smartmodem 300, which becomes the industry standard. Seagate Technologies begins shipping its 5 MB 5.25-inch hard drives, for US$1700. A college professor James Clark founds Silicon Graphics, Incorporated.

1982

Compaq Computer Corporation is founded by Rod Canion, Jim Harris, and Bill Murto, all former senior managers of Texas Instruments. Sun Microsystems is founded. "SUN" originally stood for

Stanford University Network. Microsoft releases FORTRAN for MS-DOS. Mitch Kapor founds Lotus Development Corporation. Sun Microsystems begins shipping the Sun 1 workstation computer. Microsoft releases MS-DOS 1.1 to IBM, for the IBM PC. Sony Electronics demonstrates its 3.5-inch microfloppy disk system. Columbia Data Products release the first IBM PC clone, the MPC. Lotus Development announces the Lotus 1-2-3 spreadsheet program at Comdex in Las Vegas. Microsoft releases GW-BASIC, with advanced graphics capabilities. Microsoft releases Microsoft COBOL for MS-DOS. Andrew Fluegelman begins distributing his PC-Talk communications software, the first copyrighted program distributed as shareware. John Warnock founds Adobe Systems. Mouse Systems introduces the first commercial mouse for the IBM PC. TCP/IP (Transmission Control Protocol and Internet Protocol) is established as the standard for ARPANET.

1983

AT&T announces Unix System V. *Time* magazine selects the microcomputer as its "Man" of the Year. Lotus Development ships Lotus 1-2-3 Release 1.0 for MS-DOS. Jonathan Sachs was the programmer, with Mitch Kapor as the software designer. Philippe Kahn founds Borland International. Microsoft introduces Multi-Tool Word for DOS (later renamed Microsoft Word) word processing program at Spring Comdex in Atlanta, Georgia. Microsoft introduces its first mouse, "The Microsoft Mouse." Borland International releases Turbo Pascal for CP/M and 8086-based computers. Microsoft officially releases Microsoft Word 1.0, for US$375, or US$475 with the Microsoft Mouse. IBM and Microsoft begin co-developing OS/2. Syquest introduces its SyQuest storage cartridge system to the PC market. Novell introduces the NetWare network operating system for the IBM PC. Wang announces the single in-line memory module (SIMM). Philips and Sony develop the CD-ROM, as an extension of audio CD technology. Bjarn Stroustrup creates the C++ extension to the C programming language.

1984

Seiko Instruments USA, Inc. displays the first wristwatch computer, with a 10-character, 4-line LCD. Microsoft releases MS-DOS 2.11. It includes enhancements to better allow conversion into different languages and date formats. Silicon Graphics begins shipping its first 3-D graphics workstations. Apple Computer releases the color Apple Scribe printer, using a special waxed ribbon and thermal print head. Quarterdeck Office Systems officially launches DESQ, a text-based windowing environment for running DOS programs. Ashton-Tate ships dBase III. IBM announces its PC Network local area network. IBM announces TopView, a DOS multitasking program. Intel introduces the 80186, 80188, and 80286 processors. Foxbase releases Foxbase for MS-DOS. The Massachusetts Institute of Technology (MIT) begins developing the X Window System

1985

Microsoft introduces Microsoft Excel for the Macintosh, in New York. Lotus Development releases Lotus Jazz for the Macintosh. Aldus releases Aldus PageMaker for the Apple Macintosh. IBM announces its token ring network. Microsoft ships Microsoft Windows 1.0. Ashton-Tate delivers dBase III Plus. IBM announces the PC Network software, its first networking software for PCs. US Robotics introduces the Courier 2400 modem.

1986

Microsoft releases MS-DOS 3.25. Intel ships the 80386. Adobe introduces Adobe Illustrator, a PostScript drawing tool, for the Macintosh. Software Publishing Corporation introduces Harvard

Presentation Graphics for the PC. Gateway 2000 ships its first PC. The Small Computer System Interface (SCSI-1) standard is finalized as ANSI X3.131-1986.

