UNIT 1 COMPUTER THEIR ORIGIN AND APPLICATIONS

Structure **Page No.**

1.0 INTRODUCTION

Computer is an electronic device which performs three basic tasks i.e. inputting, processing and outputting

Perhaps Computer is the most powerful and versatile tool created by human beings. In today's scenario, computer plays a major role in almost every aspect of life and influences our lives in one way or the other. Today, you can hardly find any area which is not influenced by computer. The word computer comes from the word "compute" which means to calculate. Computer is also meant for calculation but it is much more than just a calculating machine. Computer is an electronic device which performs three basic tasks i.e., inputting, processing and outputting. A computer accepts the input through various input devices. After receiving the input data, computer performs different operations required by the user on these input. Finally, computer generates the resultant of the processed data as the output through various output devices. Hence, a computer is a data processing device. This unit will provide details about computers, its origins and also descriptions about computer's different components, their applications and some current hardware platforms of computer.

Since, computer is vastly used for making calculations or controlling operations that are expressible in numerical or logical terminology yet the development of computer started from Abacus and its journey of development is still going on. This unit also focuses on major development during different periods.

1.1 OBJECTIVES

After studying this unit, you should be able to understand:

- the basic concepts about computer's origin and development;
- functions of computer;
- role & current applications of computer in various field; and
- limitations of a computer.

1.2 ORIGIN OF COMPUTERS

Origin of computer could be rigorous efforts of men to count large numbers. This process of counting of large numbers generated various systems of numeration like Babylonian system of numeration, Greek system of numeration, Roman system of numeration and Indian system of numeration. Out of these the Indian system of numeration has been accepted universally. It is the basis of modern decimal system of numeration 0-9.

1.2.1 Abacus

Nearly 5,000 years ago, the "abacus" was developed in China in 3000 B.C. The word abacus means calculating board. The "abacus" may be considered the first computer and it has been used since ancient times by a number of civilizations for basic arithmetical calculations. A modern form of abacus is given in Figure 1.1.

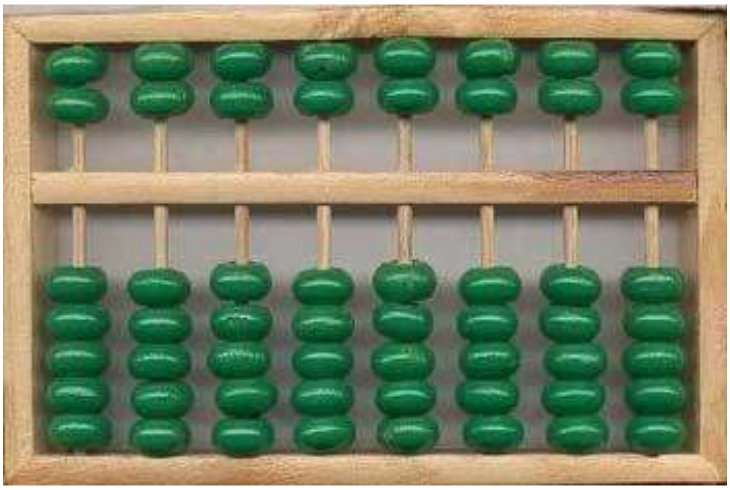

Figure 1.1: Abacus

The abacus is also called a counting frame, which is a calculating tool for performing arithmetic operations. The Chinese abacus has a frame holding vertical wires, with seven beads on each wire. A horizontal divider separates the top two beads from the bottom five, sometimes referred to as the heaven and the earth beads. The arithmetic calculations are performed by manipulating the beads by using the principle of positional weight of beads on a rack. Abacus is used even today to teach small children how to count. A skilled abacus operation can be as fast as a hand held calculator.

1.2.2 Napier's Bones

John Napier was a mathematician who became famous for his invention of logarithms. The used of "logs" enabled him to reduce any multiplication problem. John Napier built a mechanical device for the purpose of multiplication in 1617 A.D. The device was known as Napier's bones. His "bones" are set of eleven rods side by side products and quotients of large numbers can be obtained. The sticks were called "bones" because they were made of bone of ivory.

1.2.3 Slide Rule

English mathematician E. Gunter developed the slide rule. This machine could perform operations like addition, subtraction, multiplication, and division. Although the slide rule appeared in various forms during the seventeenth century, it consists of two movable rulers placed side by side. Each ruler is marked off in such a way that the actual distances from the beginning of the ruler are proportional to the logarithms of the numbers printed on the ruler. By sliding the rulers, one can quickly multiply and divide.

1.2.4 Pascal's Calculator

Blaise Pascal was a French mathematician and one of the first modern scientists to developed and build calculator. He developed a machine at the age of 19 that was capable of adding and subtracting numbers. The machine was operated by dialing a series of wheels, gears and cylinders.

1.2.5 Leibniz's Multiplication and Dividing Machine

Like Pascal, Gottfried Leibniz was a seventeenth century scientist who recognized the value of building machines and built around 1673 a mechanical device that could do mathematical calculations and save labor too.

1.2.6 Difference Engine

The first step towards the creation of computers was made by an English mathematics professor, Charles Babbage. Early on, he realized that all mathematical calculations can be broken up into simple operations which are then constantly repeated, and that these operations could be carried out by an automatic machine. In the 1820s Charles Babbage started working on a 'Difference Engine', but after ten years he abandoned it for the 'Analytical Engine' – the real predecessor of the Computer.

Babbage outlined the basic elements of a modern general purpose computer which was based on the method of finite differences. It uses only arithmetical addition and removes the need for multiplication and division which are more difficult to implement mechanically. Charles Babbage is called the father of the computer.

1.2.7 The Analytical Engine

The Analytical Engine marks the progression from the arithmetic calculation to general-purpose computation. It was also developed by Charles Babbage. This machine was based on the principle that, for certain formulas, the difference between certain values is constant. The Analytical Engine has many essential features found in the modern digital computer.

The Engine had a 'Store' (memory) where numbers and intermediate results could be held, and a separate 'Mill' (processor) where the arithmetic processing was performed. It had an internal stock of the four arithmetical functions and could perform direct multiplication and division. It was also capable of functions like: conditional branching, looping (iteration), microprogramming, parallel processing, latching, and polling etc. The logical structure of the Analytical Engine was essentially the same as that which has dominated computer design in the electronic era.

1.2.8 Mechanical and Electrical Calculator

In the beginning of 19^{th} century, the mechanical calculator was developed to perform all sorts of mathematical calculations. Up to the 1960s, it was widely used. Later the rotating part of mechanical calculator was replaced by electric motor. So it was called the electrical calculator.

1.2.9 Modern Electronic Calculator

The electronic calculator used in 1960s was run with electron tubes, which was quite bulky. Later it was replaced with transistors and as a result the size of calculators became fairly small. The modern electronic calculator can compute all kinds of mathematical computations and mathematical functions. It can also be used to store some data permanently. Some calculators have in-built programs to perform some complicated calculations. Modern electronic calculators contain a keyboard with buttons for digits and arithmetical operations. These calculators can perform sophisticated arithmetic and financial computations such as converting from polar to rectangular coordinates, taking square roots, computing logarithms and trigonometric relationships.

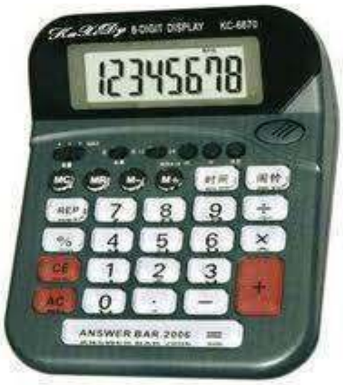

Figure 1.2: Electronic Calculator

1.3 COMPUTER GENERATIONS

The evolution of computer started from 16th century and resulted in today's modern machines. The present day computer, however, has also undergone rapid change over the years. This period, during which the evolution of computer took place, can be divided into five distinct phases known as Generations of Computers. Each new generation of computers is not only superior from their predecessor in processing and capabilities but also differs in looks and sizes. Each phase is distinguished from others on the basis of the type of switching circuits used. These Generations are:

The period, during which the evolution of computer took place, can be divided into five distinct phases known as generations of computers

- First Generation Computers (1940-1956)
- Second Generation Computers (1956-1963)
- Third Generation Computers (1964-1971)
- Fourth Generation Computers (1971-Present)
- Fifth Generation Computers (Present and Beyond)

1.3.1 First Generation Computers: Vacuum Tubes (1940-1956)

First generation computers are characterized by the use of vacuum tube

First generation computers are characterized by the use of vacuum tube. A vacuum tube was a fragile glass device, which used filaments as a source of electronics. It could control and amplify electronic signals. These vacuum tubes were used for calculation as well as storage and control. The first general purpose programmable electronic computer was the Electronic Numerical Integrator and Computer (ENIAC), built by J. Presper Eckert and John V. Mauchly at the University of Pennsylvania. The ENIAC was 30-50 feet long, weighed 30 tons, contained 18,000 vacuum tubes, 70,000 registers, 10,000 capacitors and required 150,000 watts of electricity. First generation computers were too bulky in size which required large room for installation and they used to emit large amount of heat, so air-condition was must for the proper working of computers. Programs written in high level programming languages retranslated into assembly language or machine language by a compiler. Assembly language program retranslated into machine language by a program called an assembler (assembly language compiler).

Before ENIAC was finished, Von Neumann designed the Electronic Discrete Variable Automatic Computer (EDVAC) with a memory to hold both a stored program as well as data. This enabled much faster operation since the computer had rapid access to both data and instructions. The other advantages of storing instruction were that computer could do logical decision internally. Eckert and Mauchly later developed what was arguably the first commercially successful computer, the Universal Automatic Computer (UNIVAC), in 1952.

Examples: ENIAC, EDVAC, UNIVAC-1

1.3.2 Second Generation Computers: Transistors (1956-1963)

Second generation computers are characterized by the use of transistors

Solid-State components (transistors and diodes) and magnetic core storage formed the basis for the second generation of computers. Transistor is a device composed of semiconductor material that amplifies a signal or opens or closes a circuit. Invented in Bell Labs, transistors have become the key ingredient of all digital circuits, including computers. Transistor replaced the bulky electric tubes in the first generation computer. Transistors perform the same functions as a vacuum tube, except that electrons move through solid materials instead of through a vacuum. Transistors were made of a semi-conducting material and controlled the flow of electricity through the circuit. They also allowed computers to become smaller and more powerful and faster at the same time. They are also less expensive, required less electricity and emitted less heat than vacuum tubes. Manufacturing cost was also very low.

It is in the second generation that the concept of Central Processing Unit (CPU), memory, programming language and input and output units were developed. Second-generation computers moved from cryptic binary machine language to symbolic, or assembly, languages, which allowed programmers to specify instructions in words. These were also the first computers that stored their instructions in their memory, which moved from a magnetic drum to magnetic core technology. During the second generation many high level programming languages were introduced, including FORTRAN (1956), ALGOL (1958) and COBOL (1959).

Examples: PDP-8, IBM1400 series, IBM 1620, IBM 7090, CDC 3600

Third generation computers are characterized by the use of integrated circuits (ICs)

1.3.3 Third Generation Computers: Integrated Circuits (1964-1971)

The third generation computers were introduced in 1964. Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers. They used Integrated Circuits (ICs). The development of

ICs proved to be a milestone in the field of computer and electronics. These ICs are popularly known as chips.
Silicon is the basic material used to make computer chips, transistors, silicon diodes and other electronic circuits and switching devices because its atomic structure makes the element an ideal semiconductor. Silicon is commonly doped, or mixed, with other elements, such as boron, phosphorous and arsenic, to alter its conductive properties. A typical chip is less than ¼-square inches and can contain millions of electronic components (transistors). Computers consist of many chips placed on electronic boards called printed circuit boards. There are different types of chips. For example, CPU chips (also called microprocessors) contain an entire processing unit, whereas memory chips contain blank memory.

A single IC, has many transistors, registers and capacitors built on a single thin slice of silicon. Development in ICs ranges from small scale integration (SSI) to medium scale integration (MSI). Multilayered printed circuits were developed and core memory was replaced by faster, solid state memories. The IC technology was also known as "microelectronics" technology, since large number of circuit could be integrated on a single chip.

Computers of this generation were small in size, low cost, large memory and processing speed is very high. Higher level language such as BASIC (Beginners All purpose Symbolic Instruction Code) was developed during this period. Integrated solid-state circuitry, improved secondary storage devices, and new input/output devices were the most important advantages in this generation. The new circuitry increased the speed of the computer. Arithmetic and logical operations were now being performed in microseconds or even nanoseconds. The development of mini computers also took place during this generation.

Examples: NCR 395, B6500, IBM 360,370

1.3.4 Fourth Generation Computers: Microprocessors (1971-Present)

Fourth generation computers started around 1971 by using large scale of integration (LSI) in the construction of computing elements. LSI circuits built on a single silicon chip called microprocessors. A microprocessor contains all the circuits required to perform arithmetic, logic and control functions on a single chip. Because of microprocessors, the fourth generation includes more data processing capacity than equivalent-sized third generation computers. Due to the development of microprocessor it is possible to place computer's central processing unit (CPU) on single chip. These computers are called microcomputers. Later very large scale Integrated (VLSI) circuits replaced LSI circuits. What in the first generation filled an entire room could now fit in the palm of the hand. The Intel 4004chip, developed in 1971, located all the components of the computer - from the central processing unit and memory to input/output controls - on a single chip.

Fourth generation computers are characterized by the use of microprocessor

The major innovations in this generation were the development of microelectronics and the different areas in computer technology such as multiprocessing, multiprogramming, time-sharing, operating speed, and virtual storage. During this period, high speed vector processors changed the scenario of high performance computing. Mostly microcomputers and workstations were introduced for time shared mainframe computers. Thus the computer which was occupying a very large room in earlier days can now be placed on a table. The personal computer is a Fourth Generation Computer. It is the period when evolution of computer networks also took place.

Examples: Apple II, Alter 8800

1.3.5 Fifth Generation Computers (Present and Beyond)

Fifth generation computers are based on Artificial Intelligence

Fifth generation computers, based on artificial intelligence, are still in development, though there are some applications, such as voice recognition, that are being used today. Artificial Intelligence is the branch of computer science concerned with making computers behave like humans and allow the computer to take its own decision. Currently, no computers exhibit full artificial intelligence (that is, are able to simulate human behavior). The greatest advances have occurred in the field of games playing. The best computer chess programs are now capable of beating humans. Today, the hottest area of artificial intelligence is neural networks, which are proving successful in an umber of disciplines such as voice recognition and natural-language processing. There are several programming languages that are known as AI languages because they are used almost exclusively for AI applications. The two most common are LISP and Prolog.

The speed is extremely high in fifth generation computer. In the development of Fifth generation computers, parallel processing attended the main focus of developers. Until this time, parallelism was limited to pipelining and vector processing. This generation introduced machines with hundreds of processors that could all be working on different parts of a single program. Developments of more powerful computers are still in progress. It has been predicted that such a computer will be able to communicate in natural spoken language with its user, store vast knowledge databases, search rapidly through these databases, making intelligent inferences, drawing logical conclusions, image processing and see objects in the way that humans do.

Table 1.1 shows the comparative features of five generations of computers:

Table 1.1 : Features of five Generations of Computers

Criteria	First Generation Computer	Second Generation Computer	Third Generation Computer	Fourth Generation Computer	Fifth Generation Computer
Technology	Vacuum Tube	Transistor	Integrated Circuit	Microprocessor	Artificial Intelligent
Speed	Slowest	Slow	Medium	Faster	Fastest
Size	Largest	Large	Medium	Smaller	Smallest
Reliability	Unreliable	Less Reliable	More Reliable	More Reliable	More Reliable
Operating System	None	None	Yes	Yes	Yes
Language	Machine	Assembly	High Level	High Level	High Level
Period	1940-1956	1956-1963	1964-1971	1971-Present	Present and Beyond

☞ **Check Your Progress 1**

1) What is a computer ? Why is it known as data processor ?

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2) Into how many generations the evolution of computer is divided?

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1.4 COMPUTER SYSTEM

Each computer consists of a series of devices that together operate as an integrated unit or computer system. The processor is made up of the memory, arithmetic, logic and control units. A large computer system will normally have one or more auxiliary units, where input and output data are stored. A brief description of computer system is given here. More detailed study about this will be covered in unit 2 in this block.

1.4.1 How Computers Work ?

Input: This is the process of entering data and programs in to the computer system. Since computer is an electronic machine like any other machine which takes as inputs raw data and performs some processing giving out processed data, the input unit takes data from user to the computer in an organized manner for processing. Information and programs are entered into the computer through input devices such as the keyboard, disks, or through other computers via network connections or modems connected to the internet.

Storage: The process of saving data and instructions permanently is known as storage. Data has to be fed into the system before the actual processing starts. It is because the processing speed of Central Processing Unit (CPU) is so fast that the data has to be provided to CPU with the same speed. Therefore the data is first stored in the storage unit for faster access and processing. This storage unit or the primary storage of the computer system is designed to do the above functionality. It provides space for storing data and instructions. The storage unit performs the following major functions:

(a) All data and instructions are stored here before and after processing.

(b) Intermediate results of processing are also stored here.

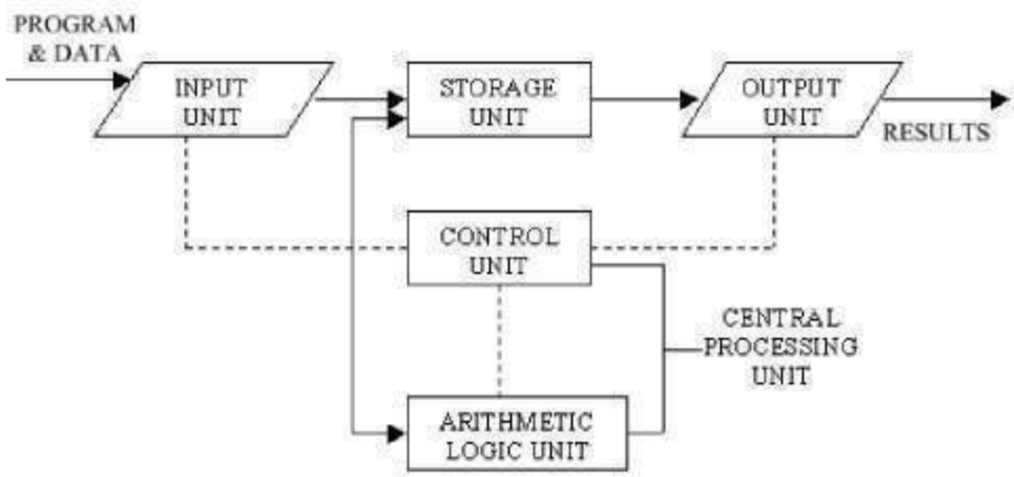

Figure 1.3 : Basic Computer Operations

Processing: The task of performing operations like arithmetic and logical operations is called processing. The CPU or central processing unit takes data and instructions from the storage unit and makes all sorts of calculations based on the instructions given and the type of data provided. It is then sent back to the storage unit. The coprocessor or the arithmetic-logic unit does arithmetic and logical operations. The RAM temporarily stores information.

Output: This is the process of producing results from the data for getting useful information. Output devices display information on the screen (monitor) or the printer and sends information to other computers. They also display messages about what errors may have occurred and brings up message or dialog box asking for more information to be input. Again the output is also stored inside the computer for further processing.

Figure 1.4 : Computer

1.4.2 Operational Unit

In order to carry out the operations, the computer allocates the task among its various operational units. These are 1) arithmetic logical unit, 2) control unit, and 3) central processing unit.

Arithmetic Logical Unit (ALU)

The Arithmetic Logical Unit is an important component of the CPU, which carry the actual execution of the instructions. After entering the data through the input device it is stored in the primary storage unit. Then processing of the data and instruction are performed by Arithmetic Logical Unit. The major operations performed by the ALU are addition, subtraction, multiplication, division, logic and comparison. Data is transferred to ALU from storage unit when required. After processing, the output is returned to the storage unit for further processing or getting stored.

Control Unit (CU)

The next component of computer is the Control Unit, which acts like the supervisor seeing that things are done in proper fashion. The control unit determines the sequence in which computer programs and instructions are executed. Things like processing of programs stored in the main memory, interpretation of the instructions and issuing of signals for other units of the computer to execute them. It also acts as a switch board operator when several users access the computer simultaneously. Thereby it coordinates the activities of computer's peripheral equipment as they perform the input and output. Therefore, it is the manager of all operations mentioned in the previous section.

Central Processing Unit (CPU)

The ALU and the CU of a computer system are jointly known as the central processing unit. The term CPU relates to a specific chip or the processor. CPU may be considered as the brain of any computer system. It is just like brain that takes all major decisions, makes all sorts of calculations and directs different parts of the computer functions by activating and controlling the operations. The fundamental operation of most CPU is to execute a series of instructions called as a program. The different chip manufacturers use different measuring standards to measure the processor's speed. It depends on the circuit board that the chip is housed in, or the motherboard. The motherboard contains the circuitry and connections that allow the various components to communicate with each other.

The ALU and the CU of a computer system are jointly known as the central processing unit (CPU)

1.4.3 System Unit

A computer system unit contains many parts :

Ports and Connectors : A port is a connector located on the motherboard or on a separate adapter. Ports and Connectors allow the computer to communicate with different devices and peripherals attached with it.

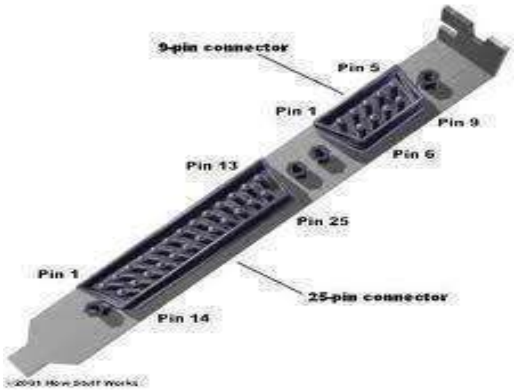

Figure 1.5 : Connector

Power Supply : Power supply changes normal household electricity into electricity that a computer can use. A power supply or power supply unit (PSU) is an internal component used to supply the power to the components of a computer. Power supply is rated by the number of watts it generates.

Figure 1.6: Power Supply

Motherboard : The motherboard is the main circuit board of a microcomputer. It is also known as the main board or system board. It is the circuit board in which all the components are connected through cable within a personal computer. Many devices are connected with motherboard directly or indirectly. Motherboards usually provide the interface between the CPU memory and input/output peripheral circuits, main memory, and facilities for initial setup of the computer immediately after power-on.

1.4.4 Von Neumann Architecture

Mathematician John Von Neumann conceived a computer architecture which forms the core of nearly every computer system in use today

Mathematician John Von Neumann conceived a computer architecture which forms the core of nearly every computer system in use today. This architecture is known as Von Neumann architecture. It is a design model for the modern computers which has central processing unit (CPU) and the concept of memory used for storing both data and instructions. This model implements the stored program concept in which the data and the instructions both are stored in the memory. All computers share the same basic architecture which have memory, an I/O system, arithmetic logic unit (ALU) and control unit (CU).

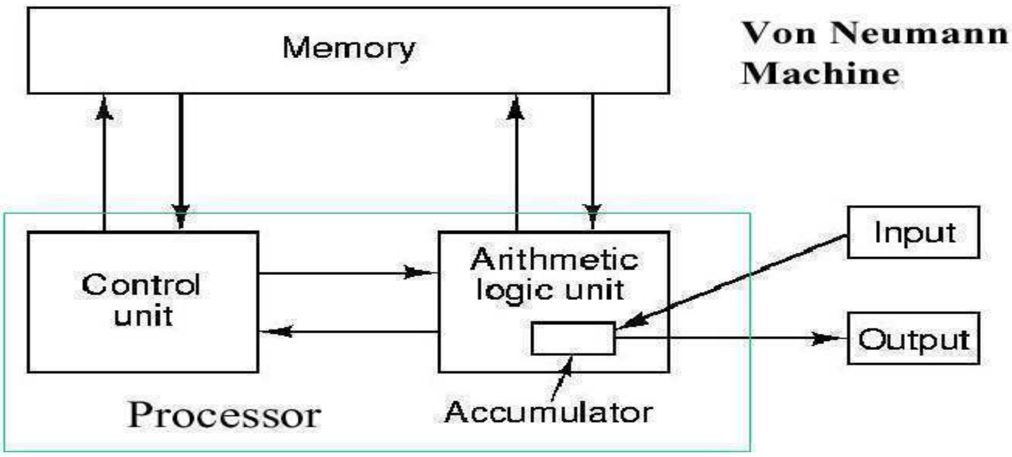

Figure 1.7 : Von Neumann architecture

1.4.5 Classification of Computers

Computers are available in different sizes, shapes, and weights. Due to these different sizes and shapes, they perform different sort of jobs from one another. They can be classified in different ways. All the computers are designed by qualified computer architects who design these machines as per different requirements. A computer that is used in a home differs in size and shape from the computer being used in a hospital. Following sections are going to describe different classifications of computers. The term "capacity" refers to the volume of work or the data processing capacity a computer can handle. Their performance is judged by the:

1. Amount of data that can be stored in memory
2. Speed of internal operation of the computer
3. Number and type of peripheral devices
4. Amount and type of software available for use with the computer

The capacity of early generation computers were determined by their physical size- the large the size, the greater the volume. In computer terms, size and speed of operation are at present proportionate to each other. Generally, though, recent, technology is tending to create smaller machines, making it possible to package equivalent speed and capacity in a smaller format.

Microcomputers: The mass production of silicon chips since 1971 has made it possible to put a "brain" into all sorts of machines. One such machine is the microcomputer. This machine has taken fullest advantage of the use of large-scale integration on silicon chips. The microprocessors literally contain a computer on a chip that can pass through the eye of needle. Microcomputers memories are generally made of semiconductors fabricated on silicon's chips. It is a digital computer system under the control of a stored program that uses a microprocessor, a programmable read-only memory (ROM), and a random-access memory (RAM). The ROM defines the instructions to be executed by the computer while RAM is the functional equivalent of computer memory. Today microcomputers are called as Personal Computers more commonly as PCs. These are small, relatively inexpensive computers designed for personal use in home or offices.

Minicomputers: Technological advances in the 1960's enabled manufactures to respond to the growing demand for a similar stand-alone machine, the minicomputer, to handle task that large computers could not perform economically. Minicomputer systems (or small mainframe computers) provide faster operating speeds and larger storage capacities than microcomputers systems. These Computers can support a large number of high-speed input/output devices. Several desk drives can be used to provide online access to large data files as required for direct - access processing. Operating system developed for minicomputer systems generally support both multiprogramming and virtual storage. This means that many programs can be run concurrently. This type of computer system is very flexible and can be improvised to meet the needs of users. Although the minicomputer is not as powerful as the medium or large-size computer, it is quite close.

Medium-size Computers : It provides faster operating speeds and larger storage capabilities than small computer systems. These Computers can support a large number of high-speed input-output devices, and several disk drives can be used to provide online access processing. The possibility of increasing the data processing capability of a computer by adding devices, such additional memory, and other peripheral devices, is called expandability.

Large Computers : These Computers are the ultimate in flexibility and speed. These usually contain full control systems with minimal operator intervention. Large computer systems range from single-processing configurations to nationwide computer based networks involving general large computers. Large computers have internal operating speeds measured in terms of nanoseconds, as a compared to smaller computers where speed in terms of microseconds.

Mainframe Computers : Mainframes are huge, multi-user systems designed to process millions of instructions per second and capable of accessing billions of data. They can handle gigantic processing jobs in large corporations or government agencies. This computer is commonly used in big hospitals, air line reservations companies and many other huge companies prefer mainframe because of its capability of retrieving data on huge basis. Mainframe allows its user to maintain large information storage at a centralized location and be able to access and process this data from different computers located at different locations.

Mainframe computers are normally too expensive and out of reach from a salaried person who wants this computer for his home. Mainframe is the second largest in capability and size of computer family.

Supercomputers : The most expensive in price, biggest and fastest machines today are the supercomputers that are used when billions or even trillions of calculations are needed. Supercomputers are ultra fast computers designed to process huge amounts of scientific data then display the underlying patterns that have been discovered. These machines are essential for applications ranging from nuclear weapon to accurate weather forecasting. Super Computers are used for highly calculation-intensive tasks such as molecular modeling, climate research, weather forecasting, quantum physics, physical simulations etc.

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Supercomputers are machines that have speed in the 100-million-instructions-per-second range. Governments specially use this type of computer for their different calculations and heavy duty. Different industries also use this huge computer for designing their products. It is also used for animation purpose. The PARAM supercomputer is one of the supercomputer developed by India’s Center for Development of Advanced Computing(C-DAC) and promises processing speeds of up to 1 trillions instructions per second. Since October 2010, the Tianhe-1A supercomputer is considered as the fastest supercomputer in the world which is located in China. Some of the examples of Supercomputer are: IBM Blue Gene/L, IBM Roadrunner, Cray Jaguar etc.

1.4.6 Classification by Technology

There are essentially two different types of computer processing. Each is made possible by a different kind of circuitry, and each is suitable for different purposes.

Analog Computers: The name analog comes from the word "analogous", meaning similar. Analog signal is a continuous signal whose amplitude can take any value in a continuous range. It can have infinite number of values. Analog computers deal with quantities that are continuously variable. They give only approximate results. These types of computer provide an analog or simulation of the object or system it represents. It is especially useful for solving problems that involve relationships between variable quantities in systems that change with time. The analog compute may express changing relationships in output in the form of graphs. It is able to create such pictures because it responds to changes in electrical voltages that match changes in variable quantities.

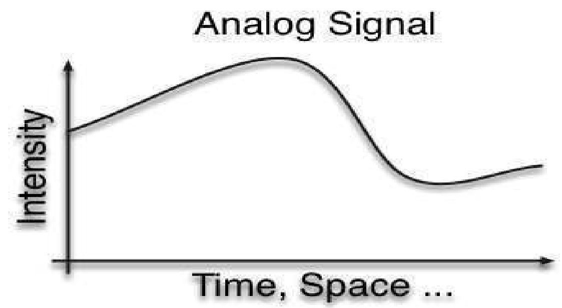

Figure 1.8: Analog Signal

Digital Computers : It is a machine that specializes in counting. It operates by counting values that are discrete, or separate and distinct, unlike the continuous quantities that can be measured by the analog computer. Digital signal is a discrete time signal that has a discrete number of levels. It can only assume one of the two values 0 or 1. While analog technology uses continuous signals, digital technology encodes the information into discrete signal states. Digital Computers are used for both business data processing and accuracy. The basic operation performed by a digital computer is addition. It can store the sums of addition problems as they accumulate, and can complete a single calculation in a fraction of a nanosecond. The digital computer is capable of storing data as long as needed, performing logical operations, editing input data, and printing out the results of its processing at high speed. Advantages of digital systems include flexible processing, easy to design, accuracy and precision, simple operation, easy data storage, less prone to noises etc.

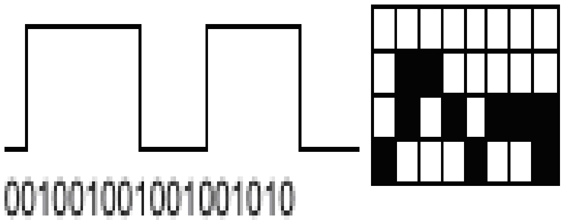

Figure 1.9: Digital Signal

Hybrid Computers: Although both analog and digital computers are extremely used and widely accepted in various industries, manufacturers have to attempt to design a computer that combines the best features of both types. This special-purpose machine called a hybrid computer which combines the measuring capabilities of the analog computer and the logical and control capabilities of the digital computer. It offers an efficient and economical method of working out special types of problems in science and various areas of engineering. Some Hybrid machines contain special equipment to convert analog voltages into digital voltages, and vice-versa.

☞ **Check Your Progress 2**

1) Distinguish between Microcomputer and Mainframe computer.

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2) What are the five basic operations performed by the computer?

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3) How can you classify computers according to technology?

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1.5 INTEGRATED CIRCUITS

Our world is full of integrated circuits (semiconductor devices with several transistors built into one physical component). It is an electronic circuit which involves thousands or millions of interconnected components like transistors, diodes and resistors. They are usually called ICs. We can find several of them in computers. For example, most people have probably heard about the microprocessor. The microprocessor is an integrated circuit that processes all information in the computer.

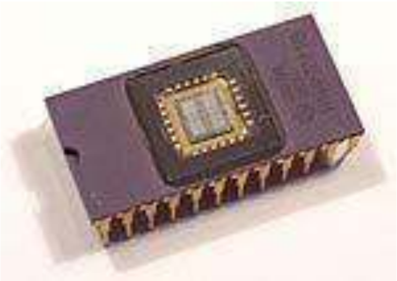

Figure 1.10: Chip

It keeps track of what keys are pressed and if the mouse has been moved. It counts numbers and runs programs, games and the operating system. The first integrated circuits (ICs) were based on small scale integration (SSI) circuits, which had around 10 devices per circuit (or ‘chip’), and evolved to the use of medium-scale integrated (MSI) circuits, which had up to 100 devices per chip. Integrated circuits are also found in almost every modern electrical device such as cars, television sets, CD players, cellular phones, etc. The main benefits of ICs are lower costs, high reliability and smaller space requirements. But what is an integrated circuit and what is the history behind it?

1.5.1 Electronic Circuits

The integrated circuit is nothing more than a very advanced electric circuit. An electric circuit is made from different electrical components such as transistors, resistors, capacitors and diodes, which are connected to each other in different ways. It is an unbroken loop of conductive material that allows electrons to flow continuously. If a circuit is “broken”, its conductive elements will no longer form a complete path and continuous electron flow cannot occur. The transistor acts like a switch. It can turn electricity on or off, or it can amplify current. It is used for example in computers to store information.

The resistor limits the flow of electricity and gives us the possibility to control the amount of current that is allowed to pass. For example resistors are used, among other things, to control the volume in television sets or radios.

The capacitor collects electricity and releases it all in one quick burst. The diode stops electricity under some conditions and allows it to pass only when these conditions change. This is used in, for example, photocells where a light beam that is broken triggers the diode to stop electricity from flowing through it.

The flashlight is an example of electric circuits. It contains electrical energy (dry cells) as a source, a load (the bulb) which changes the electrical energy into light and a switch to control the energy delivered to the load.

1.5.2 The Transistor vs. the Vacuum Tube

The transistor is the most important one for the development of modern computers. Before the transistor, engineers had to use vacuum tubes. Just as the transistor, the vacuum tube can switch electricity on or off, or amplify a current. So why was the vacuum tube replaced by the transistor? There are several reasons.The vacuum tube looks and behaves very much like a light bulb; it generates a lot of heat and has a tendency to burn out. Also, compared to the transistor it is slow, big and bulky. When engineers tried to build complex circuits using the vacuum tube, they quickly became aware of its limitations. The first digital computer ENIAC, for example, was a huge monster that weighed over thirty tons, and consumed 200 kilowatts of electrical power. It had around 18,000 vacuum tubes that constantly burned out, making it very unreliable. When the transistor was invented in 1947 it was considered a revolution. Small, fast, reliable and effective, it quickly replaced the vacuum tube.

1.6 OPERATING SYSTEM

Operating system is a program that acts as an interface between user of computer and the computer hardware

All computers need some sort of hardware platform to run the software; these platforms are called Operating System (OS). Operating system is a program that acts as an interface between user of computer and the computer hardware. The purpose of an operating system is to provide an environment in which user can execute program in a convenient and efficient manner. Operating system is an important part of almost every computer system. It manages all resources of computer system. Operating system is installed in secondary memory, while it's some part are stored permanently in read only memory. Some part of the operating system resides in random access memory and the computer begins to execute this part of the system.

The majority of modern home computers use some form of Microsoft's operating systems. The original Microsoft operating system was called DOS (Disk Operating System) though most computers use Windows. Windows comes in various versions beginning with version 3.x then 95, 98, XP and currently Windows 7. A few computers use IBM's O/S2. Apple's Mac use their own operating system beginning with OS 1 though most modern Macs use version 8.x or 9.x. Apple's latest version is OS 10.1.x. Some computer professionals, Internet Service Providers (ISP) and mainframe computer users use an operating system such as UNIX, Windows NT or 2000 or server based operating systems. The operating system controls the input and output or directs the flow of information to and from the CPU. Much of this is done automatically by the system. In short, we can say that an Operating System is one of the most important components of the computer software which is essential to operate a computer. When computer is turned on, it first needs to load the operating system sometimes referred to a booting up. It checks all its components and will usually display a message if there is a problem. It is also known as Power on Self Test (POST). Loading the system is usually automatic. Once the system is loaded, the user can start the application or program that he/she going to use.

1.7 CURRENT APPLICATIONS OF COMPUTER

Some major applications of Computers are given below :

Banking : When there was no computer, every where manual system was followed which was a very complicated and hard work but now with the arrival of computer, every thing has become much more systematic and easy to use. Every bank is now using a computerized system because it is very fast and user friendly. Personal Computer banking lets us view our bank balance, request transfers between accounts and pay bills electronically. Now-a-days, online banking is getting very popular which offers more convenience and ease to the customers.

Traffic Light Control : In traffic light control, the computer is being employed to orchestrate the traffic light. There are some programmed codes like turn off/on the red light which control the traffic light and also to carry out other instructions.

Sports : Computers have revolutionized the sports industry. Computer is used to maintain player records, track scores, create virtual playing field etc. The sports equipment industry also relies heavily on computer-aided design (CAD).In sports, computers are used in conjunction with video cameras. These are used to record the motion of all the sports men. 3D programs are used to help the trainers see their movements and could improve their styles of playing. Online games allow us to play with other people regardless of their physical locations.

Schools and Colleges : There are many uses of computer in schools and colleges e.g. every students details need to be stored so a computer program comes to help in. Multimedia, animations, graphics and charts could be used to teach the students and many boring topics can be made interesting using multimedia. Students could access internet for online help and courses for more information. Computers are used in a variety of ways in the educational field. Computers can be used in school management such as budget, inventory, student records, communications, library circulation, and library public access catalog.

Learning and Instruction : Computer applications can be used in education for learning and for instruction. Instruction and learning can be divided into two major areas, teacher-centered instruction and student-centered learning. Teacher-centered instruction examined the computer as the object of instruction as well as a tool of instruction and the management of instruction. With the advancement in the Technology and Internet, Online Education, e-learning, m-learning are getting very popular which offers more flexibility and convenience to the learners.

Student-centered learning views the computer as a tool for the student to use and create access, retrieve, manipulate, and transmit information in order to solve a problem. Understanding the concept of the computer as an information tool relies on accepting the fact that the computer is a productivity tool for the student and the teacher alike.

Educational Research : Computers are used widely in all educational research. Educational research includes functions relating to information gathering and processing. The teacher/researcher may examine student performance data in new and revealing ways. Bibliographic citations of studies performed by educators around the world can be acquired and perused by the desktop computer.

Entertainment : Computers and Internet are a major source of entertainment. It is one of the latest forms of entertainment for the modern society. It allows us to play computer games, listen to music, watch videos and movies etc.

Agriculture : Computer usage among agronomists and farmers has risen rapidly in the recent times. With the flow of information becoming faster and easier, the agricultural sector is also getting benefited from computer. Computer allows the farmer to collect adequate information related to prices, latest farming techniques, weather conditions, cultivation of crops, farm machineries etc. which enhances the decision making capability of the farmers.

Health Care Management and Hospital : Today almost every hospital is computerized and utilizing the benefits of computer. Many computer applications, such as patient information system, monitoring and control system and diagnostic systems have been used to enhance health care. Hospital Information System (HIS) allows to manage the administrative, financial and clinical aspects of a Hospital more easily. It also allows easy access to patient data from a centralized database which helps the doctor in retrieving the history of all the patients. Computers are also being used in medical diagnosis and surgery.

Some of the other applications include Transport Management, Weather forecasting, Industries etc.

1.8 LIMITATIONS OF A COMPUTER

The computer can outperform human beings in speed, memory and accuracy but still the computer has limitations. Following are the limitations of computer.

Programmed and Supervised by Human : Though computer is programmed to work efficiently, fast and accurately but it is programmed by human beings to do so. Without a program, computer is nothing. Computer only follows these instructions. If the instructions are not accurate the working of computer will not accurate. Without supervision, computers will operate poorly when dealing with unexpected circumstances, such as information or instructions that are incorrect or incomplete.

No Intelligence : Although computers are faster, more diligent, accurate and versatile than human beings, it cannot replace them. Unlike human beings, computers do not have any intelligence. Its performance is depends on instructions given to it. It cannot carry any task at its own and can’t take any decision on its own.

Self Care : Computer can not care for itself like a human. A computer is dependent still to human beings for this purpose.

Emotionless : Computers are emotionless. They do not have emotion and feelings. A computer can not feel about something like a human. A computer can not compete human in respect of relations. Computers are simply machines which work as per the instruction given to them.

Thinking : Computer can not think itself. The concept of artificial intelligence shows that the computer can think. But still this concept is dependent on set of instructions provided by the human beings.

Retrieval of Memory : Computer can retrieve data very fast but this technique is linear. A human being's mind does not follow this rule. A human mind can think randomly which a computer machine can not.

1.9 SUMMARY

Computer is an electronic device that performs mathematical and non-mathematical operations in order to achieve the results. Its' first generation used the vacuum tube. The second generation used the transistors which were much smaller than vacuum tube. Integrated circuits were used in third generations. VLSI comes in fourth generation computer and now fifth generation growing towards parallel computing. The operating system is an important component of modern computer. The two main objectives of operating system are controlling the computer's hardware and providing an interactive interface between the user and machine. Computer have enters almost in every field of human life and found applications in various fields like medicine and health care, business, science, technology, engineering, entertainment etc.

1.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) A computer is an electronic device, which is used to accept, store, retrieve and process the data at faster speed and with greater accuracy. It is also called as data processor because it is mainly used for processing the input data given to it and producing the desired result.

2) Evolution of computer can be divided into five generations: First Generation (Vacuum tubes), Second Generation (Transistors), Third Generation (ICs), Fourth Generation (Microprocessor), Fifth Generation (Artificial intelligence).

Check Your Progress 2

1) **Microcomputer** is at the lowest end of the computer range in terms of speed and storage capacity. Its CPU is a microprocessor. The first microcomputers were built of 8-bit microprocessor chips. The most common application of personal computers (PC) is in this category. The PC supports a number of input and output devices. An improvement of 8-bit chip is 16-bit and 32-bit chips. Examples of microcomputer are IBM PC, PC-AT.

   Mainframes computers are generally 32-bit microprocessors. They operate at very high speed, have very large storage capacity and can handle the work load of many users. They are generally used in centralized databases. They are also used as controlling nodes in Wide Area Networks (WAN). Example of mainframes are DEC, ICL and IBM 3000 series.

2) The five basic operations that a computer performs are accepting data as **input**, **storage** of these data, **processing** of data, **outputting** the information and **process control**.

3) As per technology variations computers can be classified into analog, digital and hybrid computers.

1.11 FURTHER READINGS

P. K. Sinha , Computer Fundamental (BPB Publication).

V. Rajaraman, Computer Fundamental (PHI Publication).

D. P. Sharma, *Fundamentals of Computer, IT & Programming with "C"* (CBC Publication).

Web link:

- www.wikipedia.org

UNIT 2 FUNCTIONING OF A COMPUTER

Structure **Page No.**

2.0 INTRODUCTION

We have discussed in the previous unit, that the computers have undergone through a long history of evolution. The evolutionary history is often divided into mechanical and electronic era, with electronic computers started being developed in second half of the 20^{th} century. Since then electronic computers have undergone major transformations in terms of architectural design, components used and the IC fabrication technologies. Modern computers primarily use electronic components for processing element & primary memory and both magnetic & optical components (and solid state devices very recently) for secondary storage.

This unit aims to identify the major components of a digital computer and to describe the functions performed by them. As the unit progresses, we will discuss about the architectural blueprint of digital computers identifying the major components and their roles. This is followed by an introduction to decimal & binary number systems and popularly used binary code systems. We then move to understand the concept of a machine instruction through a simple example, followed by description of functioning of Control Unit and Arithmetic and Logic Unit. The unit concludes with a brief summary of learning outcomes.

2.1 OBJECTIVES

After going through this unit, you should be able to:

- identify the major components of a digital computer;
- understand the role of each component and their interconnection
- understand the language of digital computers;
- describe the decimal and binary number systems;
- describe the binary codes and their use;
- perform inter number system conversions;
- distinguish between weighted and un-weighted codes;
- describe the ASCII and Unicode;
- understand the format of machine instruction; and
- describe the function performed by Control Unit and Arithmetic & Logic Unit.

2.2 COMPONENTS OF A DIGITAL COMPUTER & THEIR ROLE

A digital computer is an electronic device that receives data, performs arithmetic and logical operations and produces results according to a predetermined program. It receives data through an input device (usually keyboard) and displays the results to some output device (usually monitor). All data processing in a digital computer is done by a central processing unit, also known as processor. A working memory is used to store data and instructions. Figure 2.1 presents a block diagram of a digital computer identifying the key components and their interconnection.

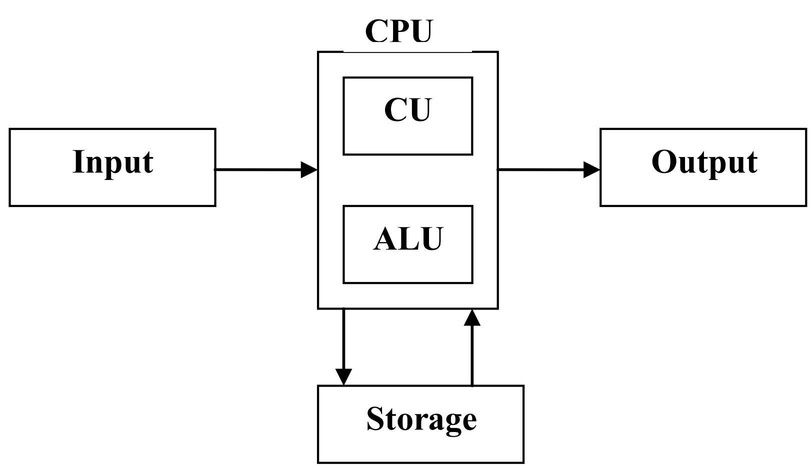

Figure 2.1: Block Diagram of a Digital Computer

2.2.1 Components of a Digital Computer

The key elements of a digital computer, as elaborated in the block diagram given in Figure 2.1 include: Central Processing Unit, Input, Output and Memory. The Central Processing Unit (CPU) is like the brain of the computer. It is responsible for executing instructions. It controls and coordinates the execution of instructions. It is comprised of a Control Unit (CU), an Arithmetic & Logic Unit (ALU) and registers. The CU controls the execution of instructions by decoding the instruction and generating micro-operations to be performed for executing that instruction. The ALU is responsible for performing arithmetic and logic operations. Execution of an instruction involves almost all parts (CU, ALU & Registers) of the CPU. Hence, CPU is known as the most vital component of a computer system.

Input devices are used to read the instructions and data to be processed and output devices display the results obtained after executing the program. Keyboard, Mouse and Scanner are examples of input devices, whereas Monitor, Printer and Plotter are examples of output devices. Memory is used as a working storage for temporarily storing the data and intermediate results generated during program execution. Computers use two kinds of memories: primary & secondary. The primary memory is often referred to as RAM in everyday language. It is a read/write memory used to store both the program and data. Since RAM is volatile, computers also use a second level of memory- secondary memory- to permanently store the contents. Hard Disk is the non-removable secondary storage device which stores virtually everything on the machine. Computers also use other removable secondary memories like CD-ROMs, Magnetic tapes and recently Flash Drives to permanently take backup of the data onto Hard Disk or to transfer data from one machine to another.

A more practical description of a digital computer can be given by describing the major units and their interconnections for a simple personal computer (PC). If you open the CPU cabinet of your PC, you will notice that it contains a printed circuit board on which a number of devices are plugged in. This printed circuit board is often called the mother board. All other major components of the computer are either plugged in directly to this mother board or connected through a bunch of wires. CPU, RAM and Device Cards are plugged in various slots of the mother board. Devices like Hard Disk, Floppy Drive, CDROM Drive, which are attached to the CPU cabinet, are connected through wire ribbons. The mother board has printed circuitry which allows all these components to communicate with each other. CPU cabinet also houses a power supply unit which provides power to all the components of the computer system. On the back end of the CPU cabinet, you can notice a number of connection slots. These slots are used to connect various input/output devices such as keyboard, mouse, printer, scanner, to the computer.

2.2.2 Computer as a Data Processor

Computer takes the raw data as input and performs several operations on these data in order to produce the desired output so it acts as a processing unit for those data

The main function of a computer is to process the input data according to a specific program to produce the desired output. This is the reason why a computer is often viewed as a data processing device. Various components of a computer work coherently to perform different operations to process the data according to program instructions. The word 'Data' refers to any raw collection of facts, figures and statistics. The input data to a computer may include both numbers and characters. Processing the data thus means manipulation of letters, numbers and symbols in a specific manner. The processing may include calculations, decision making, comparisons, classification, sorting, aligning & formatting etc. The processing of data results in some meaningful values, often termed as 'information'. As we see, computer takes the raw data as input and performs several operations on these data in order to produce the desired output so it acts as a processing unit for those data.

The programmers write programs for various data processing tasks. Writing a program to sort a given list of names, to search for a roll number in the list of qualified candidates, preparing and formatting a curriculum vitae, doing an accounting job, are all examples of data processing. As described in Unit I, digital computers have versatile capabilities and that is the reason why they are being used by a variety of people for different purposes. Now-a-days computers have something to offer to everyone. Whether it is an engineer, a business tycoon, a graphic designer, an accountant, a statistician, a student or even a farmer; everyone is now making use of computers. Thanks to the rich set of application programs, even novice users can now make effective use of computers.

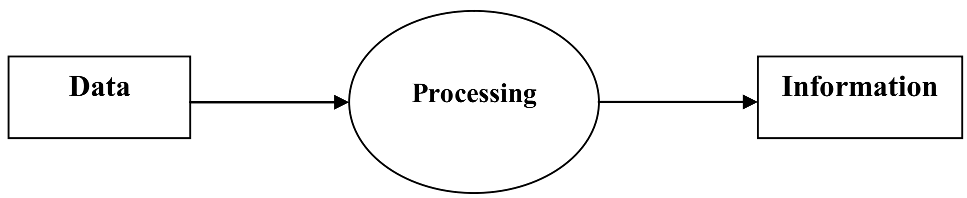

Figure 2.2: Data Processing

2.2.3 Language of Digital Computers

Digital computers are electronic devices which operate on two valued logic (On and OFF). The ability of a transistor to act as a switch is the key to designing digital computers. The digital circuits used in computers are bi-stable, one state each corresponding to ON and OFF values. The two valued Boolean logic (using two distinct symbols 0 and 1) serves as an appropriate representation of states of digital circuits. Every instruction and data item therefore needs to be represented only by using two symbols 0 and 1. Since machines are capable of executing 400-500 distinct instructions and a unique binary code is required to specify every instruction, the machine instructions are specified using multiple bits (binary digits). Similarly the data items also need to be specified using 0 and 1 only. Numbers, alphabets and other characters can be represented by using some binary code system. The next section describes in detail the binary number system and different binary codes.

Though computers use a kind of binary language, we would never like to use them if we are forced to learn and use binary language for working on a computer. In fact, had this been the case, computers would have never become popular. To bridge the gap between the language used by computers and human beings, software got evolved. Software acts as an interface between the machine and the user. Initially the software performed only simple tasks of making the better utilization of machine resources and to make it more convenient for the user to use the machine. The convenience is the simplicity of the way through which users can give instructions to a computer. But as computers started becoming cheaper and popular, softwares to perform more complicated and domain specific tasks were written. Now we refer to these two varieties of softwares as System and Application software respectively. While systems softwares are concerned with driving the machine, application softwares provide task specific functionalities. System software is must to operate a computer system. Operating system is a kind of systems software whereas wordprocessing, database, accounting packages are all examples of applications software. Figure 2.3 below presents the layered view of a computing system.

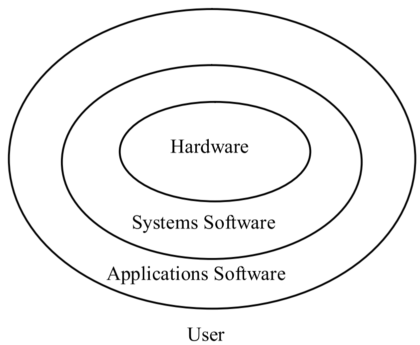

Figure 2.3: Layered View of a Computing System

☞ Check Your Progress 1

1) Fill in the blanks:

   (a) A digital computer is made of following four basic components:

   (i)………………(ii)……………. (iii) ……………… (iv)……………….

   (b) The CPU stands for ....

   (c) Modern processors are capable of executing ……………. distinct machine instructions.

2) What is the significance of a computer being termed as a data processer?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………

3) What kind of language is used to specify machine instructions of a digital computer?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

4) Choose the best alternative:

   (a) CPU is like ………………… of the computer.

   (i) heart (ii) eyes (iii) brain (iv) ears.

   (b) The language of digital computers comprise of:

   (i) decimal numbers (ii) alphabets (iii) binary numbers

   (c) Which part of the CPU is responsible for arithmetic computations and comparisons?

   (i) Control Unit (ii) Arithmetic & Logic Unit (iii) Registers

2.3 NUMBER SYSTEM

A number system with base r will have r distinct symbols, from 0 to r-1. Binary number system (r = 2), octal number system (r = 8) and hexadecimal number system (r = 16) are some of the frequently used number

We are familiar with decimal number system which uses ten distinct symbols from 0…9, and has base 10. In the decimal number system a number $n_4n_3n_2n_1$ is interpreted as $n_4\times10^3+n_3\times10^2+n_2\times10^1+n_1\times10^0$. Thus decimal number 5632 represents 5000+600+30+2. It is a weighted code system since numbers 5632, 2563, 3562, 6532 all represent different quantities despite the fact that all of them use the same symbols (2,3,5,6). The magnitude/ value of a number is determined both by the symbols used and the places at which they are present. Thus, symbol 3 at ten's place represent 30, but when written at thousands' place it represent 3000. Although we use only the decimal number system in everyday applications but there are many other number systems possible. In fact, we can have number system with any base r.

A number system with base r will have r distinct symbols, from 0 to r-1. Binary number system (r = 2), octal number system (r = 8) and hexadecimal number system (r = 16) are some of the frequently used number systems in computer science. Binary number system has two distinct symbols 0 & 1; Octal has seven distinct symbols 0,1,2,3,4,5,6,7; and Hexadecimal number system has sixteen distinct symbols namely 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F. The numbers written in a particular number system can be transformed to an equivalent value in a different number system. For example a number 3F in hexadecimal is equivalent to 63 ($3\times16^1 + F \times 16^0$) in decimal number system. And similarly a number 302 in octal is equivalent to 194 ($3\times 8^2 + 0 \times 8^1+2 \times 8^0$) in decimal number system.

2.3.1 Binary Number System

As stated above, the binary number system has base 2 and therefore uses only two distinct symbols 0 and 1. Any number in binary is written only by using these two symbols. Though it uses just two symbols but it has enough expressive power to represent any number. A binary number 1001 thus represents the number $1\times 2^3 + 0 \times 2^2 + 0\times 2^1 + 1\times 2^0$. It is equivalent to number 9 in decimal number system. Similarly 11001 and 10001 represent numbers 25 and 17 respectively in decimal number system. Please note that the base in binary number system is 2.

A binary number can be converted to its decimal equivalent by forming the sum of powers of 2 of those coefficients whose value is 1.
For example:

$$(10101)_2 = 2^4 + 2^2 + 2^0 = (21)_{10}$$
$$(100011)_2 = 2^5 + 2^1 + 2^0 = (35)_{10}$$
$$(1010.011)_2 = 2^3 + 2^1 + 2^{-2} + 2^{-3} = (10.375)_{10}$$

The conversion from decimal to binary or to any other base-r system is done by separating the number into an integer part and a fraction part and then converting each part separately. For example the decimal number 41.6875 can be converted to binary equivalent, by converting the integer and fraction parts separately, as follows:

Operation	Quotient	Remainder
41 / 2	20	1
20 / 2	10	0
10 / 2	5	0
5 / 2	2	1
2 / 2	1	0
1 / 2	0	1

The number is divided by 2 and the remainder part is extracted. The quotient obtained is again divided by 2 and this process is repeated until the quotient becomes 0. Every time the remainder obtained is recorded. The set of remainders obtained, read from the bottom to top form the binary equivalent of the integer part of the number. Thus $(41)_{10}$ = $(101001)_2$.

In order to convert the fraction part, it is multiplied by 2 to obtain resultant integer and fraction parts. The integer part in the resultant is extracted and the fraction part is again multiplied by 2. This multiplication process is repeated till the fraction part becomes 0 or a desired precision is achieved. The integer part of the given number (.6875) can be converted to binary as follows:

Operation	Resulting Integer part	Resulting Fraction part
0.6875 X 2	1	.3750
0.3750 X 2	0	.7500
0.7500 X 2	1	.5000
0.5000 X 2	1	.0000

The binary equivalent of fraction 0.6875 is 1011, obtained by reading the integer parts from top to down. Thus, the decimal number 41.6875 is equivalent to 101001.1011 binary number system.

Conversion

Decimal to Binary:

Q. Convert $(13)_{10}$ to an equivalent binary number**.**

	Quotient	**Remainder**
13/2	6	1
6/2	3	0
3/2	1	1
1/2	0	1

We take the remainder from bottom to top. Hence $(13)_{10} = (1101)_2$

Binary To Decimal

Q. Convert $(101011)_2$ to an equivalent decimal number.

$$\begin{array}{cccccc} 5 & 4 & 3 & 2 & 1 & 0 \\ (1 & 0 & 1 & 0 & 1 & 1)_2 \end{array}$$

$= 2^5 + 2^3 + 2^1 + 2^0 = 32 + 8 + 2 + 1 = 43$

Hence, $(101011)_2 = 43$

Hexadecimal to Binary

Q. Convert $(2D5)_{16}$ to an equivalent Binary number.

$(2D5)_{16}$ = 2 D 5

0010 1101 0101

We replaced each digit in the given number by its 4-bit binary equivalent. So

$(2D5)_{16}$ = 0010 1101 0101

Thus, $(2D5)_{16} = (001011010101)_2$

Binary to Hexa Decimal

Q. Convert $(10100110101111)_2$ to its equivalent Hexa Decimal Number.

Starting from the least significant bit, each group of 4 bits is replaced by its decimal equivalents.

$(10100110101111)_2$ = 0010 1001 1010 1111

2 9 A F

Thus, $(10100110101111)_2 = (29AF)_{16}$

2.3.2 Binary Codes

We have seen earlier that digital computers use signals that have two distinct values and there exists a direct analogy between binary signals and binary digits. Computers not only manipulate numbers but also other discrete elements of information. The distinct discrete quantities can be represented by a group of binary digits (known as bits). For example, to represent two different quantities uniquely two symbols are sufficient and hence one binary digit (either 0 or 1) will be sufficient to uniquely represent the two symbols. But one bit will not suffice if one has to represent more than two quantities. In those cases more than one bits are required, i.e. the bits have to used repeatedly. For example if we have to give unique codes for three distinct items we need at least 2 bits. With two bits we can have codes 00, 01, 10 and 11. Out of this we can use first three to assign unique codes to three distinct quantities and leave the fourth one unused. In general, an n-bit binary code can be used to represent 2^n distinct quantities. Thus group of two bits can represent four distinct quantities through unique symbols 00, 01, 10 & 11. Three bits can be used to represent eight distinct quantities by unique symbols 000, 001, 010, 011, 100, 101, 110 & 111. In other words, to assign unique codes to m distinct items we need at least *n* bit code such that $2^n >= m$.

Digital computers use binary codes to represent all kinds of information ranging from numbers to alphabets. Whether we have to input an alphabet, a number or a punctuation symbol; we need to convey it to machine through a unique code for each item. Thus, the instruction to be performed by the CPU and the input data which form the operands of the instruction are represented using a binary code system. A typical machine instruction in a digital computer system could therefore look like a set of 0s and 1s. Many binary codes are used in digital systems. BCD code for representing decimal numbers, ASCII code for information interchange between computer and keyboard, Unicode for use over Internet and Reflected (Gray) code are some commonly studied binary code systems.

2.3.3 ASCII & Unicode

An alphanumeric code has to represent 10 decimal digits, 26 alphabets and certain other symbols such as punctuation marks and special characters. Therefore, a minimum of six bits is required to code alphanumeric characters ($2^6 = 64$, but $2^5 = 32$ is insufficient). With a few variations this 6 bit code is used to represent alphanumeric characters internally. However, the need to represent more than 64 characters (to incorporate lowercase and uppercase letters and special characters), have given rise to seven- and eight- bit alphanumeric codes. ASCII code is one such seven bit code that is used to identify key press on the keyboard. ASCII stands for American Standard Code for Information Interchange. It's an alphanumeric code used for representing numbers, alphabets, punctuation symbols and other control characters. It's a seven bit code, but for all practical purposes it's an eight bit code, where eighth bit is added for parity. Table 2.1 below presents the ASCII code chart.

ASCII is an alphanumeric code used for representing numbers, alphabets, punctuation symbols and other control characters

Table 2.1 : ASCII Code Chart

Bits				b_7 b_6 b_5 →	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b_4	b_3	b_2	b_1	Row ↓ / Column →	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FC	,	<	L	\	l	/
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	–
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

ASCII codes represent text in computers, communications equipment, and other devices that use text. Most modern character-encoding schemes are based on ASCII, though they support many more characters than did ASCII. Historically, ASCII developed from telegraphic codes. Its first commercial use was as a seven-bit teleprinter code promoted by Bell data services. Work on ASCII formally began on October 6, 1960, with the first meeting of the American Standards Association's (ASA) X3.2 subcommittee. The first edition of the standard was published during 1963 a major revision during 1967, and the most recent update during 1986. ASCII includes definitions for 128 characters: 33 are non-printing control characters (now mostly obsolete) that affect how text and space is processed; 94 are printable characters, and the space is considered an invisible graphic. The most commonly used character encoding on the World Wide Web was US-ASCII until December 2007, when it was surpassed by UTF-8.

Unicode is a computing industry standard for the consistent encoding, representation and handling of text expressed in most of the world's writing systems

Unicode is a computing industry standard for the consistent encoding, representation and handling of text expressed in most of the world's writing systems. Developed in conjunction with the Universal Character Set standard and published in book form as *The Unicode Standard*, the latest version of Unicode consists of a repertoire of more than 107,000 characters covering 90 scripts, a set of code charts for visual reference, an encoding methodology and set of standard character encodings, an enumeration of character properties such as upper and lower case, a set of reference data computer files, and a number of related items, such as character properties, rules for normalization, decomposition, collation, rendering, and bidirectional display order (for the correct display of text containing both right-to-left scripts, such as Arabic and Hebrew, and left-to-right scripts. Unicode can be implemented by different character encodings. The most commonly used encodings are UTF-8 (which uses one byte for any ASCII characters, which have the same code values in both UTF-8 and ASCII encoding, and up to four bytes for other characters), the now-obsolete UCS-2 (which uses two bytes for each character but cannot encode every character in the current Unicode standard), and UTF-16 (which extends UCS-2 to handle code points beyond the scope of UCS-2).

The Unicode Consortium, the nonprofit organization that coordinates Unicode's development, has the ambitious goal of eventually replacing existing character encoding schemes with Unicode and its standard Unicode Transformation Format (UTF) schemes, as many of the existing schemes are limited in size and scope and are incompatible with multilingual environments. Unicode's success at unifying character sets has led to its widespread and predominant use in the internationalization and localization of computer software. The standard has been implemented in many recent technologies, including XML, the Java programming language, the Microsoft .NET Framework, and modern operating systems.

☞ Check Your Progress 2

1) Choose the best alternative:

   (a) ASCII is practically a ………………. bit code:

   (i) six (ii) seven (iii) eight (iv) nine

   (b) A number system having base r will have ………. distinct symbols:

   (i) r/2 (ii) 2^r (iii) r (iv) r^2

   (c) Unicode is used primarily for:

   (i) processing (ii) Internet technologies (iii) logical operations

   (d) The binary equivalent of $(25.25)_{10}$ is:

   (i) 11001.001 (ii) 11101.010 (iii) 10001.110

2) State **True** or **False**:
   (a) A decimal number can be converted into its binary equivalent integer and fraction parts separately. True ☐ False ☐
   (b) An n-bit binary code can represent n^2 distinct codes. True ☐ False ☐
   (c) The most commonly used Unicode Transformation Format currently is UTF-8. True ☐ False ☐
3) Briefly state the reason why ASCII can not be less than 7 bit code?
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
4) What was the main motivation behind the development of Unicode?
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………

2.4 CONCEPT OF INSTRUCTION

The CPU is a semiconductor integrated circuit chip consisting of a large number of transistors. In personal computers, the CPU is also referred by the term Microprocessor. Every CPU is capable of performing certain instructions (known as machine instruction). Modern CPUs have the logic built in to perform 400-550 machine instructions. The machine instructions that a CPU can execute demonstrates its capability. Every processor is capable of performing certain operations. An instruction refers to an operation that can be performed by the processor directly. The entire set of instructions that can be executed by the processor directly, through the logic in hardware, form the instruction set of the processor. An instruction tells the processor what task is to be performed and what micro-operations need to be completed to perform the task. Every instruction execution requires execution of a set of arithmetic and logical operations (micro-operations). The size and format of the instruction varies with different processors.