1987

Intel introduces the 20 MHz 80386DX microprocessor. 3M introduces the 2 MB high density 3 1/2-inch diskette. IBM introduces the IBM Personal System/2 (PS/2) line, with IBM's first 386 PC, and 3.5-inch floppy drives as standard. IBM unveils its Video Graphics Array (VGA) in its Model 50 and higher of the PS/2 line. IBM and Microsoft announce Operating System/2 (OS/2). Microsoft announces Microsoft Windows 2.0. Microsoft ships Microsoft Bookshelf, its first CD-ROM application. Lotus Development announces Lotus 1-2-3 for the Macintosh. Microsoft unveils the Microsoft Excel spreadsheet for Windows. Microsoft ships Microsoft Works for DOS. Microsoft releases Microsoft Word 4.0 for the PC. Borland International ships the Quattro spreadsheet program. Hewlett-Packard releases the HP PaintJet color inkjet printer. The number of hosts on the Internet breaks 10,000.

1988

Ashton-Tate releases dBase IV for MS-DOS. Microsoft releases Microsoft PowerPoint for the Macintosh. U.S. Robotics introduces the Courier Dual Standard modem, supporting both v.32 and HST protocols, and the Courier v.32 modem. Hewlett-Packard introduces the HP DeskJet inkjet printer. NEC Technologies introduces the 4.2-pound NEC UltraLite laptop PC, the first "subnotebook." It features a stylus for input, and handwriting recognition. Caere ships the OmniPage OCR software for the Macintosh.

1989

Microsoft releases Quick Pascal, designed to compete with Borland International's Turbo Pascal. The VESA graphics standard emerges, providing a uniform method of accessing SuperVGA chipsets. Microsoft ships SQL Server. Borland International releases the Quattro Pro 2.0 spreadsheet program. Lotus Development ships Lotus Notes. Microsoft ships Word for Windows 1.0. Creative Labs introduces the Sound Blaster, an 8-bit mono PC sound card. The number of hosts on the Internet breaks 100,000.

1991

Microsoft releases Microsoft Excel for Windows 3.0. Apple Computer ships the first TrueType fonts for Macintosh. Microsoft announces the Microsoft BallPoint Mouse, incorporating mouse and trackball technology in a pointing device for laptop computers. Microsoft announces Microsoft Visual BASIC for Windows. Microsoft releases MS-DOS 5.0. It adds a full-screen editor, undelete and unformat utilities, and task swapping. GW-BASIC is replaced with Qbasic, based on Microsoft's QuickBASIC. Microsoft changes the name of OS/2 v3.0 to Windows NT. The ban on business is lifted on the Internet. Apple Computer ships QuickTime 1.0. Hewlett-Packard introduces its first color image scanner, the HP Scanjet IIc. The 400 dpi 24-bit flatbed scanner is priced at about US$2000. Tim Berners-Lee develops the World Wide Web. CERN releases the first web server.

1992

NEC introduces the first double-speed CD-ROM drive. The first version of the VESA VL-Bus standard for PCs is ratified. Borland International ships Quattro Pro for Windows, release 1.0. Microsoft ships Microsoft Windows for Workgroups 3.1, which integrates networking and workgroup functionality. Quark ships QuarkXPress 3.1 for Windows. Microsoft ships Microsoft Access 1.0 database program for

Windows. WordPerfect releases WordPerfect for Windows. Creative Labs introduces the Sound Blaster 16 with Advanced Signal Processor, a 16-bit stereo PC sound card. Hewlett-Packard introduces the HP LaserJet 4 laser printer. The number of hosts on the Internet breaks 1,000,000.

1993

Novell ships UnixWare. Intel releases the final specifications for the PCI standard, for card and socket connectors. Lou Gerstner replaces John Akers as chairman of IBM. Intel introduces the Pentium processor. Microsoft introduces the MS-DOS 6.0. Microsoft ships *Microsoft Encarta*, the first multimedia encyclopedia for a computer. Microsoft releases the OLE 2.0 specification for Windows development. Novell ships NetWare 4.0. Lotus Development ships Lotus Notes Release 3.0. IBM releases OS/2 2.1, now including Windows 3.1 support. Microsoft formally launches Windows NT 3.1. Microsoft begins shipping Windows NT Workstation 3.1, and Windows NT Advanced Server 3.1. Sun Microsystems ships the 60 MHz Sun SuperSPARC processor. Gateway 2000 introduces the industry's first VESA VL-bus system. Cyrix begins shipping the Cx486DX microprocessor. Advanced Micro Devices introduces the 66 MHz Am486DX2. Microsoft ships Windows for Workgroups 3.11. IBM releases OS/2 2.1 for Windows. Microsoft releases MS-DOS 6.2. Microsoft releases Microsoft Word 6.0 for Windows. Novell buys Unix System V. Lotus Development releases Lotus Approach for Windows, Release 2.1. Cyrix ships the Cx486DRx2 processor in 16/32-, 20/40-, and 25/50 MHz versions. The chips are designed to replace Intel 386DX processors, giving 486 compatibility and performance. Microsoft releases FoxPro 2.5 for Windows. The World Wide Web sports a growth rate of 341,634% in service traffic in its third year.