The entire set of instructions that can be executed by the processor directly, through the logic in hardware, form the instruction set of the processor. An instruction tells the processor what task is to be performed and what micro-operations need to be completed to perform the task

Every instruction is comprised of two parts: **opcode** and **operands**. The opcode specifies the operation to be performed and the operands provide the data on which the operation is to be performed. To understand the concept of instruction more clearly let us assume a simple hypothetical computer which the capability to perform eight different operations. Every operation is specified by a unique opcode as given in Table 2.2.

The opcode specifies the operation to be performed and the operands provide the data on which the operation is to be performed

Table 2.2 : Unique OPcode

Operation	**Opcode**
Addition	000
Subtraction	001
Multiplication	010
Division	011
Modulus	100
Complement	101
Bitwise AND	110
Bitwise OR	111

Let us further assume that our computer can process only two-digit decimal numbers, i.e. there can be a maximum of two operands each of a maximum of two digits. Thus the computer can add or subtract numbers containing a maximum of two digits. A simple instruction can thus be written as a combination of an opcode and its associated operands. Opcode is denoted by its unique binary code. The operands are decimal digits and therefore also need to be converted to binary code system to pass them as operands to the processor. Suppose BCD code is used to represent the operands. Then following are examples of some valid instructions on the processor:

Instruction	**Effect**
0001001001100100101	93 + 25
10110000101	Complement 85
0110010010100000101	25 / 05

In the first instruction, the first three bits represent the opcode and the remaining sixteen bits represent the two operands each a two digit decimal number expressed using BCD code. The opcode for addition as described in the table is 000 and the BCD codes for 9,3,2 and 5 are 1001, 0011, 0010 and 0101 respectively. Thus the instruction 0001001001100100101 represents 93 + 25. Similarly, in the second instruction, first three bits represent the opcode and the remaining eight bits specify the operand to perform the operation. However, this is the case of a very simple hypothetical computer. Real world processors are much more complex and capable of performing more than 500 machine instructions. Further they can take their operands in a number ways: directly, from registers, from memory etc. Moreover, modern processors can perform calculations on large numbers. Thus an instruction in a modern CPU could easily comprise more than 50 bits.

Execution of a machine instruction on modern processors involves a complex sequence of operations with multiple cycles. One instruction cycle typically involves Fetch, Decode, Execute and Write back cycles. During Fetch cycle the instruction is fetched from memory. During Decode cycle the instruction is processed by the control unit of the CPU, which generate the set of micro-operations and timing signals required to execute the instruction. The micro-operations are then executed during Execute cycle to complete the instruction and any results generated are then written back to memory during Write back cycle. An instruction cycle may also involve one or more operand fetch cycles. The control unit is responsible for overall control and coordination of instruction execution. It generates the set of micro-operations either through a hard wired logic or with the help of micro program sequencer. Executing a program therefore involves executing a large number of machine instructions, where every machine instruction execution requires executing several micro-operations.

The control unit is responsible for overall control and coordination of instruction execution

2.5 ELEMENTS OF CPU AND THEIR ROLE

The CPU is a complex IC chip having millions of transistors. As mentioned earlier, a CPU has three major identifiable parts: Control Unit (CU), Arithmetic & logic Unit (ALU) and a set of Registers. The CPU chip is interfaced with other components of the computer through a system bus (printed wires on the mother board) which has three sets of wires forming Control Bus, Data Bus and Address Bus. Figure 2.4 presents the components of a CPU :

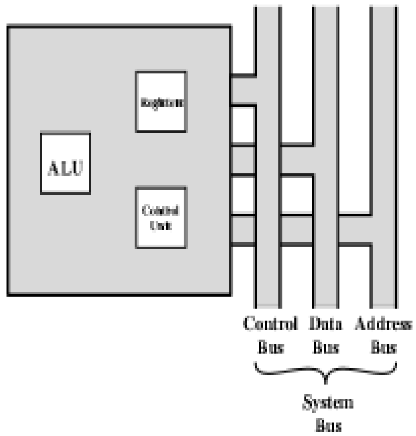

Figure 2.4 : Interfacing CPU and System Bus

CPU has a set of **Registers** which is used to store some data temporarily. Register lies above Cache and Main memory in memory hierarchy of the system. The registers in CPU perform two roles:

- **User-visible registers**: used to store temporary data items and other user accessible information useful for machine or assembly language programmers.
- **Control & Status Registers**: used by control unit to control and coordinate the operation of the processor.

The **Control Unit** of the processor is that unit which controls and coordinates the execution of instructions by the processor. It is responsible for defining and controlling the instruction cycle. In essence, it causes things to happen in the processor. It issues control signals external to the processor to cause data exchange with memory and I/O modules. It also issues control signals internal to the processor to move data between registers, to cause the ALU to perform a specified function, and to regulate other internal operations. It generates timing signals and initiates the Fetch cycle of instruction execution. When the instruction is fetched, it generates the sequence of micro-operations which need to be executed in order to execute the instruction. CU also generates timing signals for executing set of micro-operations. There are three different ways in which CU can generate these micro-operations: through a hardwired logic, by reading a programmable Array (PLA) table or by reading a Programmable Read Only Memory (PROM).

The **Control Unit** of the processor is that unit which controls and coordinates the execution of instructions by the processor

In hardwired control, the mapping between machine instruction and consequent micro-operations to be generated is permanently wired within the processor. It is relatively faster way although it cannot be modified. In PLA control the sequence of micro-operations to be generated for executing an instruction is stored as a PLA table. In Micro program control, the logic of the control unit is specified by a microprogram. Microprogram specifies the micro-operations. The microprogram control has a control memory (a PROM chip) which stores the sequence of micro-operations. As a general rule processors having smaller instruction set (such as RISC processors) have hard wired control logic whereas microprogram control is used in processors having larger instruction set. Most of the modern CISC processors use microprogram control.

The microprogram control has a control memory (a PROM chip) which stores the sequence of micro-operations

The **Arithmetic and Logic Unit** is that part of the CPU that actually performs arithmetic and logical operations on data. The CU, CPU registers and memory help in bringing the data into the ALU and then taking the results back. Figure 2.5 presents the ALU inputs and outputs.

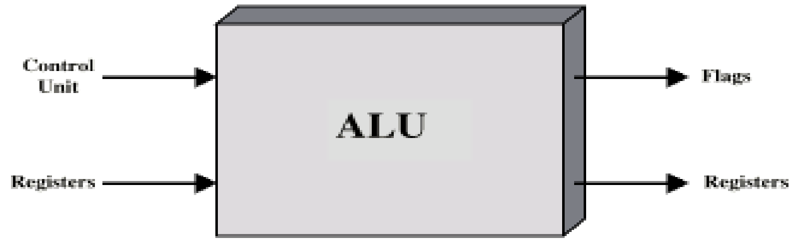

Figure 2.5 : The Arithmetic and Logic Unit

Data are presented to ALU in registers and the results are also stored in registers. Accumulator is one such register which is very frequently used during the ALU operation. ALU has many other registers such as flags and status register, which indicate information about the operation and its result. ALU has logic implemented to perform operations like addition, multiplication, division, shifting, complement etc. The operations are performed on represented numbers, both integer and floating point numbers.

Modern processors nowadays have two identifiable trends which improve their performance to a much higher level. These are use of on chip Cache memory and having more than one processor core on the same IC chip. Cache memory is a fast semiconductor memory which can be used to temporarily store instructions and data that are frequently referred by the processor. By having frequently referred instructions and data available in the processor, the wait cycles introduced due to memory references are minimized and hence the processor performance improves a lot. Another modern technique of having more than one processor core on the same IC chip tries to perform the execution of instructions in parallel and hence the performance of the processor improves a lot.

☞ Check Your Progress 3

1) Choose the best alternative:
   (a) A machine instruction consists of ……………………
       (i) ALU (ii) Operator (iii) Opcode & Operands (iv) CU
   (b) Executing an instruction involves execution of several……………….
       (i) micro-operations (ii) programs (iii) control signals
   (c) ALU is responsible for …………….
       (i) generating control signals (ii) microprogram sequencing
       (iii) arithmetic & logic
   (d) The hardwired control unit is ……………..
       (i) permanent, non-modifiable (ii) made of PROM (iii) erasable
   (e) CPU has following two kinds of registers……………
       (i) user-visible & control (ii) program counter & flags (iii) ALU & CU

2) Briefly explain the sub cycles involved in execution of a machine instruction.

……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………………….

3) What are the different ways of designing the control unit of a processor?

……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………………….

4) List the two key technological trends seen in modern processors for improving performance.

……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………………….

2.6 SUMMARY

This unit has introduced you to the components of a digital computer and their roles. A digital computer has CPU, Memory, Input and Output as constituent elements. Digital computers use binary language. The binary number system is analogous to two valued Boolean logic. Decimal numbers and alphabets are represented as binary codes for being processed by the computer. The unit describes the ASCII and Unicode code systems in brief. ASCII is the code used for information interchange between keyboard and computer. Unicode is a universal code system widely used over the Internet. The unit also introduced you with the concept and format of a machine instruction. An instruction cycle involves fetch, decode, execute and write back cycles. The three key components of CPU are: CU, ALU and registers. CU controls and coordinates the execution of instructions. ALU actually performs the operations. CPU registers work as temporary storage for executing instructions.

2.7 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) (a) CPU, Memory, Input, Output (b) Central processing Unit
(c) 400-550
2) A computer accepts raw data as input and processes it (performing computations, manipulations and formatting etc.) to produce a meaningful result. Due to its key job being processing according to user instructions, it is referred to as data processor.
3) A language comprising of binary numbers is used to specify machine instructions in digital computers. Every machine instruction is represented by a unique binary code.
4) (a) iii (b) iii (c) ii

Check Your Progress 2

1) (a) ii (b) iii (c) ii (d) i
2) (a) True (b) False (c) True
3) ASCII Code is required to have unique code for every key press on the keyboard. Through the keyboard we can enter 10 decimal digits, 26 letters of alphabets and certain other symbols such as punctuation marks and special characters. Therefore, a minimum of six bits is required to code alphanumeric characters ($2^6 = 64$, but $2^5 = 32$ is insufficient). However, the need to represent more than 64 characters (to incorporate lowercase and uppercase letters and special characters), made ASCII a 7-bit code.
4) Unicode was developed as a standard for the consistent encoding, representation and handling of text expressed in most of the world's writing systems. Unicode consists of a repertoire of more than 107,000 characters covering 90 scripts. It is the universal encoding scheme having special significance for Internet and multilingual computing

Check Your Progress 3

1) (a) iii (b) i (c) iii (d) ii (e) i
2) Execution of a machine instruction involves Fetch, Decode, Execute and Write Back cub cycles. An instruction cycle may also involve operand fetch cycles.
3) There are three ways of designing the control unit: Hard-wired control, PLA and Micro-program control.
4) The two technological trends seen in modern processors to improve performance include provision of on-chip cache memory and having multiple processing cores on the same chip.

2.8 FURTHER READINGS

William Stalling, *Computer Organization and Architecture*, 6th Ed., Pearson Education.
V. Rajaraman, *Fundamentals of Computers*, PHI.

Web Link:

- http://computer.howstuffworks.com

UNIT 3 MEMORY SYSTEM

Structure **Page No.**

3.0 INTRODUCTION

To understand how data is processed, by a computer, we can draw a simple analogy between computers and humans.

Suppose a student asks a teacher “what happens when 15 is multiplied by 8”. S/He receives the answer 120 from teacher. In the case of a computer, this process can be described as follows:

The teacher’s brain receives the question through his/her ears (analogous to a computer’s input device), processes the question with the help of his brain’s information processing and analytical ability (analogous to computer’s CPU) and gives the answer through the mouth (analogous to a computer’s output device). Further, just as the teacher can write down the answer on a sheet of paper or blackboard, the computer can also print the answer on a paper through a printer attached to it.

Every modern computer system consists of three basic sections:

1. **Input device** (i.e. Keyboard, mouse or scanner etc.)
2. **Processor** (or CPU):
   - Control unit (CU)
   - Arithmetic and Logic Unit (ALU)
   - Memory unit
3. **Output device** (Visual Display Unit (Monitor/screen) or printer etc.)

The basic parts of a computers are shown in Figure 3.1

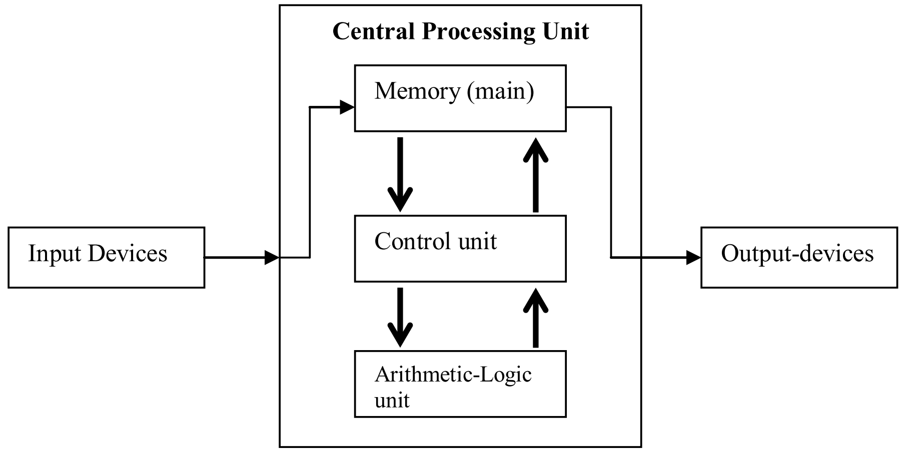

Figure 3.1: Basic Parts of a Computer

- Input devices such as a keyboard, mouse or scanner are used to enter input (data and/or instructions), directly into the computer.
- The **CPU** is like the human brain; it has a memory and just like there is a faculty in the brain that regulates the functioning of all parts of the body, a computer has a control-unit **(CU),** which controls its entire operation including its input and output devices.
- Processing of data is done in the arithmetic and logic unit (**ALU**). It performs Arithmetic and logic operations such as addition, subtraction, multiplication and division. Here the word "Logic" is used because a computer (unlike a calculator) has the capacity to do logical operations also, such as compare two numbers, and find out which of the two numbers is greater.

The Memory unit is an important component of a computer where all the data and information are stored in the form of binary digits

The Memory unit is an important component of a computer where all the data and information are stored in the form of binary digits (combination of 0's and 1's) and retrieved whenever necessary. Computer systems use a variety of devices for storing instructions and data. The computer memory is the place where the computer holds data and programs that are in use. Computer memory refers to the physical devices in a computer. If our computer's CPU had to constantly access the hard drive to retrieve every piece of data it requires, the operation will be very slow. On the other hand, when the data or information is kept in memory the CPU can access it much more quickly. From the time the computer is turned on until the time it is shut down, the CPU is constantly using the memory system. The act of entering data into a storage location is called a memory write operation, and the act of retrieving data from a storage location is called a memory read operation. Data and instructions are moved, to and from memory, in bunches of word length. These memory devices are categorised according to access time, storage capacity and cost-per-bit of storage.

Based on these criteria memory is broadly categorised into two types:
- Primary or main memory (also called semiconductor memory).
- Secondary or auxiliary memory (magnetic memory/Optical memory).

The Table 3.1 summarizes the difference between Primary (or main) memory and secondary (or auxiliary) memory.

Table: 3.1 : Difference between Memories

	Access Time	**Storage capacity**	**Cost/bit of storage**
Primary memory	Faster	Smaller	High
Secondary memory	Slower	higher	Low

That is, Primary memory (i.e. RAM, ROM etc.) have *faster access time*, *smaller storage capacity*, and *higher cost per bit of storage*, as compared to secondary memory.

Based on *access time*, *storage capacity* and *cost/bit storage*, the memory devices (such as RAM, ROM, Hard-disk, Floppy disk, Magnetic disk, Magnetic Tape, CD-ROM, and DVD etc.) can be categorized into three kinds of memory systems:

- Semiconductor memory such as RAM, ROM etc
- Magnetic memory such as Hard-disk, Floppy disk, and Magnetic tapes
- Optical memory such as CD-ROM, DVD etc

A Central Processing Unit (CPU) in a computer system is an extremely fast device as compared to the main memory, but it can not work on its own. It depends on the main memory that sends data and instruction when required for processing.

To reduce the cost of a large sized memory, a special type of high speed memory, known as ***cache memory*** can be used in between the CPU and the main memory

In other words, we can say that even memories with smaller size (i.e. primary memory) have very high access time (time taken by CPU to access a location in memory), which reduces the overall speed of a computer.

Computer memory can also be categorized on the basis of **Volatile** and **Non-Volatile** characteristics. Non-volatile Memory is a type of computer memory which can retain the stored information even if the power is shut down. Examples of Non-Volatile Memory are Read-only memory (ROM), flash memory, optical discs etc. On the other hand, a Volatile memory loses its content when the power goes off. Random Access Memory (RAM), which is the most common form of Primary Storage, is a type of volatile memory. When the computer is shut down, everything contained in RAM is lost.

To reduce the idle time of the CPU and increase the speed of processing, a fast memory can be used. This can be done by using a large size of main memory. But the cost of main memories of relatively large size is still very high. To reduce the cost of a large sized memory, a special type of high speed memory, known as ***cache memory*** can be used in between the CPU and the main memory (as shown in Figure 3.2). Thus the cost versus access time leads to a hierarchy of computer memory, where the memory is organized into a hierarchy, known as the **memory hierarchy**. This includes CPU registers, Cache memory, main memory and various secondary storage devices. Although the memory hierarchy is organized in such a way to minimize the cost, without compromising the overall speed of access.

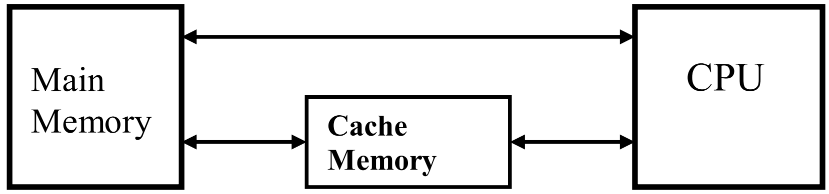

Figure 3.2: Memory Organization

In this unit we will mainly focus on storage organization and storage devices such as disk/tape, CD/DVD and ROM/PROM etc. We also discuss the memory hierarchy which includes main memory and high speed memory such as cache memory.

3.1 OBJECTIVES

After going through this unit, you should be able to:

- differentiate between types of memory and needs of the memory system;
- differentiate between various types of memories such as semiconductor, magnetic and Optical memory;
- describe the various secondary storage devices such as Hard-disk, floppy disk, CD-ROM, DVD-ROM etc; and
- describe the importance of the memory hierarchy.

3.2 MEMORY AND STORAGE DEVICES

Memory is an important component of a computer where all the data and information are stored in the form of binary digits (combination of 0's and 1's) and retrieved whenever necessary.

There are two main functions of the memory:
- To store programs, data and information into the computer.
- To store the results of computation.

A computer system uses a variety of devices for storing the instructions and data. When you want to execute a computer program, the program has to be in memory. Any input data needed for processing by that program should also be in memory. All the intermediate results and outputs from the program are stored in the memory until the machine is turned off.

The storage devices of a computer system are ranked according to the following criteria:

1. **Access time:** This is the time required to locate and retrieve stored data from the storage unit in response to a program instruction. That is the time interval between the read/write request and the availability of the data. A fast access time is always preferred.

2. **Storage capacity:** It is the amount of data that can be stored in the storage unit. A large capacity is preferred.
3. **Cost per bit of storage:** It is the cost of a storage unit for a given storage capacity. Low cost per bit of storage is always preferred. The final goal is to minimize this cost.

Based on above mentioned criteria, at present the following three kinds of memory system are commonly used in modern computers:

Table 3.2 : Memory and its Purposes

Sl.No.	Types of Memory	Purpose
1	**Processor's internal (CPU) memories**	• These are the small set of high speed registers which are internal to a processor and are used as temporary locations where actual processing is done.
2	**Primary (main) memory**	• It is a fast and large memory but is slower than processor memory. Primary memory has faster access time, smaller storage capacity and higher cost per bit storage. • This memory is accessed directly by the processor. It stores programs and data which are currently needed by the CPU. The CPU communicates directly with the main memory. The size of the main memory is kept small because of its high cost. It is a volatile type of memory.
3	**Secondary (or auxiliary) memory**	• Secondary memory is mainly used for bulk storage (mass storage) of programs, data and other information. It has much larger capacity than main memory but is slower. • It is non-volatile type of memory. It stores system software, compiler, assembler and useful packages,, large data files etc.

Thus from above discussions, we can summarize the following points:

- Secondary memory cannot be accessed directly by the CPU. First the information of these memories (which is needed by the CPU for current processing) is transferred to the main memory and then the information can be accessed as the information of main memory. Hard-disk and floppy disks are the most common secondary memories used in computers.
- Secondary storage systems must offer large storage capacities, low cost per bit and medium access times. Magnetic media (such as *floppy disks* and *hard disks*) have been used for such purposes for a long time. But audio and video media, either in compressed form or uncompressed form, require higher storage capacity than the other media forms and the storage cost for such media is significantly higher.
- Optical storage devices offer a higher storage density at a lower cost. A CD-ROM can be used as an optical storage device. Many software companies offer both operating system and application software on CD-ROMs today. This technology has

been the main catalyst for the development of multimedia in computing because it is used in multimedia external devices such as video recorders and digital recorders (Digital Audio Tape) which can be used for multimedia systems.

- Removable disk, tape cartridges are other forms of secondary storage devices used for back-up purposes having higher storage density and higher transfer rate.

There is another type of high speed memory, known as **Cache memory**, which is used to increase the speed of processing by making current programs and data available to the CPU at a rapid rate. Cache memory is a relatively small, high speed memory that stores the most recent used instructions or data. It acts as a high-speed buffer between main memory and the CPU.The cache memory is placed in between CPU and main memory. Access time is the time it takes a device or program to locate information and make it available to the computer for further processing. Cache memory access time is about 0.5 to 2.5 ns which is much less than that of the main memory. The access time of main memory is about 50-70 ns. Because of its very high cost, the capacity of the cache memory deployed is 2 to 3 percent of that of the main memory. The access time of mass storage devices such as hard disks are measured in milliseconds (ms).

The most common memory hierarchy is shown in Figure 3.3 :

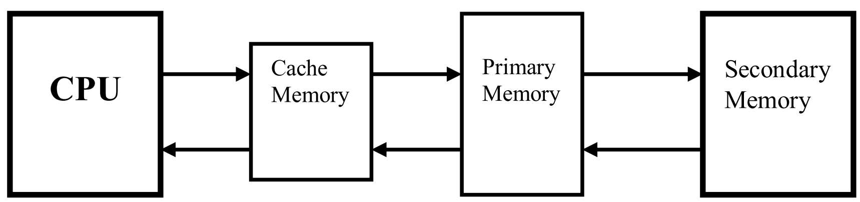

Figure 3.3 : Memory Hierarchies

Now let us start with the memory organization of primary storage. A primary or internal storage section is basic to all computers. Figure 3.4 compares the different types of memory in terms of capacity, access speed, cost per bit of storage as follows:

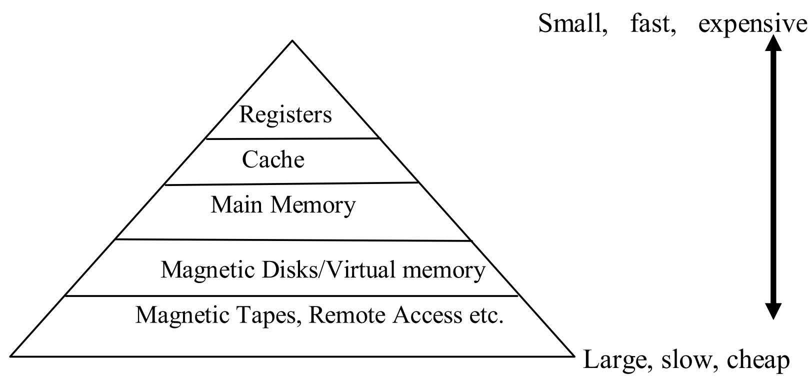

Figure 3.4 : Storage media in terms of cost, Speed and capacity trade-offs

All the memory devices can be categorized into three main categories:

- Semiconductor (or Main) memory
- Magnetic memory
- Optical memory

The Figure 3.5 illustrates the storage cost, speed and capacity of these memories. Note that cost increases with faster access speeds but decreases with access capacity.

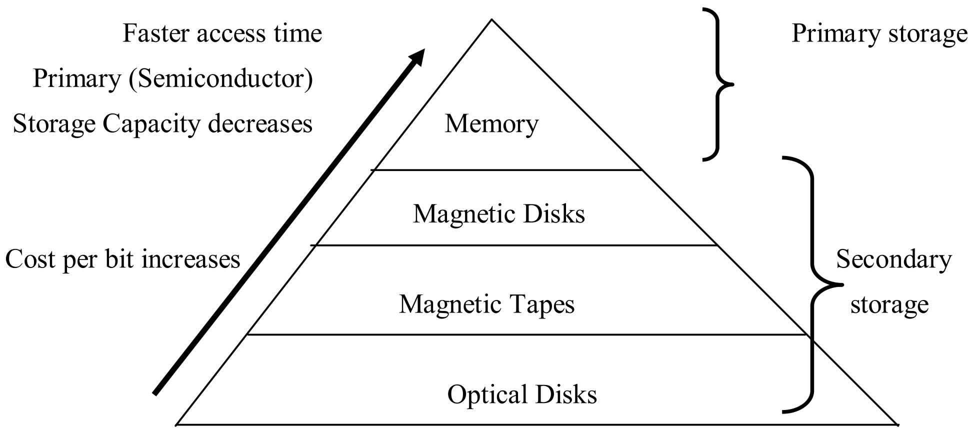

Figure 3.5: Storage media cost, Speed and capacity trade-offs

You can note down the following points from the Figure 3.5

- Semiconductor memories are used mainly for primary storage. It stores programs and data which are currently needed by the CPU.
- The semiconductor memory is an electronic, static device. There are no moving parts in it. Some examples of semiconductor memory are RAM, ROM etc.
- The semiconductor memory is faster, compact and lighter. It consumes less power.
- The magnetic and optical memories are slow compared to semiconductor memory.

But they are cheaper than semiconductor memory. They are not static devices. They are either in the form of a rotating disk or tape. All computers contain both semiconductor as well as magnetic memory.
The examples of magnetic memory are Hard-disk, floppy disk, magnetic disk and tapes.

The Figure 3.6 shows a relationship between the access-time and capacity of various types of memory.

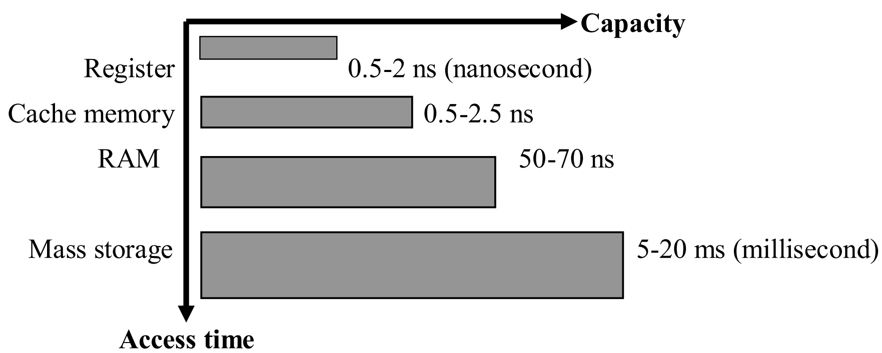

Figure 3.6 : Capacity vs. access-time

Optical recording techniques have been recently used to store data on the surface of a coated disk. Information is written to or read from an optical disk using a laser beam. An example of this kind of serial access memory is a CDROM (Compact Disk Read-Only Memory). Only one surface of an optical disk is used to stored data. An optical disk has very high storage capacity, up to 20 GB. It is relatively inexpensive and has a long life of at least 15-20 years. Better optical recording methods which records data on multiple layers on a disk surface have been recently introduced. This storage device is known as DVD-ROM (Digital Versatile Disk Read-Only Memory). The main drawback of the optical disk system is its slow average access time. Table 3.3 shows the some characteristics of the discussed various memory technologies.

Table 3.3: Characteristics of Memory Technologies

Technology	**Nature of storage medium**	**Access Mode**	**Volatile/ Nonvolatile**	**Access Time (in sec)**	**Average cost (Rs/bit)**
Semiconductor Memories	Electronic	Random (or Direct)	Volatile	10^{-8}	10^{-2}
Magnetic Memories	Magnetic	Sequential/Random	Non-volatile	10^{-1}	10^{-6}
Optical Memories	Optical (laser beam)	Random	Non-volatile	1	10^{-7}

Note that there are two basic methods of accessing information from various memory devices :

- Sequential or serial access, or
- Direct or Random access

- A ***Sequential-access*** memory device reads data in sequence. In other words, information on a serial device can only be retrieved in the same sequence in which it is stored. Data is recorded one after another in a predetermined sequence (such as in numeric order) on a storage medium. Sequential processing is quite suitable for such applications like preparation of monthly pay slips, or monthly electronic bills etc., where each address needs to be accessed in turn. If you are working with a sequential access device and information is stored at the last address, then data stored at the last address cannot be accessed until all preceding locations in the sequence have been traversed. That is locating an individual item of data requires searching the recorded data on the tape until the desired item is located.

- A sequential-access memory such as *magnetic tape* is organized by arranging memory cells in a linear sequence. These do not have unique storage address that can be directly addressed. Instead, data is presented serially for writing and is retrieved serially during a read.

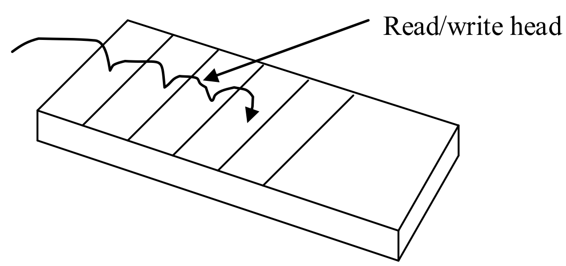

Figure 3.7: Sequential Access Memory

- In case of a ***random access*** device the information is available at random, i.e., any location in the device may be selected at random. So any location in the device can be accessed in approximately equal time in any order. In other words, we can say that each storage position (1) has a unique address and (2) can be individually accessed in approximately equal time without searching through other storage positions. Magnetic disk and CDROM are typical random access storage devices. Any data record stored on a magnetic or optical disk can be accessed directly in approximately the same time period. The Figure 3.8 shows sequential versus direct access storage:

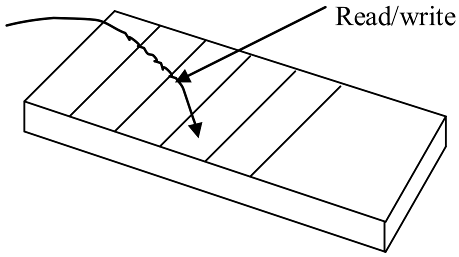

Figure 3.8: Random Access Memory

Basic Storage Fundamentals

Data is processed and stored in a computer system through the presence or absence of electronic or magnetic signals in the computer's circuitry (ie. RAM) or in the media it uses (i.e. magnetic Disk). This is called a "two-state" or **Binary representation** of data. Transistor and other semiconductor circuits are either in conducting or in non-conducting states. For Magnetic media, such as magnetic disk or tapes, these two states are represented by having magnetized spots whose magnetic fields have one of two different directions or polarities.

For any electronic circuits, the conducting (ON) state represents the number 1, while the non-conducting (OFF) state represents the number 0.This is so only for positive logic. One can always have the reverse convention that we call negative logic. For magnetic media, the magnetic field of a magnetized spot in one direction represents a 1 while magnetism in the other direction represents a 0.

For any electronic circuits, the conducting (ON) state represents the number 1, while the non-conducting (OFF) state represents the number 0

The smallest element of data is called a bit, which can have a value of either 0 or 1. The capacity of a memory chip is usually expressed in terms of bits. A group of 8-bits is known as a byte, which represents one character of data in most computer coding schemes. Thus, the capacity of a computer's memory and secondary storage devices is usually expressed in term of bytes. Computer codes such as ASCII (American Standard Code for Information Interchange) use various arrangements of bits to form bytes that represent the numbers 0 to 9, the letters of the alphabet, and many other characters.

☞ Check Your Progress 1

1. State whether **True** or **False**
   a) Primary memory is faster than secondary memory but that has a larger capacity.
   True ☐ False ☐
   b) Primary memory is mainly used for bulk storage. True ☐ False ☐
   c) CD-ROM is a Random access storage device. True ☐ False ☐

d) When we load software from a floppy, hard disk or CD-ROM, it is stored in main True ☐ False ☐

e) In Random access memory any memory location can be accessed directly.

True ☐ False ☐

f) Non-volatile memory means the stored data are lost when power goes off.

True ☐ False ☐

2. Differentiate between the following:

a) Primary (main) memory versus secondary memory

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b) Different types of memory (in terms of access speed, storage capacity and cost per bit storage).

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c) A graph showing Capacity versus access time for different types of memory.

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d) Random versus Sequential access.

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3.2.1 Semiconductor (Main) Memory

- All computers except very small computers contain both semiconductor as well as magnetic memory.
- All modern computers use semiconductor memory as its main memory (or primary memory). Semiconductor memory is known as Random access memory (RAM) because any part of the memory can be accessed for reading and writing.
- It stores programs and data which are currently needed by the CPU.
- Another part of main memory is Read Only Memory (ROM). ROMs are those memories on which it is not possible to write the data. They can only be read.
- Thus RAM and ROM memories are used as the main memory of the computer.
- The Main memory holds the programs and data required by the CPU for carrying out its operations.
- The primary (main) storage is a semiconductor device that is built using integrated circuits. The data is stored in binary form in main memory. Numeric as well as non-numeric data can be represented in binary form. With two binary digits, we can represent 4 different characters. With three binary digits, we can represent 8 different

characters. Computers internally use eight binary digits to represent characters and digits (A binary digit is referred to as a bit and 8 bits are called a byte). 256 characters can be represented by a byte.

Storage capacities are frequently measured in **Kilobytes** (KB), **Megabytes** (MB), **Gigabytes** (GB), or **Terabytes** (TB)

The capacity of a computer's memory is usually expressed in terms of bytes. Computer codes such as ASCII (American Standard Code for Information Interchange) use various arrangements of bits to form bytes that represent the numbers 0 to 9, the letters of the alphabet, and many other characters.

Storage capacities are frequently measured in **Kilobytes** (KB), **Megabytes** (MB), **Gigabytes** (GB), or **Terabytes** (TB). Table 3.4 summarizes the commonly used names with abbreviations and number of bytes for these storage capacities.

Table 3.4: Commonly used names, Abbreviations and storage capacity in bytes.

Name (Abbreviations)	**Number of Bytes**
Byte (B)	1
Kilobytes (KB)	1024
Megabytes (MB)	1024*1024 (about one million)
Gigabytes (GB)	1024*1024*1024
Terabytes (TB)	1024*1024*1024*1024

Types of Main Memory

Memory can be of various types like Random Access Memory (RAM) and Read-Only Memory (ROM). Figure 3.9 summarizes the different types of main memory.

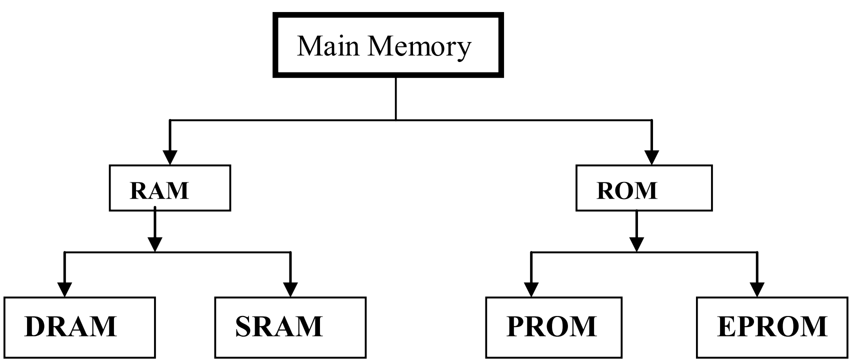

Figure 3.9: Different types of Main Memory

RAM (Random Access Memory)

- The Read and write memory (R/W memory) of a computer is called a RAM. The user can write information into RAM and read information from it. It is called **random access** since any memory location can be accessed in a random manner for reading and writing. The access time is the same for each memory location. It usually refers to "temporary" memory, which means that when the system is shut down, the memory is lost.

- ***Random Access Memory*** (RAM) is really the main store and is the place where the program and software we load gets stored. When the CPU runs a program, it fetches the program instructions from the RAM and carries them out. Similarly, if the CPU needs to store the final results of calculations, it stores them in RAM. Thus, the CPU can both READ data from RAM and WRITE data into the RAM.
- There are two important types of RAMs:
  - Static RAM (or SRAM)
  - Dynamic RAM (or DRAM)
- Static RAMs retain stored information only as long as the power supply is on whereas a Dynamic RAM loses its stored information in a very short time (a few milliseconds) even though the power supply is on.
- Dynamic RAMs are cheaper and consume less power whereas Static RAMs are costlier and consume more power. Static RAMs have a higher speed than dynamic RAMs.
- Dynamic RAM is cheaper and so is used for main memory. Static Ram is faster and so is used in cache memory.
- Dynamic RAM requires the data to be refreshed periodically in order to retain the data while SRAM does not need to be refreshed.

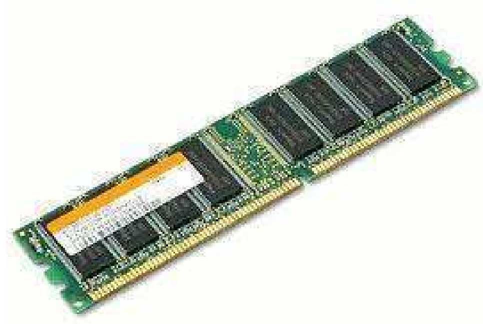

Figure 3.10 : Random Access Memory

Both static and dynamic RAMs use CMOS technology. CMOS devices consume less power. Static RAMs hold information in a flip-flop circuit consisting of two cross coupled inverters. In a RAM the memory cell must be associated with a read and write facility. Six (6) transistors are needed per memory cell in a static RAM. Dynamic RAMs required fewer transistors per memory cell. The following are commonly used RAM chips:

- **EDO (Extended Data Output RAM):** In an EDO RAM any memory access stores 256 bytes of data into latches. The latches hold next 256 bytes of information, so that in most programs which are sequentially executed, the data are available without wait states.
- **SDRAM (Synchronous DRAM) and SGRAM (Synchronous Graphics RAM):** These RAM chips use the same clock rate as the CPU uses. As a result the memory chips remain ready to transfer data when the CPU expects them to be busy. SDRAM is often used as mass storage whereas SGRAM is used as a high end graphics memory.
- **Dual-Ported DRAM:** These types of RAM allow one to access two memory locations simultaneously. Sometimes it is also called video RAM (or VRAM). WRAM (Window RAM) is a special version of VRAM, which is commonly used in PCs running WINDOWS and WINDOWS applications.

- **SIMM and DIMM:** These stand for single-Inline and Double Inline Memory Modules. These are small printed circuit cards, on which several DRAM memory chips are placed. Such cards are plugged into the system board of the computer.

ROM (Read Only Memory)

- A ***Read-Only memory*** (ROM) is a **non-volatile** memory, i.e., the information stored in it is not lost even if the power supply goes off. Thus a Read Only Memory (ROM) is one in which information is stored permanently.
- Unlike RAM, the information from ROM can only be READ and it is not possible to WRITE fresh information to it. That is, the CPU can only fetch or READ instructions from ROM. This is the reason why it is called ROM. Computers almost always contain a small amount of ***Read-Only memory*** (ROM). It is much cheaper compared to RAMs when produced in large volumes.
- ROM is used for storing a special set of instruction, which the computer needs when it starts up (boots up).
- The contents of ROMs are decided by the manufacturers. The contents are permanently stored in a ROM at the time of manufacture.
- From the programming mode point of view, we have
  - Masked-programmed
  - User-programmed
- ROMs in which contents are written at the time of IC manufacture are called *mask-programmed* ROMs. PROM, EPROM and EEPROM or any other kind of PROM are *user programmable* ROMs. If we simply write (or say) ROM it means masked programmed.
- An example of a ROM is the Toshiba mask ROM, TCS 534000.

PROM (Programmable ROM)

- A variation of ROM chip is programmable read only memory (PROM). A PROM is a memory chip on which data can be written only once.
- ROM chips are supplied by computer manufacturer and it is not possible for a user to modify the programs stored inside the ROM chip. However, in case of PROM, it is possible for a user to customize a system by storing own program in a PROM chip.
- Once a program has been written on to a PROM chip, the recorded information cannot be changed i.e., the PROM becomes a ROM and it is only possible to read the stored information.

- PROM is also a **non-volatile** memory i.e. the stored information remains even if power is switched off.
- The basic difference between 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 on 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.

Table: 3.5: Memory and its Features

Memory	Category	Volatility	Writing Mechanism	Erasure
RAM	Read-write memory	Volatile	Electrically	Electrically
ROM	Read-only memory	Non-volatile	Mask	Not-possible
PROM	Read-only memory	Non-volatile	Electrically	Not-possible
EPROM	Read-only memory	Non-volatile	Electrically	Using UV light
EEPROM	Read-only memory	Non-volatile	Electrically	Electrically

3.2.2 Magnetic Memory

In the above section we have seen various types of semiconductor RAMs. These high speed semiconductor storage devices (i.e. RAMs) are expensive. So we need some inexpensive media for storage. Also semiconductor memory has the following limitations:

1) **Limited Capacity**: Semiconductor (primary) memory of today's computers is not sufficient, since most of the data processing organizations deal with a large volume of data.
2) **Volatile Memory**: Semiconductor memory is volatile in nature. But there is always a need to store data on a permanent basis.

Thus there is a need of additional memory, that is inexpensive, non-volatile in nature and has large capacity. Magnetic material is inexpensive and long lasting, so it is an ideal choice for us. Magnetic memory is a permanent non-volatile, type of memory. Now-a-days, we are not using floppy disk.
A modern computer uses the following two types of magnetic memory:

(i) **Magnetic Disks**: Hard disks and Floppy disks.

(ii) **Magnetic Tapes** : Magnetic disks are the most common form of secondary storage because they provide fast access and high storage capacities at a reasonable cost.

Storage Mechanism: Magnetic disk drives contain metal disks that are coated on both sides with an iron oxide recording material. Several disks are mounted together on a vertical shaft which typically rotates the disks at speeds of 3600 to 7600 revolutions per minute (rpm). Electromagnetic read/write heads are positioned by access arms between the slightly separated disks to read and write data on concentric, circular tracks. Data are recorded on tracks in the form of tiny magnetized spots to form the binary digits of common computer codes. Thousands of bytes can be recorded on each track, and there are several hundred data tracks on each disk surface, which provides billions of storage positions for your software and data.

There are basically **two types** of magnetic disk arrangements, one having a removable disk cartridge and other having a fixed disk unit. Removable disk devices are popular because they are transportable and can be used as backup copies of your data.

Data Organizations: A magnetic disk is a surface device, which stores data on its surface. Its surface is divided into circular concentric tracks. The number of tracks on a disk range up to 800. Each track is divided into sectors (normally 10-100). These sectors can be either fixed or variable length sectors. The division of track into equal sized blocks or pages is set by the Operating system during disk formatting. The number of bytes stored in each sector is kept the same.

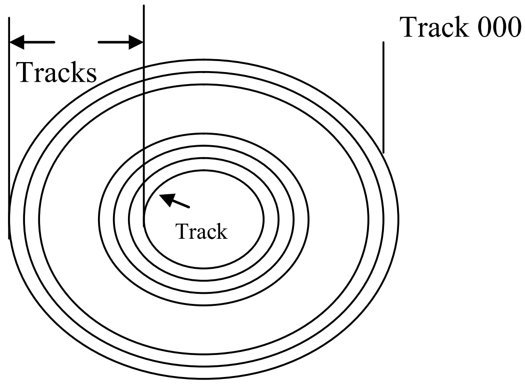

Figure 3.11 (a): tracks on disks. The no. of tracks

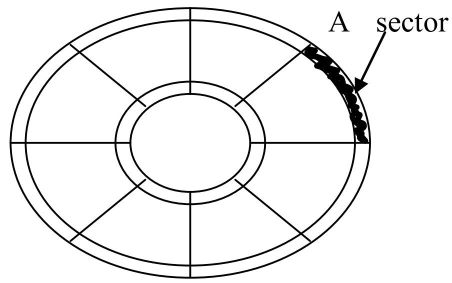

Figure 3.11 (b): Sectors of a disk.

The numbers vary but there are often 200 or more ranging up to 800 is sectors per track. Magnetic disks are semi-random devices. A track on a disk is selected in a random fashion, but data is written to or read from a sector in serial fashion.

Hard-Disk Drives (HDD)

- Hard disks are on-line storage devices.
- The term online means that the device (hard-disk) is permanently connected to the computer system and when the computer is on, the device (hard-disk) is available to store information or to retrieve information.
- HDD stores programs, data, operating system, compiler, assemblers, application programs etc.

Storage Organization in HDD

- HDD contains magnetic disks, access arms and read/write heads into a sealed, air filtered enclosure. This technique is known as **Winchester technique**.
- Winchester disk is another name for "hard disk drive". There are two stories behind the name Winchester disks; one is that the disk was developed at IBM's facility at *Winchester*, New York State; that had 30MB of fixed storage and 30MB of removable storage; the other is that the first model number was given as 3030, which is also the model number of the well-known *Winchester* Rifle popular in the Wild West. Although modern disk drives are faster and hold more data, the basic technology is the same, so *Winchester* has become synonymous with *hard disk.*
- Thus Winchester disk is a sealed "hard disk" having rotation speed typically 7200 rpm. A disk has 5000 to 10,000 concentric tracks per centimeter and about 100,000 bits per centimeter around circumference. Figure 3.12 illustrates a portion of Winchester disk.

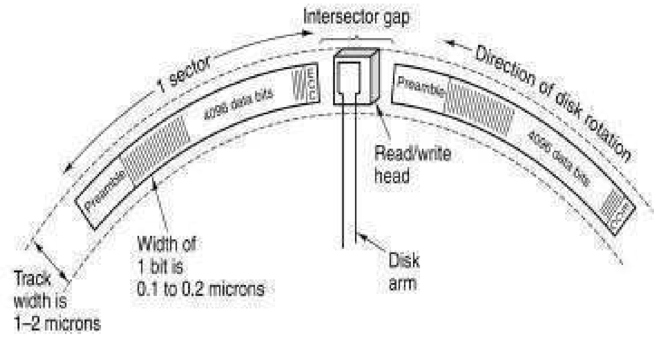

Figure 3.12: Winchester disk- a portion of disk track

- The read/write head reads data from the disk and writes data to the disk. A disk is mounted (or stacked) on the disk drive, which has the motor that rotates it. Hard-disks together with read/write heads, access mechanism and driving motor constitute a unit called **hard-disk-drive (HDD) unit**. The whole unit is fixed.
- Hard disk is also known as **platter**. It can not be removed or inserted into a HDD unit. Some disks have a single platter e.g. floppy disk.
- To increase the storage capacity several hard-disks (platters) are mounted (stacked) vertically, normally at a distance of an inch. This is known as **disk pack** or **multi-platter configuration**.
- A set of corresponding tracks in all surfaces of a disk pack (i.e. the tracks with the same diameter on the various surfaces) is called a **cylinder** (see Figure 3.13). Here the concept of cylinder is very important because data stored on the same cylinder can be retrieved much faster than if it were distributed among different cylinders.

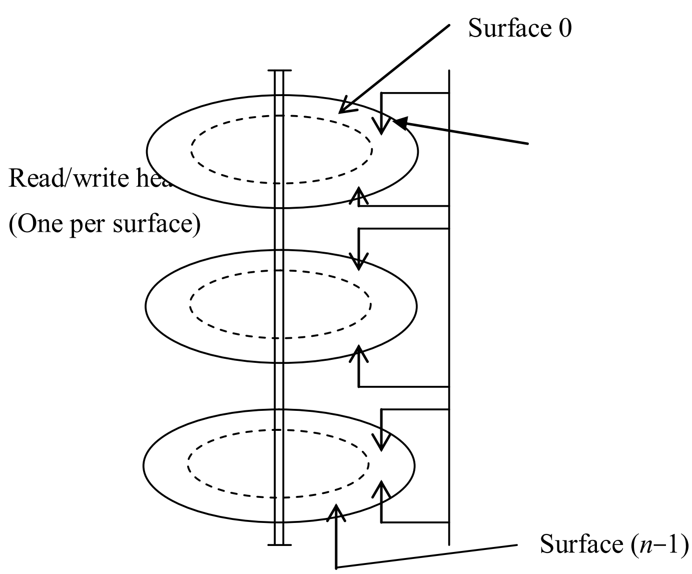

Figure 3.13: A disk having n platters (0 to n-1 plates). A set of corresponding tracks on all the (n-1) Surfaces, at a given radial distance, is called a cylinder

Relationship among Capacity, density and speed

Suppose a HDD (or disk pack) having n plates, has:
m=2n= total number of recording surfaces
t= tracks per surface
p= Sectors per track
s=bytes per sector,
π=3.14 then

- Storage capacity of the disk=(m*t*p*s) bytes
- If d is the diameter of the disk, the density of the recording is:
  Density=(s*p)/(π*d) byte/inches

Example 1: A 2.5 inch diameter disk pack has 6 plates (12 recording surfaces), 256 sectors per track, 5250 tracks per surface, 512 byes per sector. Thus disk capacity = 12×5250×256×512=8,257,536,000 bytes = 7.69 GB and recording density= (512×256)/(3.14×2.5)=16697 bytes/inch.

Example 2: What will be the storage capacity of a 2.5 inch diameter disk pack having 8 plates, 400 sectors per track, 2820 tracks per surface where 512 bytes of data can be stored per sector.

Solution: Total number of recording surface (m) = 2n = 2*8=16
Storage Capacity=16*2820*400*512 = 9240576000 bytes = 8.6 GB

There are several disk drives (C,D,F etc.) in a computer, which are connected to a **disk controller**. The controller converts instructions received form the computer (software) to electrical signals to operate disks. The Disk controller accepts commands from the computer and positions the read/write head of the specified disk for reading or writing.

For reading or writing operations on a disk pack, the computer must specify the drive number, cylinder number, surface number, and sector number. The drive number must be specified, because a controller normally controls more than one drive. Table 3.6 shows a disk address format for a disk controller of 8 drives, each disk pack having 250 cylinders, 12 surface and 256 sectors.

Table 3.6: Disk address format

Drive number	**Cylinder number**	**Surface number**	**Sector number**
3-bits	13 bits	4 bits	8-bits

Access time on a magnetic disk

Magnetic disks are semi-random devices. A track on a disk is selected in random fashion, but data is written to or read from a sector in serial fashion. In order to access information from a disk, the disk address of the desired data has to be specified. The disk address is specified in terms of track number, surface number and the sector number. Information is always written from the beginning of a sector and can be read only from the track beginning.

The time required to position the read/write head over proper track is called the **seek time**

As soon as the read/write command is received by the disk controller, the read/write heads are first positioned onto the specified track number (or cylinder) by moving the arm assembly in the proper direction. The time required to position the read/write head over proper track is called the **seek time.**

Seek time (Ts): The time required to move the read/write head on a specific (address) track.

- Seek time varies depending on the position of the arm assembly when a read/write command is received.
- Seek time will be maximum, if the arm assembly is positioned on the outer most track and the track to be reached is the inner most one and it will be zero if the arm assembly is already on the desired track.
- The average seek time is thus specified for most systems which is generally between few milliseconds to fractions of a second.

Note that seek time is associated only with movable-head system. For a fixed-head system, it is always 0 because there is a head for each track and no head movement is required for accessing a particular track.

Time required to bring the needed data (i.e. starting position of the addressed sector) under the read/write head is called the **latency time**

Once the heads are positioned on the desired track, the head on the specified surface is activated. Since the disk is continuously rotating, this head should wait for the desired data (specified sector) to come under this head. This rotational waiting time i.e. time required to bring the needed data (i.e. starting position of the addressed sector) under the read/write head is called the **latency time**.

Latency Time (t_L) or **Search time:** Time required to bring the needed data under the R/W head. Latency time is also a variable and depends on the following two parameters:

- Distance of the desired data from the initial position of the head on the specified track.
- Rotational speed of the disk.

The average seek time is thus normally specified for most systems which is generally of the order of 10 to 15 milliseconds.

The total access time for a disk is equal to the seek time plus the latency time.

Access time = Seek time + Latency time

The average access time for most disk systems is usually between 10 to 100 milliseconds.

Pen Drive

Now-a-days a Pen Drive is available as a very convenient and flexible data storage medium which can store up to 256 GB data. It can be used for the same purposes as floppy-disks or CD-ROMs. Pen Drives are a smaller, faster, durable and more reliable storage medium. Compared to floppy disks or CD-ROMs it has thousands of times more data storage capacity. It is a portable USB flash memory device. It is integrated with a USB (Universal Serial Bus) interface. It can be used to quickly transfer data from one system to another. The pen drive derives its name from the fact that many of these devices resemble a small pen or pencil in shape and size. Flash drives implement the USB mass storage device class so it is possible for modern operating systems to read and write from them without installing the device driver software. Some computers can even boot up from flash drives.

Figure 3.14: Pen Drive

Magnetic Tapes

A Magnetic tape is a sequential access type secondary storage device. It is used for backups in servers, workstations, and large computers. The main advantages of magnetic tapes are that they are cheaper and since these are removable from the drive, they provide unlimited storage capacity (20 GB to 150 GB).

The read/write heads of magnetic tape drives record data in the form of magnetized spots on the iron oxide coating of the plastic tape. Magnetic tape devices include tape reels and cartridges in mainframes and midrange systems, and small cassettes or cartridges for PCs.

The main drawback of magnetic tapes is that they store information sequentially. A file or some particular information stored on a magnetic tape cannot be accessed directly o random basis as is possible in the case of hard-disks or floppy disks. These devices a slower, but due to their low cost, they are still widely used for massive data warehouse and other business storage requirements.

The storage capacity of a tape is measured by multiplying its length and data recording density

The storage capacity of a tape is measured by multiplying its length and data recording density. Data recording density is the amount of data that can be stored on a given length of tape. That is,

Storage Capacity = data recording density * length

Example 1 : If a tape length is 3400 feet long and has a data recording density of 900 bpi (bytes per inch) its storage capacity will be 3400*12 inches *900 bpi =36720000 bytes.

☞ Check Your Progress 2

1. State **True** or **False :**
   a) ROM is a volatile type of memory. True ☐ False ☐
   b) 1 Terabyte (1 TB) equals 2^{30} bytes. True ☐ False ☐
   c) Magnetic disk has higher storage capacity than Magnetic tape. True ☐ False ☐
   d) The basic difference between PROM and a ROM is manufactured as blank that a PROM is memor, whereas a ROM is programmed during the manufacturing process. True ☐ False ☐
   e) When we load software from a floppy disk, hard disk or CD-ROM, it is stored in the main memory. True ☐ False ☐
   f) Tracks with the same diameter on the various surfaces are known as a cylinder. True ☐ False ☐
   g) Time required to bring the needed data under R/W. head is known as seek time. True ☐ False ☐
   h) Access time is the sum of seek time and latency time. True ☐ False ☐

Multiple Choice Questions

2) The different types of memory units are:
   a) RAM
   b) ROM
   c) PROM
   d) All of the above
3) Which of the following memory loses it contents when the computer is turned off?
   a) RAM
   b) ROM
   c) PROM
   d) All of the above
4) Which of the following memory chips is programmed during the manufacturing process?
   a) RAM
   b) ROM
   c) PROM
   d) EEPROM
5) An EEPROM can be erased by exposing it to:
   a) Sunlight
   b) Ultraviolet Radiation
   c) Magnetic field
   d) Electric Charge

6. Match the following:

i) Semiconductor memory	a) Hard-disk
ii) Magnetic memory	b) CD-ROM
iii) Optical memory	c) Floppy disk
iv) Double side double density	d) RAM

7. Suppose in your library the following types of memory are present:
   RAM, ROM, PROM, EPROM, and EEPROM.
   Differentiate between these memories on the basis of their volatility.
8. A 2.5 inch diameter disk pack has 6 plates (12 recording surfaces), 256 sectors per track, 5268 tracks per surface, and 512 byes per sector. Find the capacity and recording density of the disk pack.
9. Explain the following terms with respect to. magnetic memory:
   a) Seek time and Latency time
   b) Track, sectors and cylinder

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3.2.3 Optical Memories

Optical memories or Optical disks are alternate mass storage devices with huge capacity (up to 20 GB). Information is written to or read from an optical disk using a laser beam. Only one surface of an optical disk is used to stored data. An optical disk is relatively inexpensive, and has a long life of at least 15 years. Since the read/write head does not touch the disk surface, there is no problem of disk wear or head crash. The main draw back of the optical disk system is its slow average access time. Here, we will discuss 3 types of optical disks:

1. CD-ROM (Compact-Disk Read Only Memory)
2. WORM (Write Once Read many) or CD-R (CD-Recordable).
3. Erasable Optical Disk
4. DVD-ROM, DVD-R and DVD-RAM

(1) **CD-ROM**

CD-ROM technology uses 12-centimeter (4.7-inch) compact disks (CDs) similar to those used in stereo music systems. Each disk can store more than 600 MB. That is approximately equivalent to 400 1.44 MB floppy disks or 300,000 double-spaced pages of text.

First of all a master disk is prepared. On a master disk, a laser records data by burning permanent microscopic pits in a spiral track to represent 1. From a master disk, CD-ROMs are produced on mass scale. Then CD-ROM disk drives use a laser device to read the binary codes formed by those pits.

For reading the data a laser beam of lower intensity is employed. A laser system needs 25mW for writing whereas only 5mW are needed for reading.

CD-ROMs use long spiral tracks to store data serially, as shown in Figure 3.15. The track is divided into blocks of same size as shown in the figure. A CD-ROM disk rotates at a variable speed so that the pits are read by the laser at a constant linear speed. The speed of the disk is adjusted in such a way that the track passes under the read/write head at a constant linear velocity.

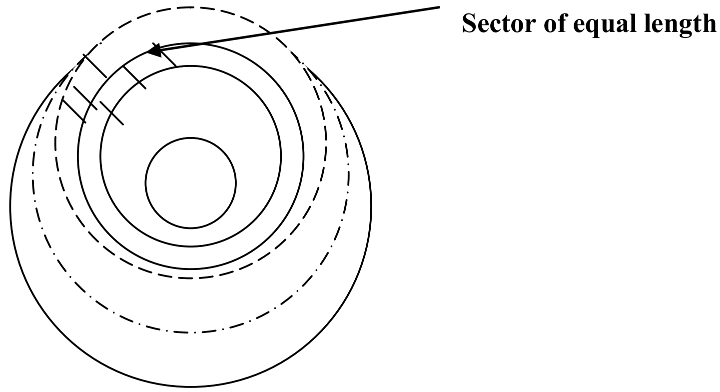


Figure 3.15: A CD-ROM disk layout

Advantages

- High storage capacity.
- Cost per bit of storage is cheaper than the other types of memory devices.
- Removable from the computer, so suitable for archival storage. 5.25 inch disks store 650 MB data.

Disadvantages

- Longer access time as compared to that of a magnetic hard disk (because locating a desired address involves first moving the head to the specific area then adjusting the rotating speed and then reading the address, and then to find and access the specific sector).
- Information can not be updated because it is a read-only (permanent) memory.

(2) **WORM or CD-R (CD-Recordable)**

CD-R (compact-disk recordable) is another optical disk technology. The user can record (write) their own data once on a CD with a CD-R disk drive unit. After this recording user can read the data as many times as desired.

CD-R is suitable for data and files which are not to be changed. The user can store permanent data, information, and files for maintaining records.

Advantages and Limitations

- High storage capacity.
- Better reliability and long life.
- Greater access time as compared to a hard-disk.

(3) **Erasable Optical disk or CD-RW (CD-rewritable)**

The major limitation of CD-ROM and CD-R disks is that recorded data can not be erased. However, CD-RW (CD-rewritable) optical disk systems have now become available which record and erase data by using a laser to heat a microscopic point on the disk's surface.

Advantages and limitations

- Very high storage capacity. A 5.25 inch optical disk can store about 650 MB data
- It is more reliable and has a long life.
- Longer access time as compared to that of a hard-disk.

(4) **DVD-ROM, DVD-R and DVD-RAM**

DVD stands for **Digital Video Disks** or **Digital Versatile Disks**. A DVD stores much more data than a CD-ROM. Its capacities are 4.7GB, 8.5GB, and 20GB etc. The capacity depends on whether it is a single layer, double layer; single sided or double sided disk. DVD uses laser beam of shorter wavelength than CD-ROM uses and therefore more tracks are available. Working principles of DVD disks are same as those of a CD-ROM, CD-R or CD-RW.

The Speed of CD-ROM or DVD-ROM is given in terms of nX, where n is an integer. For example 32X. In case of CD, X=150 KB/s, so 32X=32x150=4.8 MB/s. In case of DVD, X=1.38 MB/s.

DVD-R: It is a recordable DVD, same as a CD-R disk. The user can write data once on a DVD-R, then read the data as many times as required.

DVD-RAM: It is a rewritable DVD, same as a CD-RW disk. DVD-RAM uses a phase change technology to write, read and erase data.

Table 3.7 summarizes the different types of secondary (auxiliary) memory devices

Table: 3.7: Different types of Secondary Memories and its Features

Medium	**Capacity**	**Advantages**	**Disadvantages**	**Primary Uses**	**Storage mechanism**
Hard Disk	Variable	Usually integrated into the PC • very robust	• Slower computer performance when disk is full	• To store data and files • To store software	Magnetic
Pen Drive	1 GB-256 GB	Portable Large storage capacity Smaller, faster and reliable	Most USB flash drives do not include a write-protect mechanism. Due to its small size they can easily be misplaced or lost.	• To store data and files. For transferring data and files between computers	
CD-ROM/ CD-R/CD-RW	650-700 MB	Portable & Medium storage capacity • Inexpensive • Some types (CD-RW) can be reused i.e. rewritable disk. • Can be used in certain models of DVD players	Some older computers cannot read CD-RW media • CD-R discs are 'write once', which means once data is copied to it, new or additional data cannot be added	To store files and software • To store archive material from hard disks • To store scanned files such as exam papers • To store applications from the Internet	Optical
DVD-ROM DVD±R DVD±RW	4.7GB to 8.5GB	• Large storage capacity • Some types (DVD±RW) can be reused or rewritable. • Can be used in certain models of DVD players.	• Not all computers can read DVD±R or DVD±RW disks. DVD±R discs are 'write once', which means once data is copied to it, new or additional data cannot be added	Same as.. CD-ROM/ CD-R/CD-RW	Optical
Magnetic tape	20GB to 2TB +	• Very Large storage capacity • Disks are durable, robust and rewriteable • Inexpensive	• Data cannot be accessed immediately • Requires tape drive and third party software • Tape drives for large capacity tapes can be very expensive	• To store files • Ideal for large scale daily and weekly backup operations, particularly for servers.	Magnetic

3.3 MEMORY HIERARCHY AND THEIR NEEDS

Every programmer wishes to have a large and fast memory. However, the two requirements are conflicting. Fast memories are expensive and small; and slow memories are cheaper and large. To give a user the illusion of both fast and large, the memory system of modern computers is organized in a hierarchical way. The very top of the hierarchy is CPU registers, between the CPU and main memory, a fast cache memory is added. The hard disk is used by the technique of virtual memory to expand the capacity of main memory. Most computer systems make use of a hierarchy of memory technologies as a single type of memory is not sufficient. This hierarchy is known as the memory hierarchy.

Most computer systems make use of a hierarchy of memory technologies, this hierarchy is known as the memory hierarchy

In the previous section, we have discussed the various types of memory systems such as semiconductor (main) memory, Magnetic memory and Optical memory. In this section, we will discuss the hierarchy of these memory systems.

As you have seen in the previous section faster memory technology (such as semiconductor memory) is more expensive. In addition fast memory requires power supply till the information needs to be stored. Furthermore, the memory with less cost (such as Optical memory) have very high access time, that is the time taken by CPU to access the memory location is high, which result in a slower operation of CPU. Thus the cost versus access time leads to a memory hierarchy. The overall goal of Memory Hierarchy is to obtain the highest possible access speed while minimizing the total cost of the memory system. Figure 3.16 (a) illustrates the components of a typical memory system.

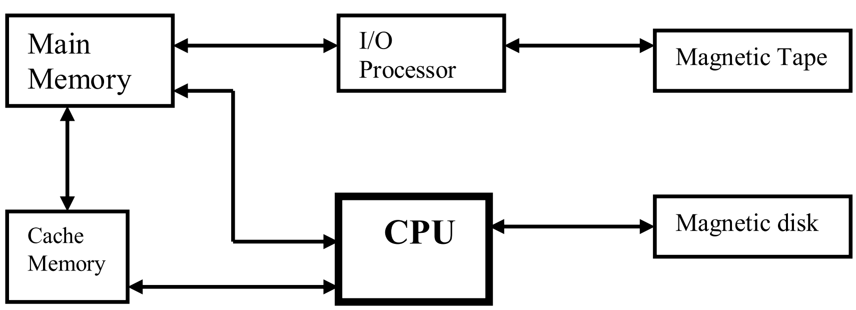


Figure 3.16 (a): Components of Memory System

A computer system uses a variety of devices for storing the instructions and data. A storage devices (or units) may vary according to the *access time*, *storage capacity*, and *cost-per-bit of storage*, as discussed in the previous section. Based on these criteria, a memory system can be considered to consist of three groups of memories.