1994

NEC Technologies ships its quad-speed CD-ROM. Microsoft releases Microsoft Windows 3.11. It includes minor driver updates, but more importantly it gives Microsoft the opportunity to include a "certificate of authenticity" hologram sticker on the packaging, making illegal copying more difficult. Microsoft releases MS-DOS 6.21, removing DoubleSpace disk compression. Apple Computer releases System 7.1, the OS for the Mac. Cyrix begins new shipments of the Cx486DX microprocessor, after fixing a flaw in the 32-bit floating-point code. Hewlett-Packard ships the HP DeskWriter 560C color inkjet printer. It features 600 x 300dpi, at a list price of US$720. Hewlett-Packard ships the HP DeskWriter 520 inkjet printer. IBM releases PC-DOS 6.3. Mosaic Communications releases Netscape Navigator 1.0, a web browser. Microsoft releases MS-DOS 6.22, bringing back disk compression under the name DriveSpace. U.S. Robotics ships the Sportster v.34 28.8 Kbps modems. Microsoft announces the name of its upcoming Windows upgrade: Windows 95. Microsoft ships Microsoft Word 6.0 for the Macintosh. IBM formally launches OS/2 Warp version 3. Intel introduces the 75-MHz Pentium processor. Cyrix announces the M1 next-generation x86 processor. Novell ships PerfectOffice 3.0 for Windows. Microsoft releases the FoxPro 2.6 for Windows, UNIX and DOS. Iomega Corp. introduces its Zip drive and Zip disks, floppy disk sized removable storage in sizes of 25 MB or 100 MB. The SCSI-2 standard is finalized as ANSI X3.131-1994. NEC Technologies ships the NEC MultiSpin 4xPro quad-speed CD-ROM drive. The main U.S. Internet backbone traffic begins routing through commercial providers as NSFNET reverts to a research network.

1995

Apple Computer announces the Newton MessagePad 120. Borland International ships Borland Delphi. IBM releases the ThinkPad 701C. It features an automatically expanding full-sized keyboard, dubbed the Butterfly. The laptop features a 10.4 inch thin-film transistor display, 50 MHz Intel 486DX2, 14.4 K fax/modem, and weighs just 4.3 pounds. IBM releases PC DOS 7. Sun Microsystems, Inc., announces Java. Lotus Development renames Ami Pro to Word Pro. Intel releases the mobile version of the 90-MHz Pentium processor. Intel introduces the P6 processor. IBM buys Lotus Development for US$3.5 billion in cash. Intel announces the immediate availability of the 133 MHz Pentium processor. Iomega introduces the Jaz line of high-capacity removable cartridge drives. The cartridges hold 1 gigabyte, costing about US$100 each. Transfer rate of the drive is up to 5 MBps. US Robotics begins shipping enhanced Courier V-Everything modems capable of transmitting data at up to 33.6 Kbps. Cyrix announces the 100 MHz CX5x86 microprocessor. Lotus Development ships SmartSuite 4.0 for Windows 3.1. Microsoft releases Windows 95. Intel demonstrates a system using a 150 MHz P6 CPU, running Windows 95. Microsoft begins shipping Windows NT Server 3.51. Compaq Computer introduces nine new desktop models based on the 133-MHz Pentium processor. Microsoft introduces Microsoft Office 95. Microsoft releases Microsoft Internet Explorer 1.0. Cyrix announces the 100 MHz CX6x86 microprocessor. Intel announces the Pentium Pro microprocessor, at speeds of 150-, 180-, and 200 MHz. Intel destroys 1.5 million flawed Pentium chips, at a rough cost of US$475 million. Microsoft releases FoxPro 3.0 for Windows, with OLE support. Sega introduces the 32-bit game system, Saturn. The first and only international conference on Year 2000 problem takes place.