1. **Processor's internal (CPU) memories:** consisting of the small set of high speed registers which are internal to a processor and are used as temporary locations where actual processing is done.
2. **Primary (main) memory:** It is a fast and large memory but slower than processor memory. Primary memory has faster access time, smaller storage capacity and higher cost per bit storage. This memory is accessed directly by the processor. It stores programs and data which are currently needed by the CPU. The size of the main memory is kept small because of its high cost.

3. **Secondary (or auxiliary) memory:** The secondary memory is mainly used for bulk storage (mass storage) of programs, data and other information. It has much larger capacity than main memory but slower than main memory. It basically stores system software, compiler, assembler and useful packages, large data files etc.

A typical storage hierarchy is shown in Figure 3.16(b).

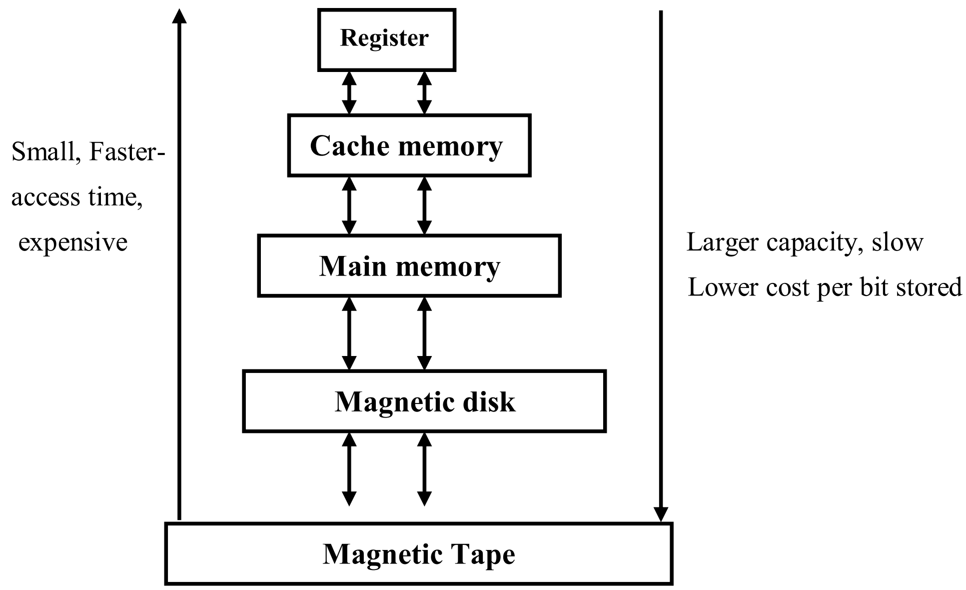


Figure 3.16 (b): The Memory Hierarchy

A block diagram of storage hierarchy, as shown in Figure-3.16(b) includes:

- CPU (register)
- Cache memory
- Main memory
- Secondary storage, and
- Mass storage

As we move up the storage hierarchy, we encountered memory elements having faster access time, less capacity and higher cost per bit stored. When we move down, we have a larger storage capacity, slower access time and lower cost per bit stored. Thus, CPU storage components generally have the fastest access time, the smallest storage capacity and the highest cost per bit stored. The cache memory which is placed in between the CPU and the main memory is a very high speed semiconductor memory used to enhance the speed of main memory. The main (primary) memory falls next in the memory hierarchy list. Secondary storage media such as hard-disk/magnetic disk memories make up the level of hierarchy just below the main memory. Secondary storage devices are at the bottom of the memory hierarchy. Secondary storage devices such as magnetic tapes are used for archival storage. They are very cost effective and so are used for mass storage of data, when fast access time is not required.

☞ **Check Your Progress 3**

1. State **True** or **False :**
   a) Cache memory is faster than the Register (CPU) memory. True ☐ False ☐
   b) Cache memory has a smaller capacity than the main memory. True ☐ False ☐
   c) Secondary memory has a faster access-time than primary memory True ☐ False ☐
   d) The main draw back of the optical disk system is its slow average access time. True ☐ False ☐
   e) CD-ROM has longer access time as compared to that of a magnetic hard disk. True ☐ False ☐
   f) In CD-R data can be read once and write indefinitely True ☐ False ☐
   g) The overall goal of Memory Hierarchy is to obtain the highest possible access speed while minimizing the total cost of the memory system. True ☐ False ☐
   h) Magnetic tape has a higher capacity than magnetic disk but slow access time than magnetic disk. True ☐ False ☐

2. Match the following:

1)	CD-ROM	a)	Write once read many times
2)	CD-R	b)	Read and write indefinitely
3)	CD-RW	c)	Read only
4)	DVD-ROM	d)	Write once, read indefinitely and having capacity up to 20GB

3. Differentiate between the following:
   a) CD-ROM, CD-R and CD-RW
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
   b) DVD-ROM versus DVD-RW
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
4. What is the overall purpose of the memory hierarchy? Name the general classes of storage media that might make up a memory hierarchy.
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………

3.4 SUMMARY

This unit basically outlines the storage organization, storage devices of different types of memory systems and the importance of the memory hierarchy.

The memory system is categorized according to access time, storage capacity and cost-per-bit of storage.

Based on these criteria memory is broadly categorised into two types:

- Primary memory
- Secondary memory.

All modern computers use semiconductor memory as its main memory (or primary memory). Semiconductor memory is known as Random access memory (RAM). Although it is a very fast memory but it is very expensive. Thus semiconductor (primary) memory of today's computers is not sufficient, since it has very limited capacity. Thus there is a need of an additional memory, which should be inexpensive, non-volatile in nature and having large capacity. Magnetic (secondary) memory is a permanent, non-volatile type memory. In this unit we have discussed the two types of magnetic memory namely magnetic disks (i.e. ,Hard-disk and floppy disk) and magnetic tapes. Magnetic disks are the most common form of secondary storage because they provide fast access and high storage capacities at a reasonable cost.

Another type of secondary storage is Optical memories or Optical disks. These devices provide a huge storage capacity (up to 20 GB), at a lower cost. Information is written to or read from an optical disk using a laser beam. An optical disk is relatively inexpensive, and has a long life of at least 15 years. Since the read/write head does not touch the disk surface, there is no problem of head crashes. The main draw back of the optical disk system is its slow average access time. Many software companies offer both operating system and application software on CD-ROM today. This technology has been the main catalyst for the development of multimedia in computing because it is used in multimedia external devices such as video recorders and digital recorders (Digital Audio Tape) which can be used for multimedia systems.

In this unit, we have discussed the various types of storage devices used by the computer system. A cost effective technique for the design of large computer systems is the use of a hierarchy of memory technologies. The overall goal of Memory Hierarchy is to obtain the highest possible access speed while minimizing the total cost of the memory system.

3.5 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. (a) False (b) False (c) True (d) True (e) True (f) False
2. (a)

Primary (semiconductor) memory	Secondary memory
• It is fast and large memory but slower than processor memory. Primary memory has faster access time, smaller storage capacity and higher cost per bit storage. • This memory is accessed directly by the processor. It stores programs and data which are currently needed by the CPU. The CPU communicates directly with the CPU. The size of the main memory is kept small because of its high cost. • It is made of **semiconductors** and uses VLSI technique. Mainly these are in the form of **Chips.**	• The secondary memory is mainly used for bulk storage (mass storage) of programs, data and other information. It has much larger capacity than main memory but slower than main memory. • It basically stores system software, compiler, assembler and useful packages, large data files etc. • These are magnetic and **optical devices.** Mainly these are in the form of **Floppy, Hard Disk and CD.**

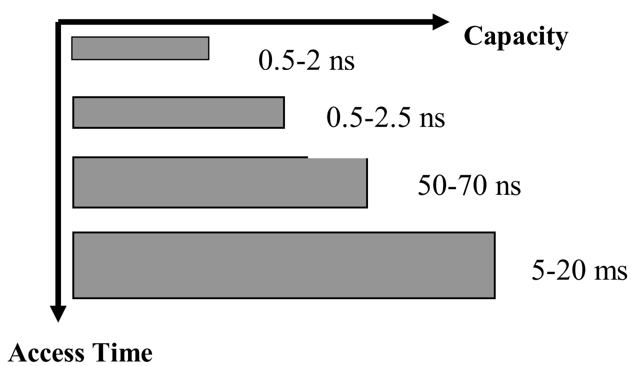
b) Different types of memory (in terms of access speed, storage capacity and cost per bit storage).

Primary memory and Secondary memory

	Access Time	Storage capacity	Cost/bit of storage
Primary memory	Faster	Smaller	High
Secondary memory	slower	higher	Low

As the **table indicates**, that the Primary memory (i.e. RAM, ROM etc.) have faster access time, smaller storage capacity, and higher cost per bit of storage, as compared to the secondary memory.

c) The following figure shows the relationship between the access-time and capacity of various types of memory.



Capacity vs. access-time

d) A ***Sequential-access*** memory device reads data in sequence. In other words, information on a serial device can only be retrieved in the same sequence in which it was stored. Data is recorded one after another in a predetermined sequence (such as in numeric order) on a storage medium. Sequential processing is quite suitable for such applications like preparation of monthly pay slips, or monthly electronic bills etc., where each address needs to be accessed in turn. If you are working with a sequential access device and information is stored at the last address, then data stored at the last address cannot be accessed until all preceding locations in the sequence have been traversed. That is locating an individual item of data requires searching much of the recoded data on the tape until the desired item is located. Example *magnetic tape*..

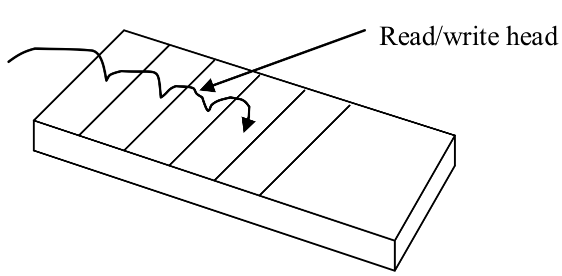


Figure 1: Sequential Access memory

- In case of ***random access*** device the information is available at random, i.e. any location in the device may be selected at random. So any location in the device can be accessed in approximately equal time. In other words we can say that each storage position (1) has a unique address and (2) can be individually accessed in approximately in equal time without searching through other storage positions. Magnetic disk and CDROM are the typical random access storage devices. Any data record stored on a magnetic or optical disk can be accessed directly in approximately the same time period. The following figure-2 shows sequential versus direct access storage.

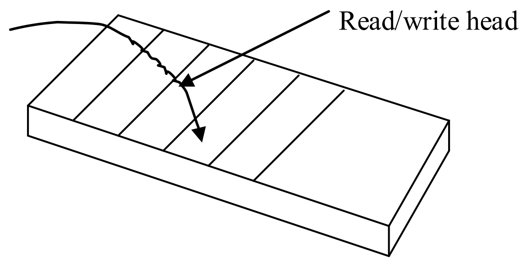


Figure 2: Random Access memory

Check Your Progress 2

1. (a) False (b) False (c) False (d) True (e) True (f) True (g) False (h) True
2. (d)
3. (a)
4. (b)
5. (d)
6. 1-(d), 2-(a), 3-(b), 4-(c)

7. Volatile memory means the stored data are lost, if the power goes off.. For example RAM is a **volatile** memory. A **non-volatile** memory means the information stored in it is not lost even if the power supply goes off. A ***Read-Only memory*** (ROM) is a non-volatile memory.

Memory	**Category**	**Volatility**	**Writing Mechanism**	**Erasure**
RAM	Read-write memory	Volatile	Electrically	Electrically
ROM	Read-only memory	Non-volatile	Mask	Not-possible
PROM	Read-only memory	Non-volatile	Electrically	Not-possible
EPROM	Read-only memory	Non-volatile	Electrically	Using UV light
EEPROM	Read-only memory	Non-volatile	Electrically	Electrically

8. **Disk capacity**= 12x5268x256x512=7.716 GB and
Recoding density= (512x256)/(3.14x2.5)=16688 bytes/inch.

9. a) **Seek time and Latency time :** The time required to position the read/write head over proper track is called the **seek time.** The time required to bring the needed data (i.e., starting position of the addressed sector) under the read/write head is called the **latency time**.

Latency Time (t_L) or **Search time**: Time required to bring the needed data under R/W head. Latency time is also a variable and depends on the following two things:

- Distance of the desired data from the initial position of the head on the specified track
- Rotational speed of the disk.
  Access time= Seek time + Latency time

b) **Track, sectors and cylinder :** A magnetic disk is a surface device, which stores data on its surface. Its surface is divided into circular concentric tracks. The number of tracks on a disk range up to 800. **Each track is divided into sectors (normally 10-100).** These sectors should be either fixed or variable length sectors. The division of track into equal sized blocks or pages is set by the Operating system during disk formatting.

A set of corresponding tracks in all surfaces of a disk pack (i.e. the tracks with the same diameter on the various surfaces) is called a **cylinder.**

Check Your Progress 3

1. (a) False (b) True (c) False (d) true (e) True (f) False (g) True (h) False
2. 1-c, 2-a, 3-b, 4-d.

3. **CD-ROM** technology uses 12-centimeter (4.7-inch) **compact disk (CDs)**. CDROM are the typical random access storage devices. Any data record stored on a magnetic or optical disk can be accessed directly in approximately the same time period.

Advantages

- High storing capacity.
- Mass copy of information stored, which is very cheaper.
- Removable disk from the computer, so suitable for archival storage. 5.25 inch disks store **650 MB data.**

CD-R (compact-disk recordable) is optical disk technology. The user can record (write) on it. It follows **write once and read many times** CD-R is suitable for data and files which are not to be changed. The user can store **permanent data**, information, and files for maintaining records.

Advantages

- High storing capacity.
- Better reliability and long life.

Erasable Optical disk or CD-RW (CD-rewritable)- As the name indicates the data written on it can be erased by using a laser to heat a microscopic point on the disk's surface.

Advantages

- Very high storing capacity. A 5.25 inch optical disk can store about 650.
- It is more reliable and having long life.

4. A *memory system* is a hierarchy of storage devices with different capacities, costs, and access times. CPU registers hold the most frequently used data. Small, fast *cache memories* nearby the CPU act as staging areas for a subset of the data and instructions stored in the relatively slow main memory. The main memory stages data stored on large, slow disks, which in turn often serve as staging areas for data stored on the disks or tapes of other machines connected by networks.

The overall effect is a large pool of memory that costs as much as the cheap storage near the bottom of the hierarchy, but that serves data to programs at the rate of the fast storage near the top of the hierarchy.

The overall purpose of Memory Hierarchy is to obtain the highest possible access speed while minimizing the total cost of the memory system.

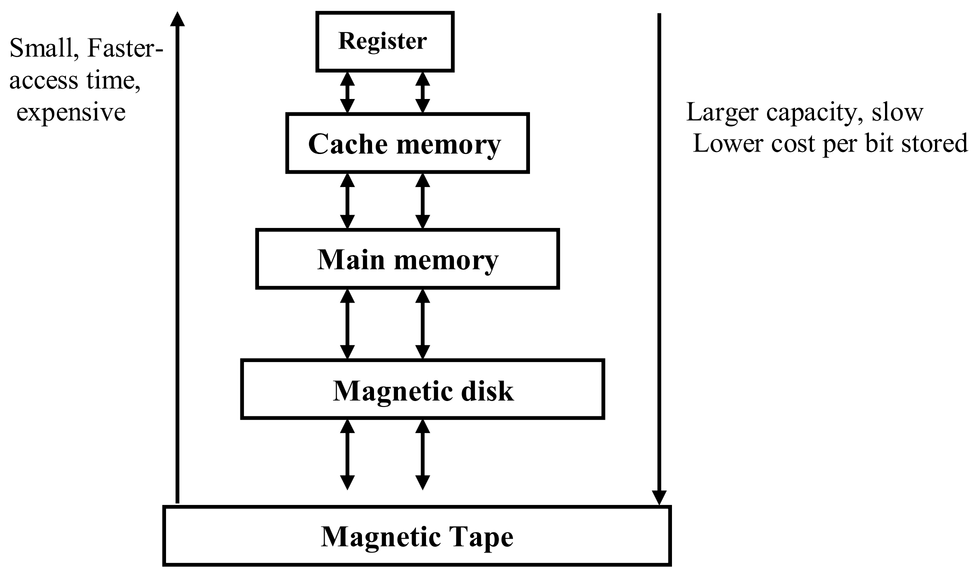


Figure 3: The Memory hierarchy

3.6 FURTHER READINGS

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UNIT 4 INPUT OUTPUT DEVICES

Structure **Page No.**

4.0 INTRODUCTION

In the previous unit, we have discussed the history of computer systems and methods to store data in computers. In this unit we shall discuss something about input/output devices and their functions. Input/output devices constitute a major part of a computer system. These are also called peripheral devices. Without I/O devices, a user cannot communicate with the computer. They are required to enter data and instructions in a computer so that the computer can process that data and provide the result to the user through output devices. In computer, inputs are the signals and data received by the system and outputs are the signals and data which are generated from the system.

First we will discuss briefly about input/output devices and then move on to the function and structure of input and output devices. And finally, we will discuss about recent trends in input devices such as digital camera, barcode reader, magnetic ink character recognition and magnetic stripe reader such as ATM machines and Electronic Point of Sale (EPOS).

4.1 OBJECTIVES

After studying this unit you should be able to understand:

- the basic concepts of input/output devices;
- functions of input/output devices;
- types of input/output devices;
- types of Ports;
- types of monitors, printers, scanners and graphics tablet; and
- newer technologies in computer hardware.

4.2 INPUT OUTPUT (I/O) DEVICES

Inputs are data or signals received by the computer system. An Input unit takes the input and converts it into binary form, so that it can be understood by the computer

The computer will be of no use if it is not communicating with the external world. Thus, a computer must have a system to receive information from the outside world and must be able to communicate results to the external world. Thus, a computer consists of input/output devices. Input and output devices can also be written as I/O devices.

Input and output devices of a computer system are the devices that connect you to computer. Input devices let you to transfer data and user command into the computer system. I/O devices are used to interact with the computer system. For example, you can type in data by using a keyboard, or you can input data in picture form by using a scanner in computer system.

On the other hand, output devices display the result of input data or signals after processing it. Examples of these could be your computer's monitor, which displays all the programs which are running on the computer, as well as the printer, which will print out a hard copy of the information which is saved in your computer.

Input and output devices allow the computer system to interact with the outside world by moving data into and out of the computer system.

Examples of some input devices are:

- Keyboard
- Mouse
- Joystick
- Microphone
- Bar code reader
- Graphics tablet
- Pen drive
- CD/DVD
- Digital Camera

An output device is used to send data out of the system. The user sees the result after processing of data by the computer through output devices. Examples of some output devices are:

- Monitor
- Printer
- Plotter
- Speaker

Input and output devices are also called I/O devices. They are directly connected to an electronic module called I/O module or device controller. For example, the speakers of a multimedia computer system are directly connected to a device controller called an audio card, which in turn is connected to the rest of the system.

Input and output devices are similar in operation but perform opposite functions. It is through the use of these devices that the computer is able to communicate with the outside world.

Input data for the computer system could be in any of the following forms :

- Manual inputs from a keyboard or console.
- Analog inputs from instruments or sensors.
- Inputs from a storage device, such as pen-drive, CD's and Floppy Drives.

The speed of a processor is far more than the input devices, such as the keyboard of computer system. Computer systems can process hundreds or thousands of computer words or characters per second. Thus, a study of the first method, i.e. manual input reflects the inability of human-operated keyboards or keypunches to supply data at a speed that matches the speed of digital computers.

☞ **Check Your Progress - 1**

Part I: State True/False

1) Keyboard is an input device.	True / False
2) Monitor is an input device.	True / False
3) Printer is an input device.	True / False
4) Graphic Tablet is an input device.	True / False
5) Joy-stick is an output device.	True / False
6) Speaker is an output device.	True / False
7) Microphone is an input device.	True / False

Part II: Short answer type questions

1) What do you mean by input devices?
…………………………………………………………………………………………….
…………………………………………………………………………………………….
…………………………………………………………………………………………….

2) What do you mean by output devices?
…………………………………………………………………………………………….
…………………………………………………………………………………………….
…………………………………………………………………………………………….

3) Name some input and output devices.
…………………………………………………………………………………………….
…………………………………………………………………………………………….
…………………………………………………………………………………………….

4.3 WHAT IS PORT ?

I/O ports are the interfaces through which computers communicate with external devices such as printers, modems, joysticks and terminals

Port is a connecting socket, outside the system into which different types of cables are plugged. It is a specific place from which other devices can be physically connected. I/O ports are the interfaces through which computers communicate with external devices such as printers, modems, joysticks and terminals. There are many types of ports used in computer system. Some of them are given as follows.

4.3.1 Parallel Port

Various peripherals can be connected through parallel port, which is a parallel communication physical interface. A parallel port transmits 8 bits of a byte of data in parallel. It is used for transmitting fast data over short distances. It is used to connect a printer to a computer. Since a parallel port transmits an entire byte at a time, it operates

I/O devices at a relatively high speed. A Parallel port is primarily used to connect printers to a computer and hence it is often called a printer port.

Figure 4.1: Parallel Port

4.3.2 Serial Port

Serial port transmits one bit of a byte, one at a time as a single stream of bits. It is meant for transmitting slow data over long distances. Communication over a phone is an example of serial communication. It is a serial communication physical interface which transmits one bit at a time. Dial-up modems and serial mice use serial ports.

Figure 4.2: Serial Port

4.3.3 Universal Serial Bus (USB)

A USB Port can connect up to 127 peripheral devices such as a digital camera, digital speakers, scanners, speakers etc. It permits *Plug and Play* – configuring of expansion cards and peripheral devices as and when they are installed.

Figure 4.3: USB

4.3.4 Small Computer System Interface (SCSI) Port

SCSI-Small Computer System Interface Port allows data to be transmitted in a daisy chain to up to 7 devices at a speed higher (32 bits at a time) than those possible with serial and parallel ports. It is a fast data transmitting device and is used to connect HDD, CD ROM drives and scanners with the computer system.

4.4 INPUT DEVICES

In this section we will discuss various types of input devices used for entering data into the computer system. These are:

4.4.1 Keyboard

It is the most common input device used for entering data and information into the computer system. This is the standard input device attached to all computers. The keyboard is a primary device for inputting text by pressing a set of keys. All the keys are neatly mounted in a keyboard connected to the computer system. Keyboard devices can be classified into two types **general purpose keyboards** and **special purpose keyboards**. General purpose keyboard are standard keyboards used with most computer system. They are called general purpose because that have enough keys to make them useful for any type of application. The layout of keyboard is just like the traditional typewriter of the type QWERTY. It also contains some extra command keys and function keys. It contains a total of 101 to 104 keys. You have to press a correct combination of keys to input data. The computer can recognize the electrical signals corresponding to the correct key combination and processing is done accordingly.

The User can enter data into the computer by pressing a set of keys on the keyboard. In a keyboard letters are printed on the keys. The first keyboard was developed in the 18th century and was named as a QWERTY keyboard. A Computer keyboard includes control circuitry which converts the key pressed by the user into key codes so that the computer can understand it. Now-a-days wireless keyboards are also being used which increase user freedom. The wireless feature is achieved by infrared signals or by radio frequency.

In general, a computer keyboard has following keys :

1. **Alphanumeric Keys:** It includes letters and numbers.
2. **Punctuation Keys:** These include comma, period, semicolon etc. and
3. **Special Keys:** These can be function keys, control keys, arrow keys and Caps lock keys etc.

Figure 4.4 : Keyboard

All the modern keyboards of computer are classified as:

(a) Original PC keyboard having 84 keys;

(b) Advance Technology (AT) Keyboard having 101-104 keys; and

(c) Multimedia Keyboard having 120 – 140 keys.

4.4.2 Mouse

A Mouse is a handy device which can be moved on a smooth surface to cause the movement of a cursor on the screen. It is a pointing device which is used to input data and information into the computer system by pointing on it. Physically, a mouse contains a small case, held under one of the user's hands with one or more buttons. For GUI-based systems a mouse is an essential pointing-device. The cursor of the mouse moves in the same direction in which the mouse ball rolls.

Figure 4.5: Mouse

Its name is derived from its shape, which looks a bit like a mouse, with its connecting wire that one can imagine to be the mouse's tail. A Mouse rolls on a small ball and has two or three buttons on the top. When you roll the mouse across a flat surface on the screen, sensors sense the mouse in the direction of mouse movement. The cursor moves very fast with a mouse giving you more freedom to work in any direction. It is easier and faster to move through a mouse compared to movement using keys.

Types of Mouse

Mouse could be mechanical, optical or cordless types. Further information regarding these types are as follows :

Mechanical Mouse : Mechanical Mouse uses ball for the movement of cursor on the computer screen. When the ball is rolled in any direction, a sensor of the mouse detects it and also moves the mouse pointer in the same direction.

Optical Mouse : Optical Mouse uses Laser rays for the movement of cursor on the computer screen. It is an advanced pointing device. Movement is detected by sensing changes in the reflected light rather than the motion of a rolling sphere.

Cord-Less Mouse : Cord-Less Mouse is battery driven and does not need any wire for the physical connection with the motherboard. It transmits data through infrared or radio signal.

Computer mice are very useful in designing pictures and graphs and computer and video games by multimedia designers. **A** Mouse pad is required to move the mouse because it provides a smooth surface. However, an optical or laser mouse doesn't require a mouse pad.

4.4.3 Digitizing (Graphic) Tablet

These are used by architects, engineers and designers in Computer Aided Design (CAD) for designing purposes, such as buildings, cars, mechanical parts, robots etc.

Digitizing or Ggraphics' tablet is a computer input device that allows one to hand-draw images and graphics, similar to the way one draws images with a pencil and paper. These tablets may also be used to capture data of handwritten signatures. Some tablets are intended as a general replacement for a mouse as the primary pointing and navigation device for desktop computers. These are used by architects, engineers and designers in Computer Aided Design (CAD) for designing purposes, such as buildings, cars, mechanical parts, robots etc. These are also used in Geographical Information System (GPS) for digitizing of maps.

Figure 4.6: Graphics Tablet

Graphics tablet is most suited for artists and those who want the natural feel of a pen-like object to manipulate the cursor on their screen. Wacom is the most well known manufacturer of graphics tablets, and is incredibly well respected.

4.4.4 Trackball

Trackball is a moveable ball mounted on a stationary device, which can be rotated manually by using fingers. It is also a pointing device. In a trackball, the ball is placed on the top along with buttons which can be rolled with the fingers. These are used in playing video games.

Figure 4.7: Trackball

Mouse and mobile phones are equipped with trackballs to navigate addresses as well as play games.

4.4.5 Joystick

Joystick is a remote control device for a computer which is used for playing video games to indicate the position. It has a stick that pivots on a base and is used for controlling the action in video games. The User moves a spherical ball with the help of a stick in the joystick as opposed to the trackball where fingers are used for moving the ball.
Joysticks are also used for controlling machines such as cranes, trucks, underwater unmanned vehicles, flight simulators, industrial robots etc.

Figure 4.8: Joystick

The Joystick shown in Figure 4.8 has a base and a handle for controlling the movement of the cursor on the screen.

☞ Check Your Progress 2

Part I: True / False

1) Cordless mice are directly connected with computer. True / False
2) Mechanical mice use laser rays for movement. True / False
3) Mouse is not a pointing device. True / False
4) Floppies are used to store data. True / False
5) Scanner is used to print documents. True / False
6) Printer is used to display pictures. True / False
7) Monitor is used to scan pictures. True / False

Part II: Short answer type questions

1) What do you mean by keyboard?

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2) What do you mean by mouse and what are its types?

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3) What do you mean by scanners and what are their functions?

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4) What do you mean by joystick and trackballs in a computer system?

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4.5 PICK DEVICES

Pick devices are used to select an object on the screen. The selected object can be text or graphics. Examples of pick devices are light pens and touch screens.

4.5.1 Light Pens

A Light pen is a pen like light-sensitive device. It is connected by a wire to the computer terminal to detect the CRT beam when pointed towards the screen and generate a narrow electrical pulse that can be fed to the computer as an input signal.
It is used to draw on the screen or to point to the displayed objects. It operates by detecting the light emitted by the screen phosphors.

A light pen can work with any CRT monitor but not with LCD monitors. It is used by architects and engineers for CAD applications and editing.

A light pen can work with any CRT monitor but not with LCD monitors

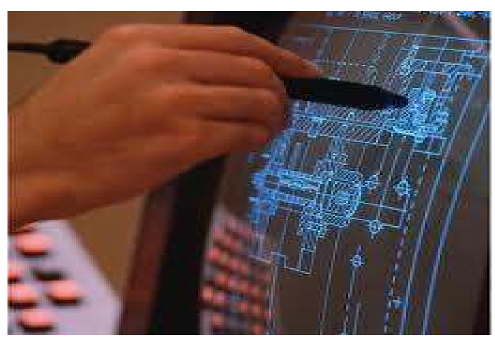

Figure 4.9: Light Pen

4.5.2 Touch Screens

Touch screens are monitors / electronic visual display screens which detect where they are being touched. The user makes selections by directly touching the screen, rather than moving a cursor to the point on the screen with a mouse or joystick
Now days touch screens are being used in ATM machines for making it user friendly and Kiosk machines are used for guiding the travelers about their travel plans. Touch screens are also used in many of the modern cell phones.

Figure 4.10: Touch Screen

4.6 SOURCE DATA ENTRY DEVICES

Entry of data into a computer system directly from the source, without transcription is called source data entry. Source data entry devices have a lower probability of error in input data than standard keyboard entry.
Some of the common source data entry devices are discussed below:

4.6.1 Digital Camera

A Digital camera is an electronic device which takes video or still photographs or both, digitally by recording images via an electronic image sensor. Digital cameras can do things which film cameras can't, for example displaying images on screen immediately after they are recorded.

Images recorded on a digital camera can be cropped for editing, deleted and various types of special effects can be created by using Photoshop software.

Digital cameras look like ordinary cameras but have sufficient memory in the form of chips to store thousands of images, rather than using photographic films.

Figure 4.11: Digital Camera

Most digital cameras allow users to choose the resolution needed for a picture. Most of those can connect directly to a computer to transfer data. A USB port is generally used for this purpose. A Wireless connection can also be used for connecting to a computer via Bluetooth.

These cameras use memory cards with flash memory to store images. The joint photographing expert's group standard (JPEG) is the most common file format used for storing data in a camera. Other formats include raw image format, DNG format etc.

4.6.2 Scanners

A Scanner is an input device and is used to input data into the computer system in the form of pictures. It optically scans images, printed text, handwriting, or an object, and converts it to a digital image. Examples of scanners are a desktop or flatbed scanner.

In scanners the document is placed on a glass window for scanning. Mechanically driven scanners that move the document are typically used for large-formatted volume of documents.

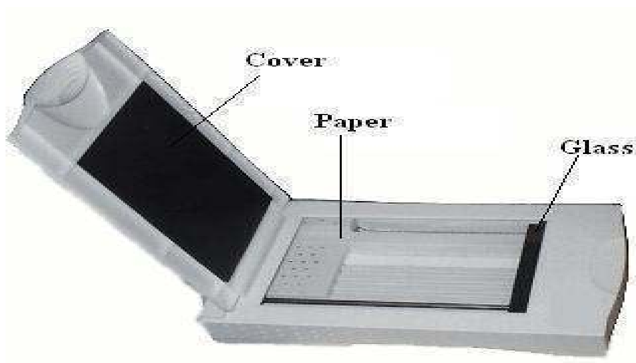

Figure 4.12: Optical Scanner

Another type of scanner is a planetary scanner. This scanner takes photographs of books and documents. Three dimensional scanners are used for producing three-dimensional models of objects.

4.6.3 Optical Mark Recognition (OMR)

OMR is the scanning of paper to detect the presence or absence of a mark in a predetermined position. Now days, it is used as an input device for source data entry purposes. Universities and colleges often use OMR for the evaluation of OMR sheets for competitive exams. OMR sheets consist of multiple choice question papers and students are required to make a mark to indicate their answers. OMR is used in the evaluation of questionnaires, surveys and university exam OMR sheets.

Universities and colleges often use OMR for the evaluation of OMR sheets for competitive exams

Figure 4.13: Optical Mark Recognition

4.6.4 Magnetic Ink Character Recognition (MICR)

Magnetic Ink **C**haracter Recognition is a character recognition system that uses special ink and characters. When a document that contains this ink needs to be read, it passes through a machine, which magnetizes the ink and then translates the magnetic information into characters.

MICR technology is used by banks for faster processing of large volumes of cheques. Numbers and characters found on the bottom of checks (usually containing the check number, sort number, and account number) are printed using Magnetic Ink. To print Magnetic Ink codes, we need a laser printer that accepts MICR toner.

MICR technology is used by banks for faster processing of large volumes of cheques

MICR provides a secure, high-speed method of scanning and processing information. This technology is used for processing large volume of data. It speeds up data input for the bank because cheques can be directly fed into the input device as it also ensures accuracy of data entry. The most commonly used character set by MICR devices are known as E13B font which consists of the numerals 0 to 9, and four special characters.