1996

The World's first Fair on Internet—The Internet 1996 World Exposition—is held. Advanced Micro Devices and NexGen complete their merger, with AMD paying US$623 million for NexGen. Intel announces the immediate availability of the 60/150 MHz Pentium processor. Intel announces the immediate availability of the 66/166-MHz Pentium P55C processor. IBM releases OS/2 for the PowerPC. Compaq announces the Scanner Keyboard, which incorporates a color page scanner into an otherwise normal keyboard. Cyrix announces volume availability of the 110 MHz P133+ CX6x86 and 60/120 MHz P150+ CX6x86 microprocessor. Cyrix announces limited availability of the 66/130 MHz P166+ CX6x86 microprocessor. IBM ships OS/2 Warp Server. Apple Computer licenses the Mac OS to Motorola. Intel releases the 133 MHz Pentium processor for notebook computers. Advanced Micro Devices begins shipping the AMD5K86 microprocessor. Corel releases Corel WordPerfect Suite 7, and Corel Office Professional Suite. Netscape Communications releases Netscape Navigator 2.02. Microsoft releases Microsoft Internet Explorer 2.0. Intel introduces the 200 MHz Pentium processor. Cyrix introduces the 6x86-P200+ processor. Advanced Micro Devices begins shipping the K5-PR100 microprocessor. It is a 100 MHz Pentium-compatible plug-in replacement. Intel begins shipping the 200 MHz Pentium Pro with a 512 KB cache. Microsoft releases Windows NT 4.0. Microsoft releases OEM Service Release 2 for Windows 95. Microsoft releases Microsoft Internet Explorer 3.0. Intel releases the 150 MHz mobile Pentium processor, designed for use in portable computers. Microsoft unveils Windows CE operating system for hand-held PCs. IBM launches OS/2 Warp 4, in San Francisco, California. Microsoft ships the Visual J++ Professional Edition development kit. Hitachi Home Electronics ships the Hitachi Handheld PC, running Windows CE. Casio Computer ships the Cassiopeia, a hand-held computer running Windows CE. Microsoft unveils Microsoft Office 97 at Fall Comdex. Intel begins shipping the 200 MHz Pentium Pro processor. At the Microprocessor Forum, Cyrix announces the M2 processor, optimized for 16- and 32-bit code, supporting MMX, and including 64 KB cache memory. The chip will plug into a standard Pentium socket. Panic hits as industry finally realizes the consequences of the Y2K problem, more than 50 international conferences on Year 2000 problem takes place.

1997

Microsoft buys WebTV for US$425 million. Microsoft releases Internet Explorer 4.0. Lotus Corporation announces Lotus Domino 4.5. Compaq ships the 4000N NetPC. Oracle Corporation introduces the first commercial object-relational database—Oracle8. Y2K conversion efforts gain momentum as more and more companies joins the Y2K conversion efforts.

1998

Microsoft releases Windows 98. Compaq Computer Corporation acquired Digital Equipment Corporation. Y2K conversion efforts are going ahead at full speed, yet experts predict full conversion will not be possible.

1999 ONWARDS

The history computing and the developments in the last 10 years is well documented and can be found by searching the internet or reading books that deals with the history of computing. We leave that delightful task of exploration to you.

- Some of the references that will help you are:
- The History of Computing (http://ei.cs.vt.edu/~history/)
- History of Computing Project (http://www.thocp.net/)
- History of Computing Information (http://ftp.arl.army.mil/~mike/comphist/)
- IEEE Annals of the History of Computing (http://www.computer.org/portal/site/annals/)

Note: This chronology of events in the history of computing and computer is by no means exhaustive and complete. We have omitted many events, people, personalities, machines, products and organizations that have played important roles in the history of computing. The computing as we see it now would not have been possible without those magnificent men and their wonderful ideas and machines. The omission is not due to lack of respect to them, but due to space constraints. We hope, you as students will explore more and get an in-depth knowledge about the events and people that have changed the world that we live in.

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