4.6.5 Bar Code Reader

A barcode reader is an electronic device which is used to read printed barcodes. Barcodes represent alphanumeric data which is a combination of vertical lines (bars) that vary in width and length. It is a fast and effective way to input data. A Barcode reader uses a laser beam to read the series of thick and thin lines which represent the bar code number.

Figure 4.14: Bar Codes

Figure 4.15: Bar Code Reader

The bar code is 13 digits long and it has four main divisions. The First two digits of a bar code represent the country, the second part represents the manufacturer's code (five digits) the third part represents the product code (five digits) and the last digit is a check digit.

4.6.6 Magnetic Stripe Reader

A magnetic reader is a hardware device which is used to read the information encoded in the magnetic stripe located at the back of a credit/debit card. A bank card holds data about the owner of the card, bank account number and code of the bank branch, where the account is held.

Figure 16: ATM Machine with Card **Figure 17: Magnetic Stripe Reader**

Magnetic stripe readers are often used at supermarkets and in many different types of shops. In these machines data is read electronically and the point of sale is called Electronic Point of Sale (EPOS).

There are several other pick devices such as microphones and speakers. These have been discussed in length under the section Out Put Devices section of this unit.

4.7 OUTPUT DEVICES

One of the most important output devices in computer system is its screen commonly called monitor. It is an output device and displays all the programs and applications which are running on the computer system. A Monitor is the visual display unit of the computer system. It displays images generated from the video output. It displays images without keeping a permanent record.

A Graphic display is made up of a series of dots called ‘**pixels**’ (picture elements) whose pattern produces images in computer system

A Graphic display is made up of a series of dots called ‘pixels’ (picture elements) whose pattern produces images in computer system. Each dot on the screen is defined as a separate unit which can be addressed separately. Since each dot on the screen can be controlled separately it gives greater flexibility in drawing pictures. The Number of dots per inch (dpi) is called the resolution of the screen and represents the quality of the computer system.

4.7.1 Cathode Ray Tube Monitors (CRT)

Monitors display what is going on in your computer. They can run at various resolutions. It is the part of computer which looks like a TV set. After typing the characters from the keyboard, we can see them on the monitor.

The main components of a CRT monitors are the electron gun, the electron beam controlled by an electromagnetic field and phosphor coated display screen. These older monitors are bulky and require a lot of space for installation.

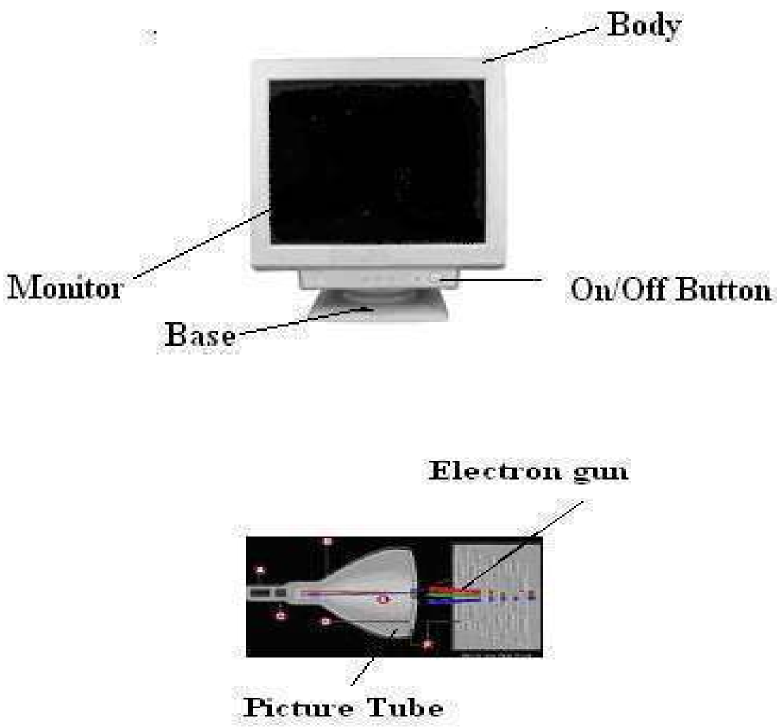

Figure 4.18: Normal CRT monitor and its internal working diagram

In CRT monitors, the image is projected on the screen by directing the electron beam onto the computer screen. To precisely direct the electron beams, copper steering coils are used to create a magnetic field inside the tube. By applying varying voltages to the copper coils a beam can be positioned at any point on the screen.

4.7.2 Liquid Crystal Displays (LCD)

First introduced in watches and clocks in the1970's, LCDs are now used to display images in monitors. A newer technology in computer screens is TFT LCD monitors. These are light weight monitors and are used in laptop computers. Active matrix structure is used by most of the modern LCD monitors and television sets. In this technology, a matrix of thin-film transistors (TFT) is added to the polarizing and color filters. It enhances the display to make it look brighter and sharper. It can also produce much better images and have quicker response times.

Figure 4.19: LCD monitor

These monitors are portable, reliable and consume less electricity. Images produced by these monitors are of better quality than that of old CRT monitors. The LCD monitors have very high resolution and emit less radiation than CRT monitors. The screen is also flicker free.

4.7.3 Thin Film Transistor Liquid Crystal Display (TFT LCD)

It is type of monitor which used thin film transistor technology to enhance the image quality of LCD Monitors. These are used as monitor in television set, desktop computer, laptop computer and mobile phones etc.

4.7.4 Light Emitting Diodes Monitors (LED)

Light Emitting Diodes (LED) is the latest technology which is being used now a days for making high definition TV screens and monitors. It is a semi-conductor light source. In this technology diodes are used to light up the screen instead of liquid crystal Diodes.

LED is known as light emitting diode. It is an electronic device that lights up when electricity is passed through it. LEDs are usually red. They are good for displaying images because they can be relatively small, and they do not burn out. However, they require more power than LCD monitors. LED is light weight monitors and is used in laptop computers and in TV.

The Life of LED monitors is three times than that of LCD monitors and they have less warm up time than that of CRT or LCD monitors. These monitors require less space on the desk, less power consumption and have flicker free screen.

4.7.5 Projection Displays

These are normally used for large group presentations. These systems can be connected to a computer and whatever appears on the computer terminal gets enlarged and projected on a large screen. Video projector receives video signals and projects the corresponding image on a projection screen. It uses a lens system for this projection.

Figure 4.20 : LCD Overhead Projector

These are popularly used for seminars, class room lectures, marketing presentations and conference room presentations etc.

Classification of monitors on the basis of color

In terms of color capabilities, monitors can be divided into the following groups:

1. **Monochrome :** These monitors display the result in two colors, i.e., black/white, green/black, amber/black. One color is for the background of the screen and other for the foreground.

2. **Gray Scale:** It is a monochrome type of monitor. But it displays the output by using different shades of gray, made by a combination of black and white.

3. **Color Monitor:** It can display the output in many colors, ranging from 16 to over 1 million different colors. These are also called as RGB monitors, because they accept three separate signals, which are red, green, and blue.

Classification of monitors on the basis of size

After color classification, the most important aspect of a monitor is its screen size. The Size of computer screen is measured in diagonal inches and is given by measuring the distance from one corner to the opposite corner (diagonally). The smallest size for VGA monitors is 14 inches, which is also the entry level monitor for most computer systems. The Larger size landscape monitors can display two full pages side by side at a time. Other typical monitor sizes are 17 inches, 20 inches, 23 inches etc.

Classification of monitors on the basis of Resolution

The resolution of a monitor means the number of pixels per inch appearing on its surface. In general the greater the number of pixels the sharper is the images. Most modern monitors can display 1024 by 768 pixels. Some high-end models of computer monitors can display 1280 by 1024, or even 1600 by 1200 pixels. Even 3280 by 2048 resolution monitors are available for special purposes. While CRTs provide variability in resolution LCDs monitor have a fixed resolution.

The greater the number of pixels the sharper is the images

Classification of monitors on the basis of signal

Computer monitor can be divided into two categories on the basis of the type of signal which they accept. These are:

1. Analog Monitor
2. Digital Monitor

Analog Monitor

The Electronic signal that is sent by signals of varying frequency, amplitude or phase instead of being sent as an ON or OFF data transmission is called an analog signal. Analog signals allow equipment to handle information that continuously changes such as voltage, current, etc.

Analog signals can be represented by a wave sign and watches which changes their position continuously as shown in Figure 4.21

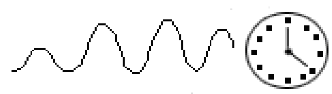

Figure 4.21: Examples of Analog Signal

These are the traditional type of color monitors and are based on CRT technology. These work like the television screen and accept analog signals.

Digital Monitor:

An electronic signal that is sent as binary digits of either ON or OFF is called a Digital signal. As shown in Figure 4.22 examples of digital signals and how they look like. In the first diagram signals are either 0 or 1 i.e. up or down for ON and OFF mode. In the right digital pictures are shown where a pixel is either ON or OFF helping to create an image on the display screen.

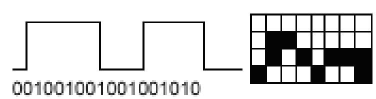

Figure 4.22: Examples of Digital Signal

The digital monitor receives digital signals and can use CRT technology. The data in these monitors is received from the video adapter. These are of different types such as CGA (Color Graphics Adapter), EGA (Enhanced Graphics Adapter), VGA (Video Graphics Array), and SVGA (Super Video Graphics Array). These are fast and produce clear images.

☞ Check Your Progress 3

Part I: True / False

1) Pick devices are used to pick objects on the monitor True / False
2) CRT monitors consume more electricity than LCD monitors True / False
3) Light Emitting Display is the full form of LED monitors True / False
4) Bar Code Reader is an OUT PUT Device True / False
5) A Graphics tablet can be used as a mouse. True / False
6) Graphic tablets are used for designing purposes. True / False

Part II: Short answer type questions

1) What is the function of Graphic Tablet?

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2) What do you mean by multimedia graphics tablet?

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3) What do you meany by Computers Microphones ?

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4) What do you mean by barcode reader?

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5) What do you mean by digital camera? Explain its various characteristics.

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4.7.6 Printers

Printers are used for producing output on paper. There are a large variety of printers and printing devices which can be classified according to the print quality and printing speed.

These varieties of printers are:

Printing Technology – impact printers vs. non impact printers

Impact printers use variations of the standard typewriter printing mechanism where a hammer strikes paper through an inked ribbon.

A non Impact printer uses chemical, heat or electrical signals to produce symbols on paper. Some of these require special coated or treated paper to print characters on them.

Classification of printers on the basis of speed :

On the basis of speed printers are of following types

1. **Character Printer :** These printers can print only one character at a time. They work similar to a typewriter. The examples are Daisy Wheel Printer, Dot Matrix Printer and Inkjet Printer.

   (a) Daisy-Wheel Printer : This printer is similar to a ball-head typewriter. This type of printer has a plastic or metal wheel on which the shape of each character is embossed.

Figure 4.23: Daisy-Wheel Printer

A hammer presses the wheel against a ribbon, which in turn makes an ink stain in the shape of the character on the paper. Daisy-wheel printers produce letter-quality print but cannot print graphics. The print quality of this impact printer is very low as is the speed. These are practically obsolete now.

(b) Dot-Matrix Printer : This is one of the most popular printers used for personal computing systems. These printers are relatively cheaper compared to other technologies and use impact technology.

In the 1970s and 1980s, dot matrix impact printers were generally considered the best tradeoff between expense and versatility, and until the 1990s they were by far the most common form of printers used with personal computers. Characters in this printer are formed by the combination of dots.

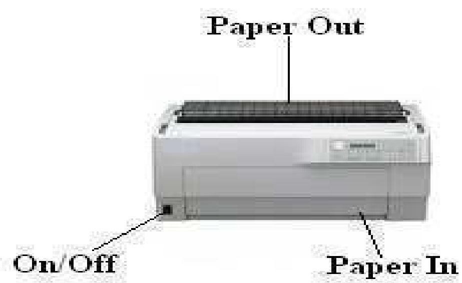

Figure 4.24: Dot Matrix Printer

A Dot-Matrix printer creates characters by striking pins against an ink soaked ribbon. Each pin makes a dot and combinations of dots form characters and illustrations. The moving portion of the printer is called the print head.

Figure 4.25: Characters as a pattern of dots

Advantages

- Dot matrix printers, like any impact printer, can print on multi-part stationery or make carbon copies.
- Impact printers have one of the lowest printing costs per page. As the ink is running out, the printout gradually fades rather than suddenly stopping part of the way through a job.

- They are able to use continuous paper rather than requiring individual sheets, making them useful for data logging. They are good, reliable and ideal for use in situations where printed content is more important than print quality.

Disadvantages

- Impact printers are usually noisy.
- They can only print low resolution graphics, with limited color performance, and limited quality.
- These printers are slow. Speed can be 225 cps to 250 cps. Speed may vary from one printer to another.

2. **Line Printer:** As the name suggests a line printer is a high speed printer which is used to print one entire line of text at a time. Line printers are used to print large amount of data, printing labels, accounting work and other large business printing applications in data centers. These are fast printers ranging in speed from 300 to 2500 lines per minute. Examples are Drum Printers and Chain Printers.

3. **Page Printer:** These are very high speed printers which produce high quality output. Their speed ranges from10-25 pages per minute. These printers are commonly used today. They use modern Laser Printer technology and print a whole page at one go. There are many varieties of laser page printers and so their prices range from base level upwards.

Classification of printers on the basis of quality

The various types of printers based on print quality are as follows

1. **Ink-jet Printer:** The Inkjet printer works on inkjet technology and produces better quality printouts than dot matrix printers. These print by spraying a controlled stream of tiny ink droplets accurately on the paper forming either dot matrix or solid characters.

   The printing quality of these printers is very good with a speed of 700 or more characters per second. These are non-impact and hence are relatively silent during the printing process. These printers are easy to use and can be used to print color pages.

Advantages

Compared to other printers, inkjet printers have a number of advantages. These are

- They are quieter in operation than impact printers.
- They can print finer, smoother details through higher print head resolution
- They can produce photographic-quality text and images.

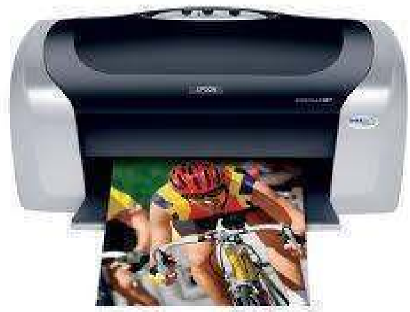

Figure 4.26: Ink-Jet Printer

Disadvantages

The disadvantages of Inkjet printers are :

- The ink is often very expensive.
- Many intelligent ink cartridges contain a microchip that communicates the estimated ink level to the printer; this may cause the printer to display an error message, or incorrectly inform the user that the ink cartridge is empty.
- The very narrow inkjet nozzles are prone to clogging with dried ink.

2. **Laser Printer :** This is a high quality, high speed and high volume technology printer. In laser printers, a laser beam is used to produce an image on a drum. The light of the laser alters the electrical charge on the drum wherever it hits it. 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. Laser printers produce very high quality text and graphics but are expensive. The technology used by them is the same as that of photocopying machines. The speed of laser printers varies from 10 pages per minute to 200 pages per minute. Laser printers are also called page printers; because they print a whole page at one go.

Standard laser printers can be classified into two categories in terms of color:

- Monochrome laser printer, and
- Color laser printer

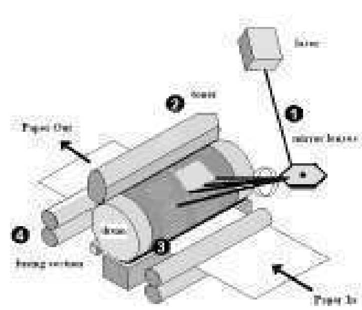

Figure 4.27: Laser Printer

Monochrome laser printers use a single toner. Color laser printers use four toners to print in full color. These printers are about five to ten times as expensive as their monochrome siblings. Color laser printers are popular and are being widely used, in spite of their cost. To print documents with graphics and photographs a color laser printer is a good option. Print speed, quality, printer resolution, reliability and the costs of toner are the major deciding factors for choosing a printer.

4.7.7 Plotters

A Plotter is a device that draws pictures on a page as output, after receiving a print command from the computer. It is also called a graph plotter. In plotters pens are used to draw lines on the paper, which is placed in the plotter.

Figure4. 28: Plotter

Plotters produce high quality diagrams on the paper and their output quality is good. Engineers, architects and planners use plotters to generate high quality, high-precision graphic output of different sizes. For several design applications such as design of layout of an aircraft, car, and architectural design of a building and in other computer-aided design applications plotter are very useful.

Engineers, architects and planners use plotters to generate high quality, high-precision graphic output of different sizes

Plotter is of two types:

- Drum Plotter
- Flat-Bed Plotter

The drum plotters are generally smaller than flatbed plotters and they have lower resolutions than flatbed plotters. HP, Canon and Epson are the popular companies which manufacture good quality of platters.

4.7.8 Speakers and Microphones

Speaker

Computer speakers, or multimedia speakers, are external speakers, commonly equipped with a low-power internal amplifier which produces sound as output. External speakers are connected with a computer by using a plug and socket.

Figure 4.29: Multimedia Speakers

Computer speakers range widely in quality and in price. Laptop computers have inbuilt speakers.

Microphone

A Microphone is an acoustic-to-electric transducer or sensor and is used to convert sound signals into electrical signals. It was originally invented by Emile Berliner in 1877, and allows you to record voices or sounds and place them onto computers, generally as a wave file.

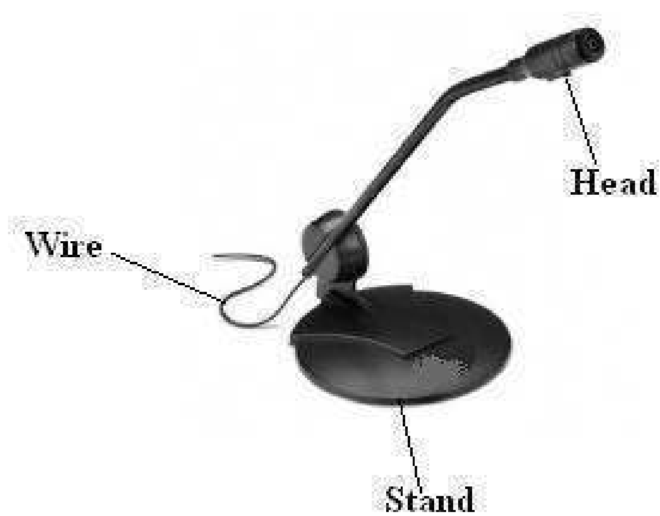

Figure 4.30: Voice Recording Microphone

To connect a microphone we insert the plug of it into the back of the computer system.

Integrated microphones can be found on laptops and some desktop monitors. These microphones are usually a small hole in front of the computer which when spoken into, will record your voice.

☞ **Check Your Progress 4**

Part I: State true or false.

1) Daisy-wheel printers prints high quality printing. True/False
2) A Dot-Matrix printer is a character printer. True/False
3) A Monochrome laser printer uses four toners. True/False
4) Color laser printers use a single toner to print. True/False
5) Laser printers are very cheap. True/False

Part II: Short answer type questions

1) What do you mean by speakers?
…………………………………………………………………………………………….
…………………………………………………………………………………………….
………..……………………..………………………………………………………….
2) What do you mean by printers? What are the various types of printers ?
…………………………………………………………………………………………….
…………………………………………………………………………………………….
………..……………………..………………………………………………………….
3) What do you mean by plotters? Explain their characteristics.
…………………………………………………………………………………………….
…………………………………………………………………………………………….
………..……………………..………………………………………………………….
4) What do you mean by a dot-matrix printer?
…………………………………………………………………………………………….
…………………………………………………………………………………………….
………..……………………..………………………………………………………….
5) What do you mean by Laser Printers?
…………………………………………………………………………………………….
…………………………………………………………………………………………….
………..……………………..………………………………………………………….

4.8 SUMMARY

Input/output devices are the devices that connect you to your computer. Input devices let you input data and other information into your computer and they also let you give your computer special instructions so that it will know what to do. For example, you can type in data by using a keyboard, or you can input data in picture form by using a scanner.
On the other hand, output devices display the results of your computer's computations. Examples of these would be your computer's monitor, which displays all of the programs you're running, as well as the printer, which will print out a hard copy of the information. Source data entry devices are those devices which automatically capture data and images at its source, record it in small chips and produces images immediately.

4.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

Part I:

(1) True (2) False (3) False (4) True (5) False
(6) True (7) True

Part II: Short answer type questions

1. Input devices let you input data and other information into the computer. They are used to give special instructions to the computer so that it will know what to do. Input devices transfer data and user commands into the computer system. Input devices are used to interact with the computer system. Inputs are data or signals received by the computer system.

   For example, you can type in data by using a keyboard, or you can input data in picture form by using a scanner.

2. Output devices display the result of your computer's computations. Examples of these are your computer's monitor. Output devices are those devices which display the result of input data or signals after processing it. When data is given to the computer to process then the processed data, in form of the desired result, comes out of the system through output devices.

3. Examples of Input devices are:
   Keyboard, Mouse, Joystick, Microphone, Bar code reader and Graphics tablet.
   Examples of output devices are:
   Monitor, Printer, Plotter and Speaker

Check Your Progress 2

Part I:

(1) False (2) False (3) False (4) True (5) False (6) False
(7) False

Part II: Short answer type questions

1. A Keyboard is one of the most important input devices and is used to input data into the computer system. Keyboards contain letters, numbers, function keys, arrow keys and some special keys on it. A User enters data into the computer by pressing a set of keys on the keyboard.

2. A Computer mouse is an input device. It is used to point on the instructions and commands are input by clicking on them by it. A mouse has two or three buttons

on it and is moved on a mouse pad which gives a smooth surface for its movement. A Mouse is a very useful input pointing device in a GUI environment.

Different types of mice are: Optical mouse, mechanical mouse, wireless mouse

3. A Scanner is an input device which is used to input data in the form of pictures. It optically scans images, printed text, handwriting, or an object, and converts it to a digital image.
4. A Joystick is a remote control device for a computer which is used for playing video games to indicate position. It has a stick that pivots on a base and is used for controlling the action in video games. A Joystick is an input device of a computer. Joysticks are also used for controlling machines such as cranes, trucks, underwater unmanned vehicles, flight simulators, industrial robots etc.

   A Trackball is a moveable ball mounted on a stationary device. It can be rotated manually by using the fingers. It is also used in playing video games. In Modern computers, a Mouse and in mobile phones trackballs are used to navigate addresses as well as play games. These are also used in playing video games.

Check Your Progress 3

Part I:

(1) True (2) True (3) True (4) False (5) True (6) True

Part II: Short answer type questions

1. Digitizing or Ggraphics' tablet is a computer input device that allows one to hand-draw images and graphics, similar to the way one draws images with a pencil and paper. These tablets may also be used to capture data of handwritten signatures.

2. A graphics tablet is a computer input device that allows one to hand-draw images and graphics, similar to the way one draws images with a pencil and paper with the natural feel of a pen-like object to manipulate the cursor on their screen. These tablets are used to capture data of handwritten signatures. Architects, engineers and designers use it in Computer Aided Design (CAD) for designing purposes.

3. A microphone is an acoustic-to-electric transducer or sensor that converts sound signals into electrical signals. A microphone is an input device which converts the sound and voice into digital signal and then gives it to the computer for further processing.

4. A barcode reader is an electronic device which is used to read printed barcodes. It is a fast and effective way to input data. A Barcode reader uses a laser beam to read the series of thick and thin lines which represent the bar code number.

5. A Digital camera is an electronic device which takes video or still photographs or both, digitally by recording images via an electronic image sensor. Digital cameras have sufficient memory in form of chips. Most digital cameras allow users to choose the resolution. The digital cameras can connect directly to a computer to transfer data. A Wireless connection can also be used for connecting to a computer via Bluetooth. These cameras use memory cards with flash memory to store images.

Check Your Progress 4

Part I:

(1) False (2) True (3) False (4) False (5) False

Part II: Short answer type questions

1. Computer speakers are output devices which produces **sound as output.** Computer speakers, or multimedia speakers, are external speakers, commonly equipped with a low-power internal amplifier. These are used to hear audio signals in a computer system.
2. A Printer is an output device and lets you take printouts of documents, pictures, and other files. It creates a hard copy of computer documents or files on a piece of paper. Whatever we see on the computer screen can be printed on a paper using a printer.

   There are many different types of printers available in the market. Printers are mainly categorized into the following types:

   Impact Printers

   a) Line Printers 1. Drum Printers,
   2. Chain Printers
   b) Character Printers 1. Dot Matrix Printer
   2. Daisy Wheel Printer
   c) Non impact Printer
   1. Thermal Printers
   2. Inkjet Printers
   3. Laser Printers

3. A Plotter is an output device which is used to produce high quality graphics on paper. Engineers, architects and planners use plotters to generate high quality, high-precision graphics output of different sizes. For several design applications such as design of layout of aircraft, car and architectural design of a building and in other computer-aided design applications plotters are very useful.

4. A Dot matrix printer or impact matrix printer refers to a type of printer with a print head that runs back and forth on the page and prints characters by impact, striking an ink-soaked cloth ribbon against the paper, much like a typewriter. Its speed is

50 cps (character per second) to 400 cps. It has one of the lowest printing costs per page.

5. Laser printers are one of the best printers available due to their high quality, high speed and high volume technology of printing. These printers produce very high quality text and graphics. Speeds of laser printers can range from **10 pages per minute to 200 pages per minute**.

4.10 FURTHER READINGS

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UNIT 5 MY PERSONAL COMPUTER

Structure **Page No.**

5.0 INTRODUCTION

A **personal computer** (**PC**) is a general-purpose computer, used for day to day activities in different areas including education, business, administration and health. Due to its size and capabilities, PC is useful for the users. A PC can be operated directly and may be used for computational, word processing, and data storage purpose.

Depending on the size and processing capacity, PCs are of many types such as, a desktop computer, a laptop tablet PC, a handheld PC /palmtop. Personal computers can be connected to the computer network by wired or wireless media. Generally, for using a PC, computer proficiency is not compulsory. PCs are being used from a school going children to a business professional for different purposes. A non-professional user may use a PC to listen songs, watching movies, creating some documentation, email etc. A professional user may use a PC for different business process such as documentation, running business program, creating databases, internet, and emailing, teleconferencing etc. Thus, the scope of a personal computer varies a lot depending on the type of its users. The configuration of a PC matters a lot in terms of its processing quality and cost.

5.1 OBJECTIVES

After reading this unit, you should be able to:

- describe the meaning and purpose of the personal computer;
- distinguish different types of personal computers;
- briefly explain hardware components of personal computer;
- describe software and its types;
- explain operating system installation process;
- to setup network configuration; and
- understand different tools and application of personal computer.

In previous units of this block you have learned about basic components of a computer system. This learning will enable you understand the working of a computer system and use computer for different activities in your life. Rest of this unit will teach you about practical aspects.

5.2 TYPES OF PC

In general, basic function of all the computers is same i.e. Computers accept data as input, perform operations on these data and generates the desired output to the user. However there are different kinds of computers available today. These computers differ due to the differences in processing capability, storage capability, looks and sizes. Different types of computers are used for different types and complexity of problems solving. For example for simple internet access or for basic word processing , a simple generic PC may be sufficient but for complex scientific computation such as atomic energy plant control or weather forecasting, specialized computer is required. With the advancement of technology, computers have also witnessed major changes and developments and today computers are more powerful in terms of processing and storage capabilities. To know in detail about a PC hardware components, it is imperative to have knowledge about its configuration.

Configuration of a PC usually mean the technical details of the System

Configuration of a PC

Generally, when you think of purchasing a Computer, you first try to exactly know what will be the hardware components such as processor, memory etc. of your computer. It depends on several factors such as your computation needs, your budget, your preferences about brands etc. Before purchasing a PC you should be aware about the different components of a PC and its typical configuration so that you can make a suitable choice. When you visit a PC shop for purchase a PC, you clearly need to state that what will be the storage capacity of your hard-disk, processor speed and its type, the amount of RAM you want to have in your PC, different ports and connector etc. One can either purchase a branded PC or may purchase individual components of PC and assemble them to form a PC.

Configuration of a PC usually mean the technical details of the System. Many softwares require that computer must have some minimum requirements so that the software can run properly on that system, hence we need to check the configuration of the system. Actually the term computer configuration means the technical specification of the computer. In this specification details generally we include speed of the processor, RAM, Hard-Disk Drive, Video card, etc. The configuration of one computer may vary from others. Generally configuration of a computer depends on the user requirement for example, a user who mostly works on multimedia software, graphics software, scientific computation etc, needs more powerful computer rather than a normal PC user.

Processor plays major role in a computer. One should carefully decide about the type of processor and its speed before making a choice. Currently Core 2 Duo processor are very common in use, in which two processor used to be fit on a single chip. Also there are Core 2 Quad are multi chip processors which offer twice the performance of a Dual Core processors. The current Core processors include the latest Intel Core i7, Intel Core i5 and Intel Core i3 etc. Pentium chip is one of the most popular brands of processor. Now multi-core processors are available. A dual-core processors has two cores, a quad-core processor contains four cores and a hexa-core processor contains six cores. Multi-core processors implement multi-processing which improves performance and speed of executions. Pentium processor is a series of x86 compatible microprocessors manufactured by Intel.

Clock speed is the speed at which a microprocessor executes instructions. Clock speeds are measured in megahertz (MHz) (also known as, millions of cycles per second) or Gigahertz (GHZ)

Generally you can find the speed of a processor during booting processes. For example, if you see Intel Pentium (TM) III 1000 MHz, it indicates that the processor is of Intel Pentium III processor and it is running at 1000 MHz or 1 GHz. One clock cycle is the time it takes to perform one instruction. Processor will be faster if the clock cycle is shorter and vice versa. The speed of a processor is directly related to the clock speed which is the speed at which a microprocessor executes instructions. Clock speeds are measured in megahertz (MHz) (also known as, millions of cycles per second) or Gigahertz (GHZ).

If you want to know about the configuration of the computer you are working on, follow these simple steps. There you will find a number of devices attached with the computer with their details:

1. Right Click on my computer, available no your PC desktop,
2. Select Properties,
3. Go to General Tab, this will give you basic information about the computer. If you want detail configuration,
4. Select Hardware Tab,

5. Select Device Manager Button.

Now let us learn about different types of PCs in terms of size, processing capacity etc.

5.2.1 Workstation

A workstation is a high-performance computer which is used for scientific and technical tasks such as computer graphics, scientific simulation, computer-aided-design (CAD), image processing, engineering calculations etc. It is generally used in such applications which require a moderate amount of computing power. Hence, the configuration of workstation used to be high. UNIX and Windows NT are the most common Operating System for workstations. Workstations are generally single user system however they can be connected together to form a LAN.

In the context of networking, workstations are sometime referred to as any computer/terminal attached to a LAN. In networked workstation, system administrator tracks and controls the activities of the user. The term *workstation* is also used for high capacity mainframe computer terminal or a PC connected to a network and working in client server mode. A workstations has superior processing and storage capabilities than a normal PC , especially with respect to providing multitasking capability.

Typical Configuration of a Workstation

Processor: Intel Core Processor (3.20 GHz)

Memory: 4GB 1333MHz

Hard Disk: 500GB,

RAM – 2GB

Here GHz is known as gigahertz. The speed of the processor is generally measured in gigahertz. 1 GHZ equals to 1 billion cycles per second. Similarly MHz is called as megahertz. 1 MHZ is equal to 1 million cycles per second. GB or Gigabyte is the measurements of the digital data in a computer. 1 GB is equal to 1024 Megabytes (MB).

5.2.2 Desktop Computers

Desktop computer is popularly known as personal computer (PC). As the name suggest, it is generally small in size and fitted on the top of a desk which can be used at a fixed location. Most of modern desktop computer has separate screens and keyboards. Generally in majority of the PCs, Microsoft Windows, LINUX and Mac OS x are used as operating system. Desktop computers are available in many different forms from large vertical tower cases to small form factor models. Advantages of desktop computer are that it may be used for day to day computational and internet communication activities of office, school etc. A PC provides more space for heat to escape. Also power consumption of a PC is not very high. There are many brands of PCs are available in Indian market and abroad including HP, HCL, Wipro, Compaq etc. A PC also can be assembled as per specific requirements, instead of a particular brand.

Figure 5.1: Desktop Computer

A Configuration of Desktop computer

Processor: Intel Pentium 4 around 3.0 GHZ

RAM: 1 GB DDR II RAM

Hard Disk: 320 GB SATA hard disk drive

Graphics: Intel Graphics Media Accelerator 950 (Intel GMA 950)

DDR stands for double data rate type 2 RAM which is an enhanced version of DDR. SATA stands for serial advanced technology attachment which is a bus interface to connect host bus adapters to storage device like hard disk. SATA has different generations.

5.2.3 Laptop

Laptop is also a personal computer but intended of using it at a single place , it is small size, portable and can be used anywhere. Portability is one of the main advantage of a Laptop over a table PC. Another advantage of a Laptops is that it contain batteries which are used for power supply. It make a laptop usable even if power is not available. In a laptop almost all the components are attached as a single unit. Although some devices like mouse, can be attached externally through ports. The basic components of laptop are similar in function to the desktop computers. Most of modern desktop computer has separate screens and keyboards. Generally in majority of the PCs, Microsoft Windows, LINUX and Mac OS x are used as operating system. Laptops are much more power efficient than desktops. The major disadvantage of Laptop is that its upgradeability is limited as compared to desktops. There are many brands of Laptop are available in Indian market and abroad including HP, HCL, Wipro, Compaq, Dell, Lenovo, Toshiba, Sony etc.

Figure 5.2: Laptop

A Configuration of Laptop is given below:

Hard Disk- 320 GB SATA HDD
Processor – Intel Pentium processor P6200 (2.13 GHz, 3 MB) RAM-3 GB
Memory: 1 GB DDR3 RAM (DDR3 RAM can transfer data twice the rate, hence it has higher bandwidth than DDR2 RAM)

5.2.4 Netbook

Netbooks are special type of Laptop which is very light and small. Due to its size and weight it is very portable and one may carry it very easily. Dissimilar to Laptop , it does not require a separate carry bag for it. Netbook are suitable for general purpose computing works and for accessing the Internet. They also use less powerful hardware than most laptops. Due to limited processing capabilities Netbooks are less expensive than laptops. Due to its size and portability Netbooks are becoming very popular for education and business works. Works related to word processing, presentation, internet access, multimedia etc can be easily carried out on a Netbook. Generally in Netbooks, Windows, Linux, and Android operating system are used along with others. There are many brands of Netbook available in Indian market and abroad including Acer, HP, Dell, HCL , Apple, Sony etc.

Figure 5.3 : Netbook

A Configuration of Netbook is given below:

Processor – Intel Atom
Memory: 1 GB DDR2 RAM
Hard Disk- 80 GB

5.2.5 Tablet PC

A tablet PC is similar to a personal computer . It is a portable device which has a touch screen for inputting of the data. A tablet computer can connect to the internet and local computer network through wireless. In general terms, tablet PC refers to a slate shaped mobile computer device, equipped with global positioning system (GPS) System , and a touch screen to operate the computer. It is generally equipped with office suits such as word, excel etc, web browsers, computer games and other similar applications, that generally can be run on a PC. Tablet PC can also use handwriting recognition and virtual keyboards for input of data. In, tablet PCs Microsoft windows, Linux and Apple operating system are used. There are many brands of Tablet PC available in Indian market and abroad including Acer, Lenovo , Panasonic, and Toshiba etc.

Figure 5.4: Tablet PC

Typical Configuration of a Tablet PC

Processor: Intel Core 2 Duo ULV processor SU9300 (1.20GHz)

Memory: 5GB (1x1GB on board, 1x4GB DIMM) DDR3 1066MHz

Hard Drive: 80GB 5400RPM SATA HDD

If we elaborate the detail of the processor mentioned above, SU9300 is the processor number, number of cores in this processor is 2 and number of threads is also 2. Clock speed is 1.2 GHz, ULV is a feature of some processors. ULV stands for Ultra low voltage. ULV processors require less power.

In previous units of this block you have learned about CPU, I/O Devices and Memory system of computer/PC. Now let us look into some other major hardware components such as motherboard and video card of a PC.

5.3 HARDWARE COMPONENTS OF A PC

The physical components of a computer which can be seen and touched are known as hardware of a computer system

Hardware is an essential component of any computer system. A computer is made up of several different components. All these components work together in order to produce desired result. The physical components of a computer which can be seen and touched are known as hardware of a computer system. Each of these parts are designed for a specific purpose. Central Processing Unit (CPU), Memory, Input / Output devices like mouse, keyboard, Monitor, CPU, Memory etc. are different hardware components of a computer system. These hardware components are the building block of a computer.

Computer Case

A computer case covers the computer circuitry. It is also known as cabinet, box, computer chassis etc. it is a box which contains different components of a computer like CPU, Motherboard, RAM, Power supply unit etc.

Computer cases are available in many different forms and sizes like desktop cases, full-size tower cases, mini tower cases etc. ATX is the most popular form factor used for desktop computer these days. Computer case includes input/output ports and power buttons. Motherboard is a main component placed inside the computer case. The power supply unit is also attached with the case. A power supply unit is responsible for providing power to other components of a computer.

Figure 5.5: Computer Case (Cabinets)

Central Processing Unit

Central Processing Unit (CPU) is considered as one of the most important component of a computer system. It is also known as the brain of a computer. The main function of a CPU is to execute a series of instructions called as program in a specific sequence. Normally there are four steps that all CPU use in order to perform their operation these are: fetch, decode, execute and output.

CPU contains Arithmetic Logic Unit (ALU) and Control Unit(CU). ALU and CU are jointly known as the central processing unit (CPU). The ALU of a computer performs all the arithmetic operations such as addition, subtraction, multiplication and division and also all the logical decisions are made by the ALU.

Control Unit (CU) is the unit which manages and coordinates the entire operation of a computer system. It controls the operation of the other components of a computer system.

Motherboard

Motherboard holds some of the most important component of the computer system. It is also known as system board, main board etc. in a typical computer microprocessor, main memory and other components are connected to the motherboard. It acts a s a base for other components. Motherboard also provides connectors for several other devices. A motherboard allows many different parts of our computer to receive power and communicate with one another. The shape , size and layout of a motherboard is called a form factor. The Motherboards usually provides the interface between the CPU memory and input/output peripheral circuits, main memory, and facilities for initial setup of the computer immediately after power-on.

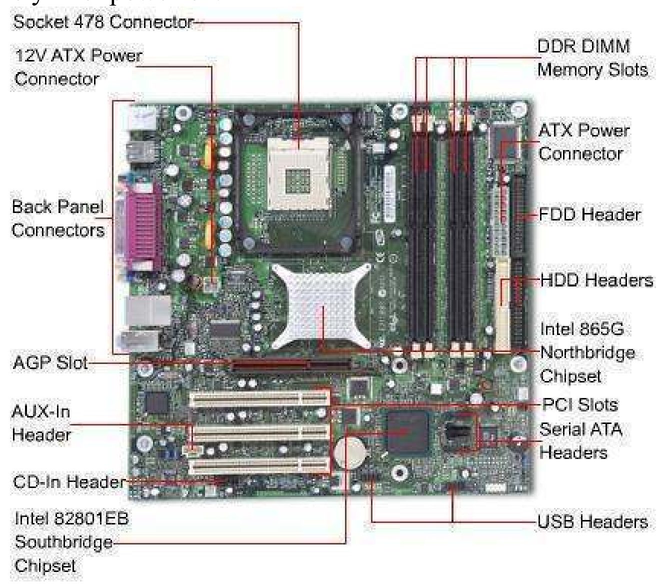

Figure 5.6: Mother Board

The below is a brief description about some parts of a motherboard:

a) **ATX Power Connector:** Advanced Technology Extended (ATX) power connector is used to connect computer's power supply to motherboard.

b) **AGP Slot:** Accelerated Graphics Ports (AGP) is a point-to point channel which is used to attach a video card to a motherboard.

c) **CD-in header:** At this CD drive is plugged in or connected .

d) **FDD Header:** Floppy Disk Drive (FDD) header is used for Floppy drive. Now this slot is obsolete because floppy disks are outdated.

e) **HDD Headers:** Hard Disk Drive header is used for connecting to hard disk .

f) **PCI Slots:** It is used for connecting the PCI (Peripheral component interconnect) card.

g) **USB Headers:** It is a group of pins to which an internal USB cable can be attached to provide extra USB ports. These ports are used for attaching external/auxiliary devices such as pen drive, printer etc.

These days high performance video cards are available for gaming purposes which requires very high resolution

Video card

A video card is an expansion card , which is used to produce output images to a display in a monitor. Its main purpose is to generate graphical information. It is responsible for rendering the image on the monitor of a PC . It is also known as video adapter, display adapter or graphics card. A video card should be capable of displaying the best resolution supported by the monitor of the system. These days high performance video cards are available for gaming purposes which requires very high resolution. Video card consists of a circuit board which holds several components such as graphics processing unit (GPU), video memory, video BIOS etc. Video graphics array (VGA), Digital visual interface, high definition multimedia port etc are some of the common connection points used between video card and display.

Now-a-days, high performance video cards are available, which has higher visual capability. With increasingly popularity of computer games video cards became one of the most important parts of a computer. One disadvantage of this high performance video card is that consume high power. The amount of video memory in video card is one of the main considerations while opting for a video card. Advanced graphics port (AGP) and PCI-Express are the two commonly slots available which is used to connect a video card.

Figure 5.7 :Video Card

Check Your Progress-1

1. True/False

(a) A workstation is a high-end personal computer designed for technical or scientific applications.

(b) Pentium Chip is one of the most popular processor brand.

(c) ALU and CPU are jointly known as Control unit.

(d) VGA stands for video graphics array.

(e) One disadvantage of high performance video card is their high power consumption.

2. Multiple Choice Questions

1. (a) Which of the following is not a part of computer motherboard.

   (i) AGP Slot (ii) ATX power connector (iii) PCI Slot (iv) Light pen

   (b) Which of the following is a type of personal computer

   (i) Tablet PC (ii) Net book (iii) Desktop (iv) All of these

   (c) Which one of these is not a hardware component of a computer.

   (i) Operating system (ii) Monitor (iii) CPU (iv) Video Card

3. What is a PC? What are different types of a PC?
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   ………………………………………………………………………………………….

4. How a laptop is differ from a desktop? Specify one configuration of a laptop.
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   ………………………………………………………………………………………….

5. What is the need of a motherboard in a computer? List some major components of a motherboard.
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   ………………………………………………………………………………………….

5.4 SOFTWARE COMPONENTS

In this unit so far we have explored about the hardware components of a PC. Now let us learn about the software component. Without which a PC can not work, no matter how good processor, memory etc you have in your PC.

To solve a given problem, we write various programs in different programming languages. Programs are nothing but a set of instructions written in a programming language to solve a problem. These computer programs are collectively known as Software. Software is an integral component of a computer system. It is the software which directs a computer to do a specific task. Software can be broadly categorized as system software, application software and utility software.

System Software

System software is set of programs which are used to run the system. System software manages all the other resources of the computer. It controls all the operations of the computer. One important system software requires to work any computer system is Operating System (OS).

Operating system is one of the most important system software. An operating system commonly called OS, is system software which acts as an interface between a user and computer hardware. It also acts as a bridge between application programs and the computer hardware. Operating system is must in order to operate a computer. Without operating system computer is of no use. A OS controls and manages all the hardware components of a computer as well as it also controls input and output, memory and files. In other word a OS can be seen as a manager of the system. It optimizes and utilizes various kinds of resources like I/O devices, Memory, CPU etc. Microsoft Windows, UNIX, LINUX, OS/360, OS/2 etc are some of the examples of an Operating system.

Now let us discuss about some of the commonly used application software and utility software in a PC. You will learn in more details about different types of software in Unit 1 of Block 2 of this course.

5.4.1 Application Software

Application software is the set of programs necessary to carry out operations for a specified application. These are programs written by programmers to enable computer to perform a specific task such as inventory control, accounting, railway reservation, billing or any such type of applications in real life. These software are user-oriented applications..

Application software enables a non-computing background people to carry out various computer related tasks more effectively and efficiently on a PC

Media Player

It is one of the other common examples of application software. It is an application which is used to play multimedia files. Most of the media players can play both audio and video files. Media library is a common part of almost all media players which contains available songs. It is generally used to watch movies and listen to music on the computer. Some media players also have the capability of ripping and burning an audio CD. With the help of ripping option you can convert an audio track to a digital audio file you can also burn a CD which will convert a digital audio file to an audio track.

There are many audio file format , which are used to store digital audio data on a computer. Some audio file farmats are - .mp2,.mp3, .wma, .wav etc. Similarly, .mpg, .mov, . rm, .wmv etc. are some commonly used video file format. Windows media player, Winamp, iTunes, WinDVD, Real Player, GOM media player are some examples of media player. Windows media player is in-built with windows operating system.

Figure 5.8: Windows Media Player

Calculator

It is application software provided by windows operating system. It is an application which is used to perform simple mathematical operations which can be performed by a normal digital calculator..

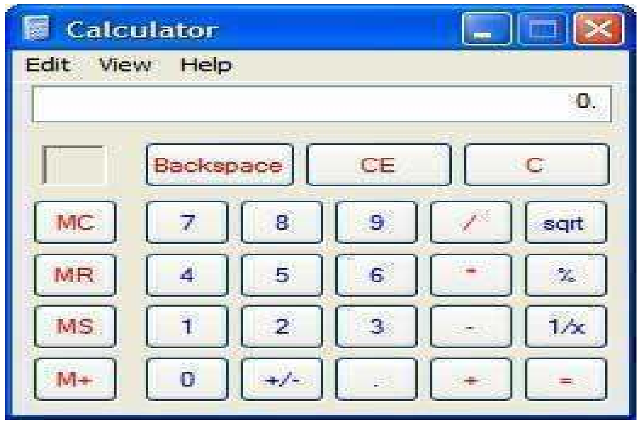

Figure 5.9 : Calculator

Below is list of some categories of application software, which are used by a common PC user:

- Word Processor
- Spreadsheet
- Presentation software
- Graphics software
- Computer games/Entertainment software
- Accounting software

5.4.2 Utility Software

Utilities help out a user for system maintenance and performing routine tasks. It basically deals to optimize, manage, configure and analyze the computer system

Utility programs are also known as utilities. Utilities help out a user for system maintenance and performing routine tasks. It basically deals to optimize, manage, configure and analyze the computer system**.** Generally utilities are included with the operating systems. While application software are user and application oriented utilities software focuses on system infrastructure. These utilities are specialized programs capable of doing a particular type of tasks. Some of the common tasks of utility software are:

- Formatting of drives
- Scanning system for viruses
- Checking the free space available in a memory
- Checking the free space available in hard disk
- Searching files
- Taking backup of files

The utilities software can be categorized in following types:

- Disk Checkers
- System restore
- Disk Defragmenters
- Disk Management
- Backup
- Anti-virus
- Disk cleaners
- Network utilities
- Data compression etc.

Now we will briefly explore some of the utility software and their functions. We have used Windows XP operating system in executing the steps involved in utilities software mentioned in this section.

Disk Checkers : Disk Checkers are used to check the integrity of the hard disk and Pen Drive/ Flash Drive. CHKDSK is a command which is used for this purpose. This command can be used on a computer running Windows operating system. It fixes the logical file system errors found in the disk/drive. It is a command line tools which is used to check the volumes for any potential errors. This command can be used to repair the problems related to bad sectors, lost clusters, directory errors etc.

How to use CHKDSK Command : You can run CHKDSK command from either My computer or windows explorer and from command prompt.

Running CHKDSK from My Computer :

- Double-click **my computer** and then right-click the disk drive you want to check.
- Click **properties** there and then click **Tools**.
  - Under **Error-checking**, click **Check Now** button. It will open a dialog-box which shows **Check disk options**.

Depending upon your preference use one of the following options:

- To run CHKDSK in read-only mode, click **Start**.
- Select the **Automatically fix file system errors** check box, and then click **Start**. It will repair errors without scanning the volume for bad sectors.
- To repair errors, locate bad sectors, and recover readable information, select the **Scan for and attempt recovery of bad sectors** check box, and then click **Start**.

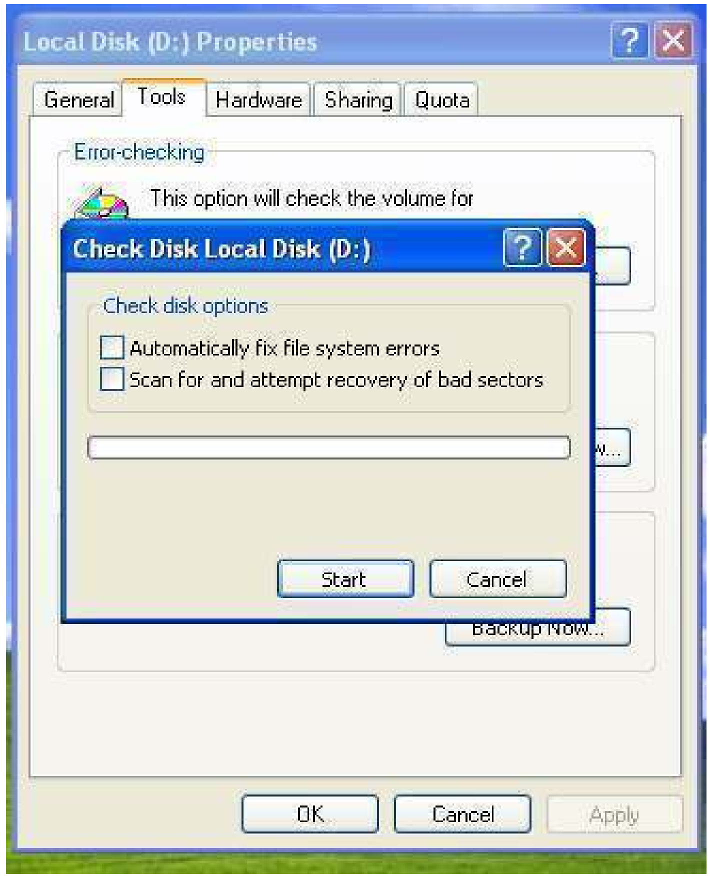

Figure 5.10: Execution of CHKDSK Command from My Computer

Running CHKDSK from Command Prompt:

- Click **Start** and then click **Run**.
- In **Open** type **cmd** and then press enter key, then use one of the following options:
  - If you want to run CHKDSK in read-only mode, type CHKDSK at command prompt and press enter.
  - If you want to repairs the error without scanning the volumes for bad sectors, type **CHKDSK volume:/f** at command prompt and press enter.
  - If you want to repair errors, locate bad sectors, and recover readable information, type **chkdsk *volume:*/r** at command prompt and then press ENTER.

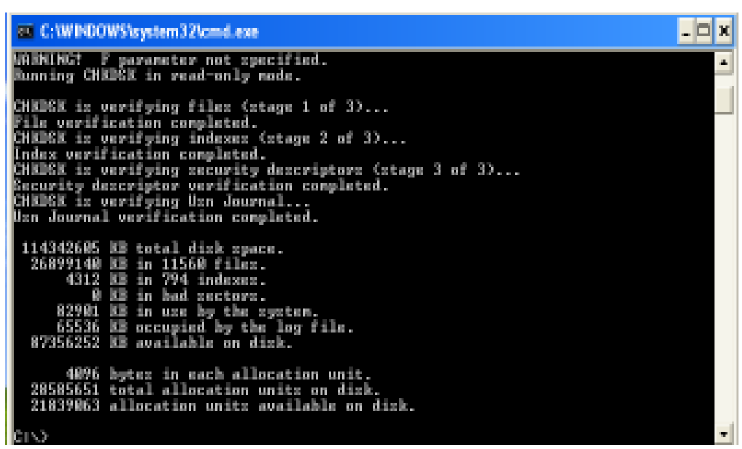

Figure 5.11: Execution of CHKDSK Command on Command Prompt

Once CHKDSK finishes the checking, it returns exit codes whose description is as below:

Exit Code	Description
0	No Errors found
1	Errors found and corrected
2	Disk cleanup was performed or disk cleanup was not performed because **/f** was not specified
3	Could not check the disk, errors could not be corrected or errors were not corrected because **/f** was not specified.

System Restore

System restore roll backs system files, registry keys etc in case of system malfunction or failure, for later use. System restore is a facility available with modern windows operating system like Windows XP, Windows vista, Windows ME, Windows 7. System restore backs up system files such as .dll, .exe etc and saves it for later use. System restore helps us to restore computer's system files to an earlier state. Sometimes it happens that while installing a program or during use of any other software in the computer, there may some problem occurs and the system starts malfunctioning. One way to get rid of such type of problem is to re-install the software or drivers. But if uninstalling the software doesn't fix the problem then we can restore the computer to an earlier date when the system was working properly. Restore points are used for this purpose which contains information related to registry settings and system information.

It is important to note that the system restore is not able to take back ups of personal files such as images, e-mails, documents etc. so if these personal files got accidentally deleted or lost it cant be restored using system restore. So it's a better practice to take back ups of your personal file regularly.

It is important to note that the system restore is not able to take back ups of personal files such as images, e-mails, documents etc.

Steps to use System Restore

Follow these steps to perform restore on your PC:

1. Click on **Start button**, select **All Programs**, from there choose **Accessories**, click on **System Tools**, and then click **System Restore**. System Restore starts.
2. On the **Welcome to System Restore** page, click **Restore my computer to an earlier time** (if it is not already selected), and then click **Next**.
3. On the **Select a Restore Point** page, click the most recent system restore point in the **On this list, click a restore point** list, and then click **Next**.
4. On the **Confirm Restore Point Selection** page, click **Next**. System Restore restores the previous Windows XP configuration, and then restarts the computer.
5. Log on to the computer as Administrator. The System Restore **Restoration Complete** page is displayed.
6. Click **OK**.

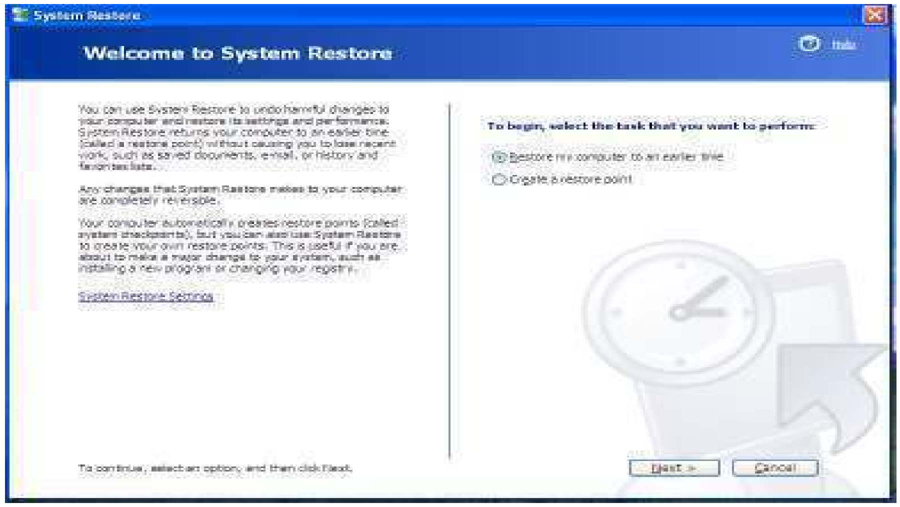

Figure 5.12: Step 1 of System Restore

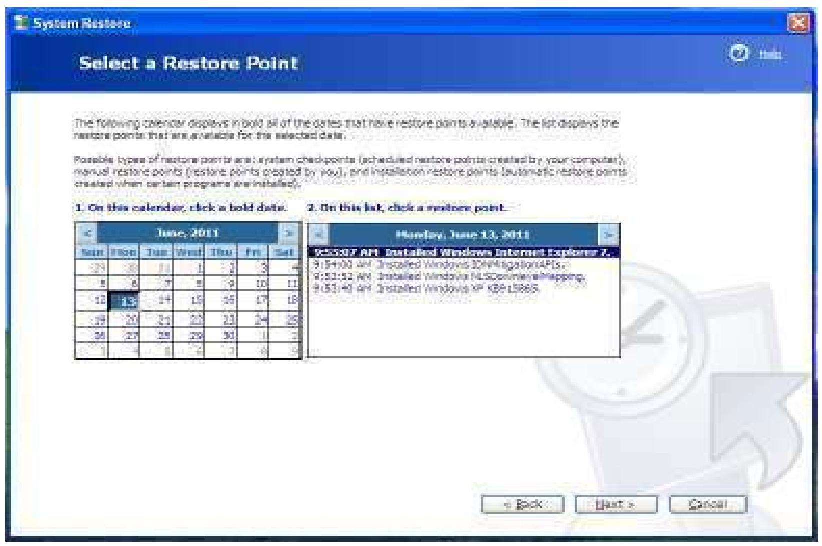

Figure 5.13: Step 2 of System Restore

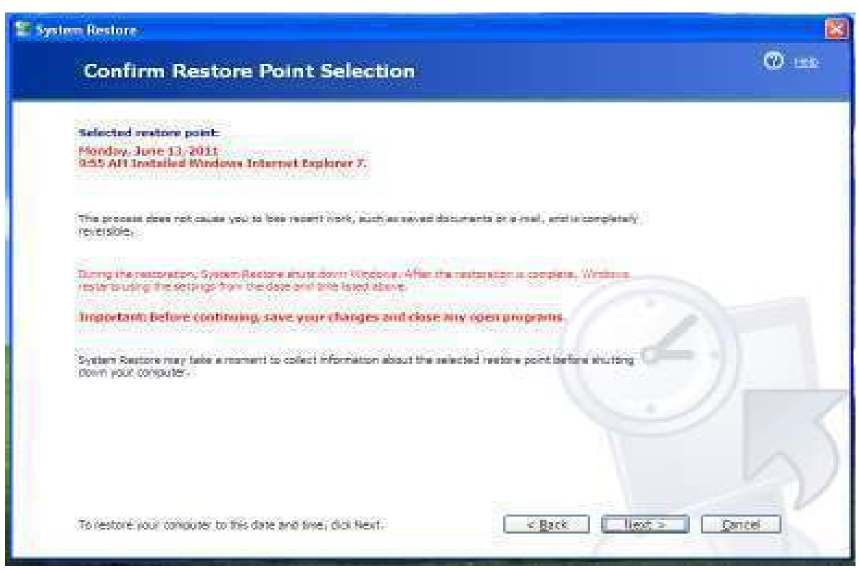

Figure 5.14: Step 3 of System Restore

Disk Defragmenter

Disk defragmenter is a utility provided with windows operating system. It re-arranges the files stored on the disk so that it can occupy contiguous memory locations. This process is known as defragmentation. The main benefits of defragmentation are that it minimizes the head movements of the hard disk , in turn which reduces the time taken to read files from and write files to the disk. It increases the access speed. With this process files are stored in contiguous locations. The defragmenter reduces the fragmentation in the file systems. Fragmentation of the memory slows the performance of the system. Large number of files and some larger files contribute to fragmentation. When files are stored neatly it speeds up reading and writing to the disks. One should run defragmenter in the PC at regular intervals. It keeps the computer running quickly and efficiently.

Running Defragmenter

- Click **Start button**, select **All Programs**, click on **Accessories** click **System Tools**, and then click **Disk Defragmenter**.
- In the **Disk Defragmenter** dialog box, click the drives that you want to defragment and then click the **Analyze** button. After the disk is analyzed, a dialog box appears, letting you know whether you should defragment the analyzed drives.
- To defragment the selected drive or drives, click the **Defragment** button.
- After the defragmentation is complete, Disk Defragmenter displays the results.
- If you want to view the detailed report about the defragmented disk, click on **View Report.**

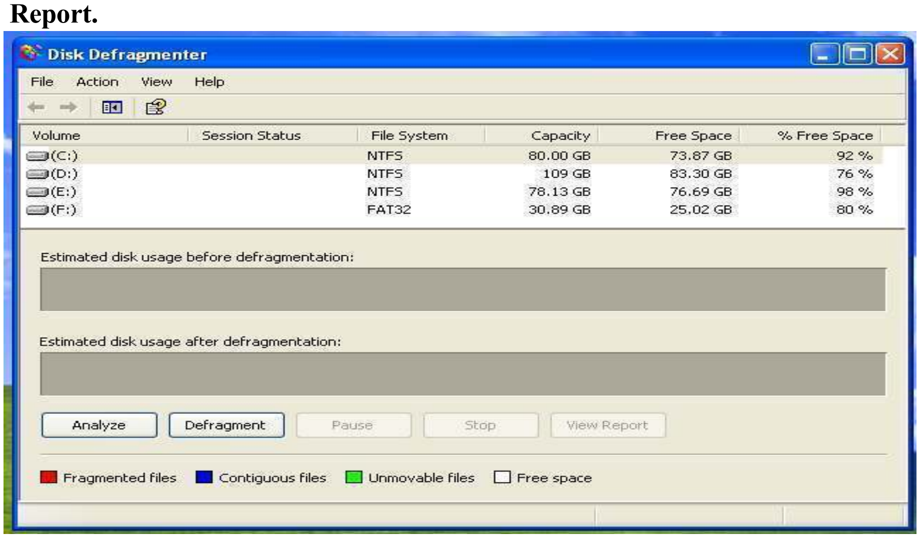

Figure 5.15: Disk Defragmenter

Data Compression

Data compression is the process in which information is encoded with lesser bits in compare to the original representation. Data compression is very useful, as it reduces the size of the file so it consumes fewer resources like disk space. For this purpose, you can use **zip/unzip** utility.

Zipping a file creates the compressed version of the file which takes much smaller space then the original file. A zipped file has .zip file extension. Some of the advantages of zipping a file includes less storage space, smaller file reduces transmission time on the network, also some zip utilities also have the facility to encrypt the data for security purposes. For example, if a original word document is of 6.5 MB in size it may reduce to 2.5 MB when zipped. Text files are generally reduced more than the graphics file after compression. Similarly after zipping a file you need to unzip it, in order to view its contents or get it into its original form.

Using Zip

- **Right- click** on any file you want to zip
- Click **WinZip** from the shortcut menu
- Click **add to zip file**
- It will create **.zip file**

Using unzip

- **Right- click** on any .zip file you want to unzip
- Click **Extract** from the shortcut menu.

Disk Management

Disk Management is a tool used to manage system disks and their partitions locally or remotely. With disk management utility we can perform most disk related tasks such as initialization of disks, creation of volumes, formatting volumes, etc. it allows one to create fault-tolerant disk systems. Disk management is easy to use and its user interface and wizards allow us to carry out various disk related functions very efficiently. You can also manage remote computers using disk management.

We can also use command line tool **Disk Part** as an alternative to disk management for disk related tasks. You can also display disks and volumes in graphical or list view. Before deleting or creating a new partition it is best practice to keep back ups of data from the disk as it will destroy the existing data.

How to open Disk Management

- Click **My Computer,** and then open **Control Panel**. Click **Administrative Tools**, and then double-click **Computer Management**.

- In the console tree, click **Storage** and then click **Disk Management**.

You can also open Disk Management in following way :

1. Click **Start**, then click **Run**, type **compmgmt.msc**, and then click **OK**.
2. In the console tree, click **Disk Management**. The Disk Management window appears.

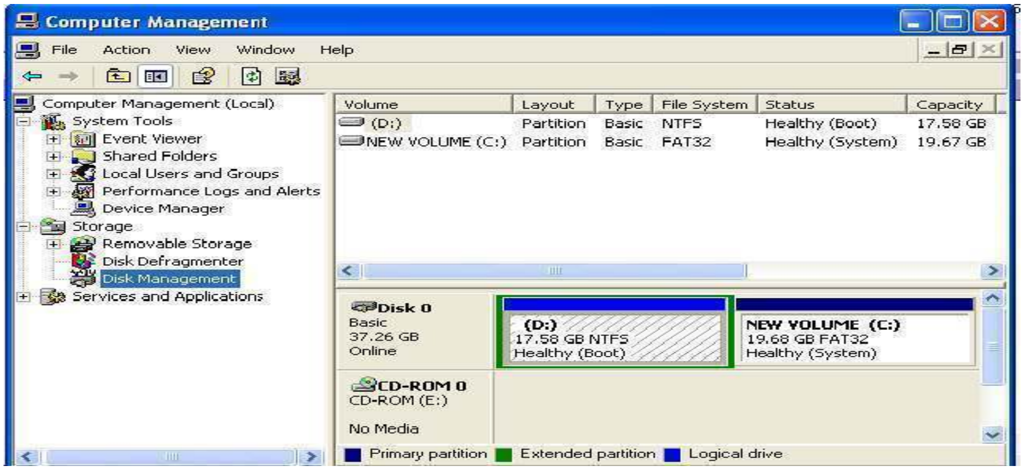

Figure 5.16: Computer Management Window

In Disk Management window, the upper section displays lists of all the partitions in the disk, and the bottom section contains the graphical representation of the drives in the computer.

Check Your Progress-2

1. **True/False**

   (a) Formatting a volume of a memory disk will erase all the data on that volume.

   (b) Zipped file have .zp file extension.

   (c) Disk defragmenter helps the files to store in contiguous locations.

   (d) System restore can be used to take up back-ups of personal files.

2. **Fill in the Blanks :**

   (a) You can use command line tool **………..** as an alternative to disk management for disk related tasks.

   (b) For data compression you can use …………….. utility.

   (c) ………… utility helps us to restore computer's system files to an earlier state. System Restore

   (d) ………….. is a command used for disk checking.

3. What is an Operating system?

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   …………………………………………………………………………………………….

4. What is utility software? List some utility software used in a PC.

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   …………………………………………………………………………………………….

5. Why System Restore is used? Explain how you will use the System Restore.

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   …………………………………………………………………………………………….

5.5 DESKTOP

A desktop is a place which holds icons, files, folders etc.

In most modern computers, you can see the desktop which is a part of Graphical User Interface (GUI). A desktop is a place which holds icons, files, folders etc. Desktop is a visible image which covers the entire screen. The desktop environment provides GUI to the Personal Computer users. On the desktop you can find several small images called as icons. These Icons may also be found on the toolbars and in the menus of computer application software such as Microsoft Word, Microsoft Excel etc . Icons are more user-friendly compare to text-based commands.

Desktop is the background area on our computer screen. We can customize our desktop in several ways. We can add background picture, background color etc. on a desktop. Icons on a desktop are small graphical images which represents various items found on a desktop such as my computer, recycle bin, my documents etc. We can also rename an icon by right-clicking on it.

Figure 5.17: Desktop

Some of the commonly used items found on a Desktop are:

- My Computer
- My Documents
- Recycle Bin
- Task Bar

5.5.1 My Computer

This icon displays the main components of your computer. You can open any of the items in this window to further examine the components of your computer by clicking on my computer icon. It displays different drives/disks attached with the computer.

5.5.2 My Documents

It is the default space where all the files are stored unless we specifically instruct the computer to save at a specified location. It is a special folder where the system stores user's files, pictures, music, download etc.

5.5.3 Recycle Bin

In Windows Operating System, Recycle Bin is a temporary folder which holds files and folders before it is permanently deleted from the storage devices. The Recycle Bin only stores, files deleted from hard drives, not from removable media, such as memory cards and pen drive/ flash drives. It also doesn't store files deleted from network drives. We can also restore the files from the recycle bin to its original location.

It is also possible that you can bypass the recycle bin and the files deleted will be directly removed from the computer without moving it to the recycle bin. For this you keep holding the SHIFT key and delete the desired files.

Sometimes it might happen that we need to restore the files which has been deleted accidentally. You can restore the deleted files from recycle bin. For this follow these steps :

- Double click the icon of recycle bin on your desktop
- Choose a file which you want to restore back and right-click on it and then click **restore**
- To restore all the files in the recycle bin click on **restore all items.**

5.5.4 Taskbar

The taskbar is the long horizontal bar at the bottom of your screen. It is used to launch and monitor running applications. It has four main sections:

- The Start button which opens the start menu.
- The quick launch toolbar which allows you to open programs with a single click.
- The middle section allows you to see the documents and programs which you have opened and to switch between them.
- The notification area, which includes a clock and icons which shows the status of certain programs and computer settings.

5.6 INTERNET ON A PC

Internet is the backbone of modern communication system. In today's life, we are dependent on the internet for almost everything from information collection to carry out various activities such as reservation, online shopping and education. Internet is a collection of computers world over connected together to share various resources.

There are various ways to connect an internet. Generally dial-up connection and broadband connection are the two types of internet connections which are used commonly.

5.6.1 Dial-up Internet Connection

It is a way to connect to the internet in which public switched telephone network (PSTN) is used to make a Internet connection via telephone lines to an internet service provider (ISP). In dial-up connection telephone network is of prime importance. Since dial-up connection requires telephone lines which have limited capacity. Its transmission speed is limited and it is slow. Generally dialup operate at speeds of 14.4Kbit, 28.8Kbit, or 56Kbit. Dialup speeds vary by the quality of the phone line and the many different user configurations. A MODEM is required for dial-up internet connection. MODEM is short form of modulator-demodulator. A modem is a hardware device or a software application program that is used in a computer to transmit data/ information over a network such as a telephone or cable lines. In computer information is stored in digital form whereas information transmitted over telephone lines is transmitted in the form of analog signal. A modem is used to convert between these two forms of analog to digital and vice versa. Now-a-days, dial-up connections are gradually being replaced by Broadband connections.

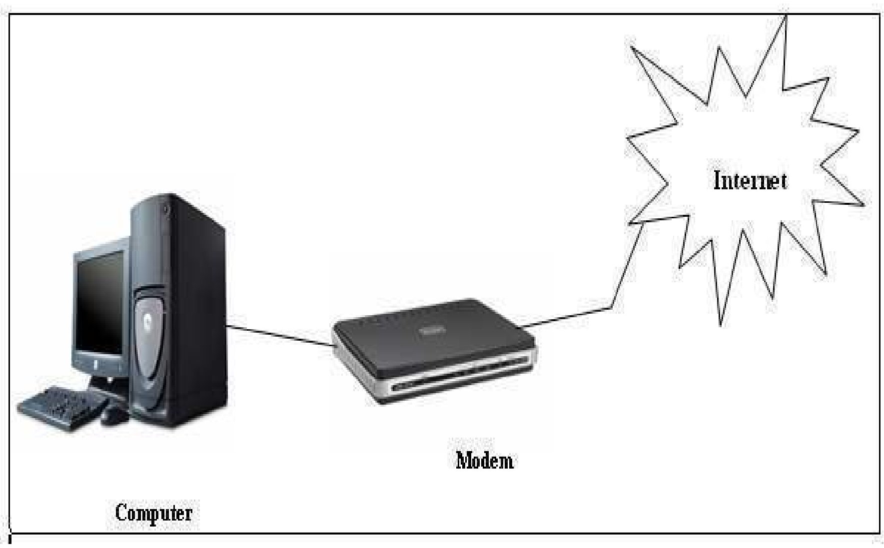

Figure 5.18 : Dial-Up Connection

5.6.2 Broadband Internet Connection

Broadband Connection is a high data rate connection as compared to dial-up connection. Broadband has very high rate of data transmission. In contrast to dialup connection, it is a permanent connection, which can be set up over a high-speed communication links. Generally, an internet connection of 256 kbps (kilo byte per second) or more is considered as broadband Internet connection. Multimedia applications such as video and computer games, can be downloaded very quickly and easily with broadband connection which was not possible, as fast in dial-up connection.

Webcasting is nothing but broadcasting on the internet. This facility is possible only due to high speed internet connection such as broadband connection. When we distribute same media files over the internet to different users using streaming media technology, it is called as webcast. Now-a-days, online web media is a great source of information and it is being successfully used in different sectors such as education, entertainment, technology etc. Online education is one of the most important field which is using this facility. You can find several webcast academic classes on the internet by experts. Even you can find the web lecturers on web link: http://www.ignouonline.ac.in/Broadcast/

Figure 5.19: Webcasting of EDUSAT lectures

5.6.3 Proxy Server

Proxy server is used in a computer network. Proxy server is a server which acts as an intermediary between the client application and the Web server. Proxy server is used to improve performance and for filtering purposes. In an organization, proxy server can be used to prevent its employee to access certain types of website. It provides security and check to the overall system. It can also improve the performance of the network. Suppose two users access the web through proxy server. If user X requests a webpage, say page 1. Sometime later if user Y requests the same page then this request will not forwarded to the web server. Proxy server simply returns the same page which it has access for user X, thus saving lot of time.

Proxy server is a server which acts as an intermediary between the client application and the Web server

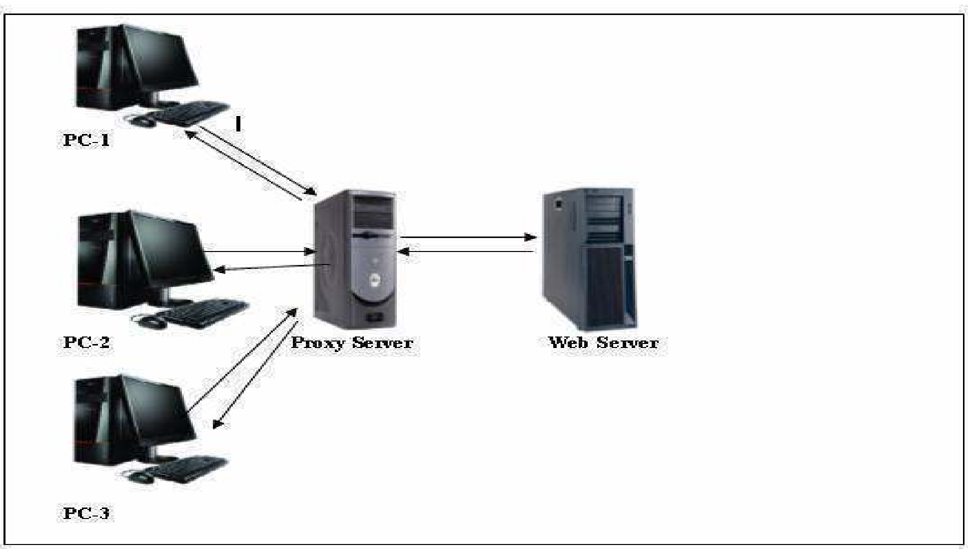

Figure 5.20 : Proxy Server

You may configure Internet Explorer to use a proxy over a LAN connection on your PC. To configure **Internet Explorer 6.0 on your PC, follow the following steps:**

1. On the **Tools** menu in Internet Explorer, you click **Internet Options**, click the **Connections** tab, and then click **LAN Settings**.
2. Under **Proxy server**, click to select the **Use a proxy server for your LAN** chec box.

   In the **Address** box, type the IP address of the proxy server.
3. In the **Port** box, type the port number that is used by the proxy server for client connections. The port number by default is 8080.
4. You can click to select the **Bypass proxy server for local addresses** check box if you do not want the proxy server computer to be used when you connect to a computer on the local network (this may speed up performance).
5. Click **OK** to close the **LAN Settings** dialog box.
6. Click **OK** again to close the **Internet Options** dialog box.

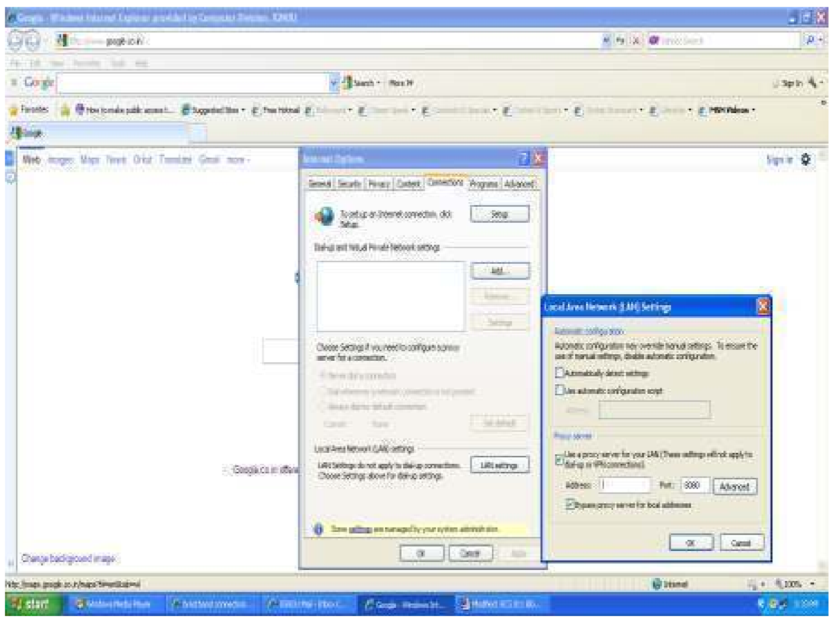

Figure 5.21: Proxy Server Setting

You will learn in more details about computer networks and Internet in **Block 3** of this course.

Check Your Progress-3

1. True/False

(a) A Desktop is a storage area for software and programs.

(b) Recycle bin is the default space where all the files are stored unless we specifically instruct the computer to save at a specified location.

(c) Direct connection and dial-up connection are two main methods to connect to Internet.

(d) For dial up connection to the Internet, you need to have an account on an ISP.

2. **Fill in blanks**

   (i) …………… is a temporary folder which holds files and folders before it is permanently deleted from the storage devices. Recycle bin

   (ii) The most common desktop environment on Personal Computer is ……………

   (iii) A ………….. is an area which holds windows, menus, icons etc. desktop

3. What is desktop on a computer? What are different items found on desktop?

   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………

4. What are the different methods for accessing the internet? Explain methods.

   …………………………………………………………………………………………
   …………………………………………………………………………………………

5.7 SUMMARY

A personal computer (PC) is a general-purpose computer, used for day to day activities in different areas including education, business, administration and health. Now-a-days PC has become vital part of the life of a person. In this unit we have focused on the practical aspects of a PC. We have discussed about various types of personal computer such as Desktop Computer, Laptop, Work Station, Netbook, Tablet PC etc. We have also discussed about the configuration of these computers. Configuration is basically the technical specifications/details about a computer. As we know hardware is essential part of a computer. Different hardware components such as monitors, CPU, Mouse, Key board etc. are combined together to form a PC. We have studied about some of the hardware components such as computer cases, central processing unit(CPU), motherboard, video card in this unit. Apart from hardware components software is also very important to operate a computer. Software plays major role in a computer. Without software computer is of no use. Software can be broadly classified as System software, Application software and Utilities. In this unit we have mainly focused on Application software and Utility software. Desktop is the place on a computer screen which holds icons, images, files, folders etc. we have also briefly mentioned about My Computer, My Documents, Recycle Bin and Taskbar on the desktop of a computer. Finally this unit provides knowledge and details about Internet and different types of Internet connections.

5.8 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress-1

1. **True/ False**

   (a) True (b) True (c) False (d) True (e) True

Multiple choice Questions

2. (a) Light pen (b) All of these (c) Operating system

3. PC stands for personal computer. It is a general purpose computer which is used for personal use. It is mostly suited for a single user and we can perform day-to-day activities in areas such as education, office, business etc. It is used for computational, word processing, and data storage purpose among others.

   Types of PC

   Desktop computer, Laptop Computer, Netbook, PC Tablet etc are different types of a PC.
4. Although both laptop and desktop computers are personal computers but the main characteristics which separates both is their portability feature. A laptop is a portable device which can be used anywhere by the user whereas a desktop is not a portable device. It has to be fixed as a given location and can be operated there. Also their looks and sizes make them different from each other.

Configuration of a Laptop

Processor: Intel Core™ i5-2410M
Memory: 4GB DDR3 1333MHz memory
Hard Disk: 640GB HDD (5400rpm)

5. Motherboard holds some of the most important components of the computer system. It acts as a base for these components. It is also known as system board, main board etc.In a typical computer microprocessor, main memory and other components are connected to the motherboard. Motherboard also provides connectors for several other devices.

Some major components of a motherboard are:

i) ATX Power Connector
ii) AGP Slot
iii) CD-in header
iv) PCI Slots
v) USB Headers

Check Your Progress-2

1. **True/ False**

   (a) True (b) False (c) True (d) False
2. **Fill in the Blank**

   (b) DiskPart (b) Zip (c) System Restore (d) CHKDSK
3. Operating system is an example of system software. It acts as an interface between user and hardware of a computer. Operating system is must in order to operate a computer. OS controls and manages all the hardware components of a computer as well as it also controls input and output, memory and files. It optimizes and utilizes various kinds of resources like I/O devices, Memory, CPU etc.

4. Utility software is basically a set of programs that helps user to perform routine system task and maintenance such as taking back ups of data, checking disks for potential errors, disk management etc. It basically deals to optimize, manage, configure and analyze the computer system**.** Generally utilities are included with the operating systems. Generally Utility programs play supporting roles and it is small programs for specific tasks.

Examples of Utility Software:

- System Restore
- Disk Defragmenter
- Data Compression
- Disk Management
- File compare

5. System restore is used to undo changes to the computer and it restores its settings and performance. System restore helps us to restore computer's system files to an earlier state. System restore backs up system files such as .dll, .exe etc and saves it for later use. System restore creates restore point for this purpose.

To use System Restore follow these steps:

1. Click on **Start button**, select **All Programs**, from there choose **Accessories**, click on **System Tools**, and then click **System Restore**. System Restore starts.
2. On the **Welcome to System Restore** page, click **Restore my computer to an earlier time** (if it is not already selected), and then click **Next**.
3. On the **Select a Restore Point** page, click the most recent system restore point in the **On this list, click a restore point** list, and then click **Next**.
4. On the **Confirm Restore Point Selection** page, click **Next**, System Restore restores the previous Windows XP configuration, and then restarts the computer.
5. Log on to the computer as Administrator. The System Restore **Restoration Complete** page is displayed.
6. Click **OK**.

Check Your Progress-3

1. **True/ False**

   (a) False (b) False (c)True (d) True

2. **Fill in the Blank**

   (b) Recycle Bin (b) Microsoft Windows interface (c) Desktop

3. Desktop is a place on our computer which holds icons, folders, files etc. it is the background area on our computer screen. We can also customize our desktop in different ways like we can add background picture, background colors etc. When we start our computer desktop is the first thing which comes in front of us.

Some of the items found on the Desktop are:

- My Computer
- My Documents
- Recycle Bin
- Task Bar

4. The two primary methods of accessing the Internet are through a direct connection and dial-up connections through a modem and phone line. Direct connection is an ISDN (Integrated services digital network) line, a fiber optical line etc. Direction internet connection is faster than dial-up connection. It is a permanent connection, which can be set up over a high-speed communication line. This is normally used in organizations and corporate, using cable modem (used for cable Internet) and DSL connect to the Internet.

   In Dial-Up connection, telephone lines are used to establish a connection to the internet service providers (ISP). Dial-up internet service is provided through a number of ISPs. A Modem is required for dial-up internet connection.

5.9 FURTHER READINGS

P. K. Sinha , *Computer Fundamental* (BPB publication)

Weblinks:

- http://support.microsoft.com ,
- www.wikipedia.org,
- www.sciencedaily.com,
- http://depts.alverno.edu/cil/mod1/software/system.html,
- http://www.techiwarehouse.com/cat/13/Motherboard.

UNIT 1 SOFTWARE EVOLUTION

Structure **Page No.**

1.0 INTRODUCTION

You all must have come across computers being used at many different places – post offices, hospitals, book stores, grocery stores, universities, banks, publishing houses, etc. You have also studied about computers and their applications in the previous block. But, have you ever wondered how the similar looking machines can behave so differently? What is it that makes them extremely useful machines for varied and unlimited purposes, unlike any other machine available to us? For example we can use a crane only to move loads – its usage is quite limited, but a computer can be used to create a document, do calculations, give presentations, book movie tickets, play movies, music or games and accomplish much more. What makes computer the versatile machines that they are?

It is the **software** that enables a computer to perform all the useful and desired functions. Different types of software help a computer to be used for multiple and varied purposes, in totally different areas of work. We will study about the software aspect of computers in detail in this unit.

1.2 OBJECTIVES

After going through this unit, you will be able to:

- define what is software;
- discuss different aspects of software evolution; and
- differentiate between types of software.

1.2 WHAT IS SOFTWARE ?

A computer system consists of two parts – hardware and software. The first part, computer hardware, refers to all the visible components of the computer system: keyboard, monitor, hard disc, printer, scanner, processing unit, memory, electrical connections, etc. It does all of the physical work a computer is known for. The second part is a set of simple and step-by-step sequence of instructions that tell the hardware what to do and how to do it. This organized set of instructions written in a defined order and to accomplish a specific task is called **computer software** or **computer program**. Hence, a computer software provides intelligence to the hardware, which otherwise is just a collection of circuits and pieces of plastic and metal.

A computer programmer writes the software that gives a computer the ability to solve any business or scientific problem.

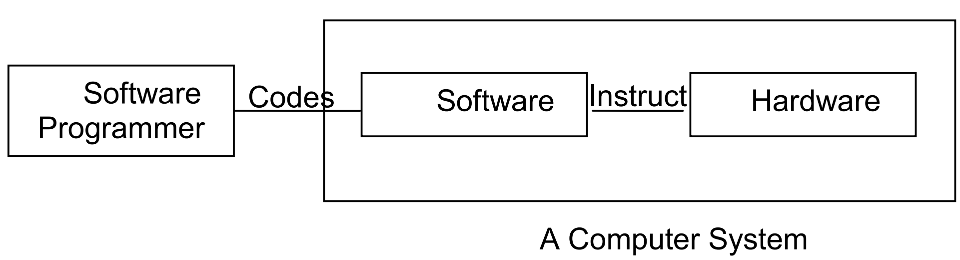

Figure 1.1: Relationship between Hardware and Software

You already know that the computer hardware is essentially a piece of complex electronics that understands only 1's and 0's – electrical "on" or "off" conditions. Hence, the instructions to perform a task must be written in a series of binary 1's and 0's. But, although this binary format, called the machine code makes perfect sense to a machine, it is incomprehensible to a computer programmer who writes the program. So a programmer codes the program in the English like programming language which is easier to understand. This program is then translated into machine code by another computer program. This translated program, called the software is eventually executed to achieve the desired goal.

You will study about types of software and its evolution in the following sections.

1.3 SOFTWARE EVOLUTION

As you know that in a computer system both hardware and software complement each other – one is of hardly any use without the other. Hence, since the very beginning of computer history, software evolution has been closely tied to the advances made in hardware. As hardware became faster, cheaper and with better capacity of storage, software became more complex and sophisticated.

Over the decades computers have been used in new areas and to solve new problems. With changing needs and improved hardware, the software has evolved in its various aspects. The software architecture, its design paradigms, programming languages, its usage, costing and licensing have all changed and evolved over the years.

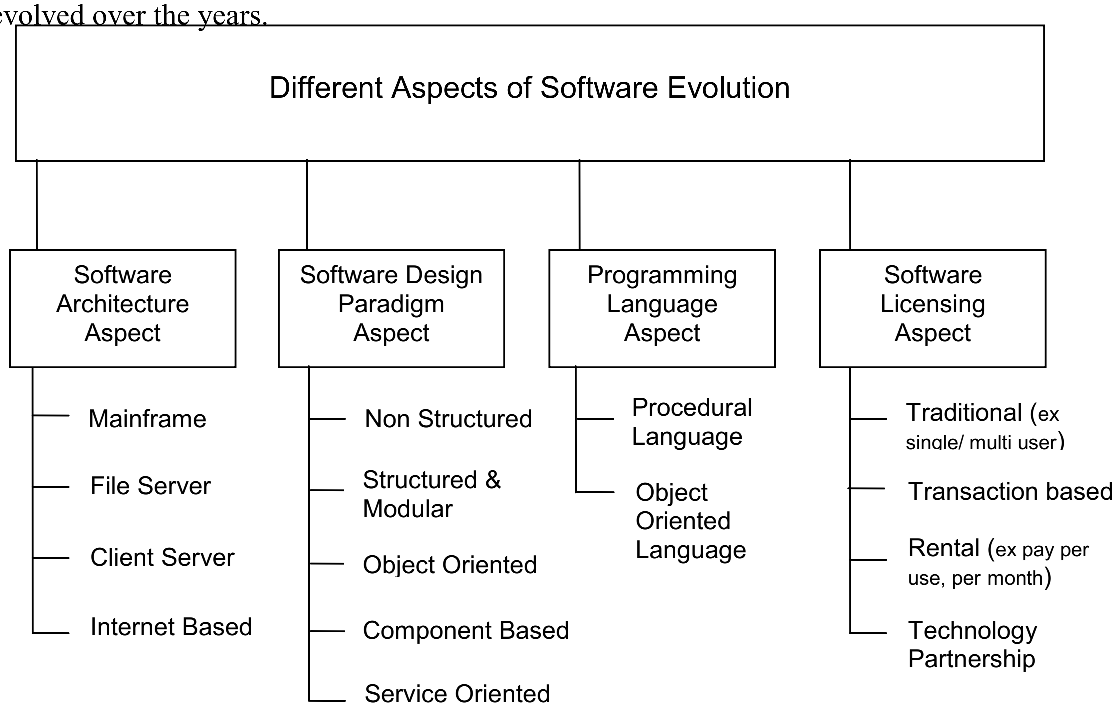

Figure 1.2: Different Aspects of Software Evolution

Software evolution with respect to its architecture, design styles, programming language and licensing will be covered in the following section.

1.3.1 Evolution of Software Architecture

The software architecture has always moved in unison with the hardware advancement.

1.3.1.1 Mainframe Architecture

Till a few decades back, all computing was controlled through the central mainframes server. Multiple users could connect to the central host through unintelligent terminals which captured the keystrokes, sent the information to the host and displayed the text output. All the processing was done by the applications residing on the main central server. Only large transaction-oriented applications were developed during that time. Business tasks such as accounts receivable, accounts payable, general ledger, credit account management and payroll that were repetitive and could be run as batch jobs were automated.

In these centralized computing models, the host provided both the data storage and processing power for the client systems. There was no support for graphical user interface or access to multiple databases from geographically dispersed sites.

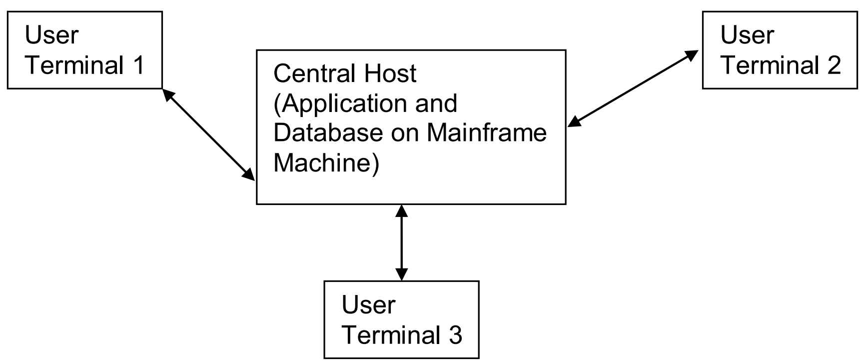

Figure 1.3: Mainframe Architecture

1.3.1.2 File Sharing Architecture

The development of microprocessor, PC and LAN transformed dumb terminals into “smart” clients. This brought a complete change in the computing environment. The client workstations or desktops, with there enhanced capabilities were now responsible for the user interface and execution of the application logic. The server provided access to computing resources like printers and large hard drives for storing the files. It downloaded the file from the shared location on the server to the client machine. The user application that worked on the data was run on the client and the file was written back to the server. The application had to be installed on each workstation that accessed the file.

In this architecture, resources could be added as and when necessary or desired. Thus, it provided a low cost entry point with flexible arrangement. The drawback was that application logic was executed on the client and server typically provided files to store data. It worked fine as long as the volume of data transfer was low and shared usage and content update was low. As the number of online users grew, the network traffic got congested and the file sharing got strained. Taking into account the demerits of the file server architectures, the client/ server architecture made its advent.

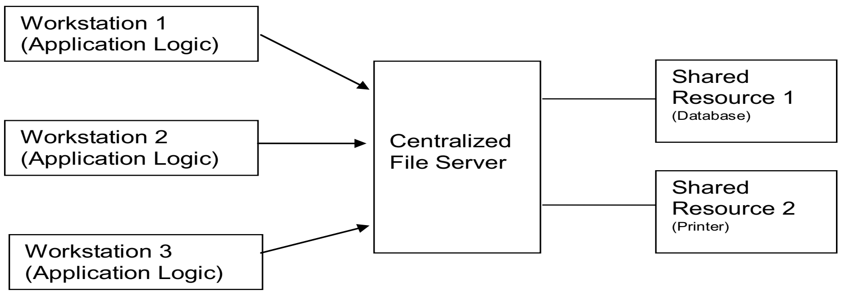

Figure 1.4: File Sharing Architecture'

1.3.1.3 Client/ Server Architecture

As the capacity and power of personal computers improved, the need to share the processing demands between the host server and the client workstation increased. This need for greater computing control and more computing value led to the evolution of client/server technology.

In client/server architecture, the tasks or workloads are partitioned as:

- server programs – providers of a resource or service
- client programs – requester of resource or service

Clients and servers may reside in the same machine or they typically reside in separate pieces of hardware and communicate over a computer network. A server machine is a host that runs one or more server programs which share their resource with clients. A client does not share any of its resources, but requests a server function or service. The server program fulfills the client request. Clients initiate a communication session with the server.
The client/ server system may be two-tiered, three-tiered or n-tiered.

Two-tiered architecture: This approach basically introduced a database server to replace the file server. The emergence of relational database management systems and graphical user interface applications led to database server which could be accessed through the GUI based client applications. Since, the clients query the database over the network and only the relevant data is supplied to the client, the network traffic is greatly reduced in comparison to the file server system.

The application or business logic in client server applications may reside on the server (fat server – thin client) or on the client (fat client – thin server). Since, clients and server interact over the network, increases in the number of users often lead to network congestion. Also, maintenance of the application becomes difficult with more users. This lack of scalability (Ability of a system to support increased demands of work, usage or service levels almost instantly, without any change and with no significant drop in cost effectiveness or quality of service) and flexibility gave rise to 3-tiered and n-tiered architectures.

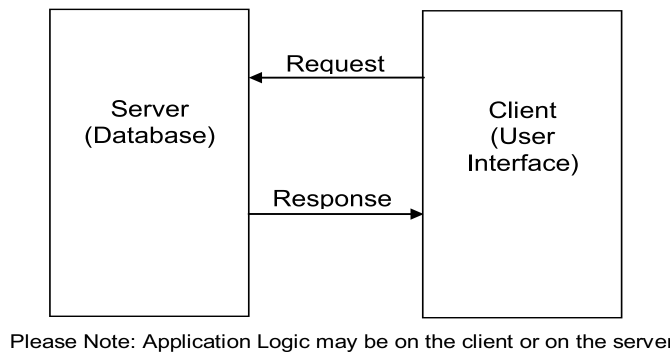

Figure 1.5: Two Tier Client Server Architecture

Three-tiered architecture: A new generation of client/server implementation takes a step further and adds a middle tier in between client and server to achieve "3-tier" architecture. The 3-tier architecture attempts to overcome some of the limitations of 2-tier schemes by separating presentation (user interface), processing (business functionality) and data into separate distinct entities. This leads to enhanced network performance and improved extensibility of business systems. Still, it has been found that three-tier methodology lacks some critical features such as reusability (Ability of a computer program to be used repeatedly with little or no modifications in many different applications) of application logic code and scalability. There may arise a situation whereby a collection of application logic code can not be reused and also they do not communicate with one another. Thus, there came a need for a viable architecture that mainly facilitates reusability of business logic as reusability phenomena has been found to reduce the cost of software development and the time to market and its quality is assured.

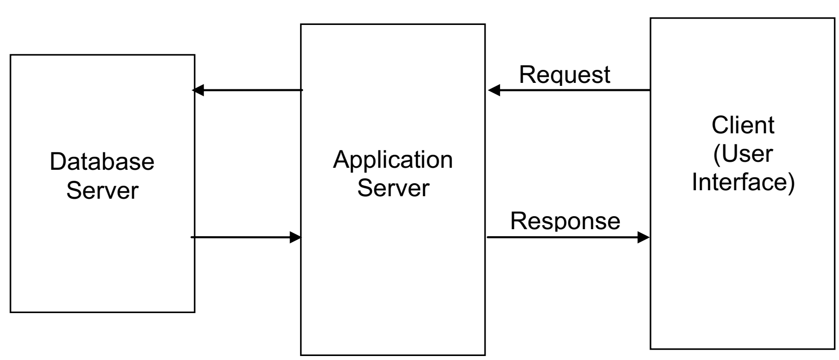

Figure 1.6: Three Tier Client Server Architecture

N-tiered architecture: The 3-tier architecture can be extended to N-tiers when the middle tier provides connections to various types of services, integrating and coupling them to the client, and to each other. Partitioning the application logic among various hosts can also create an N-tiered system. Encapsulation of distributed functionality in such a manner provides significant advantages such as reusability, and thus reliability (Ability of a computer program to perform its intended functions and operations for the specified period of time, in the specified system's environment, without experiencing any failure).

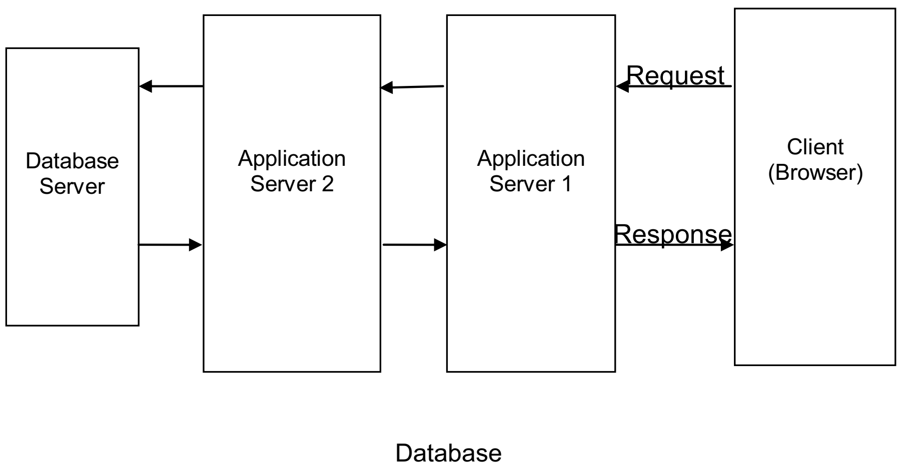

Figure 1.7 : N-Tiered Client Server Architecture

Internet-based architecture: In the late 1990's, the client/server trend was augmented by the internet. The users access the web servers through the web browsers on the client machines and over the internet. This led to very thin client based applications, which reside on corporate web servers.

The advantage of web based applications is that they do not have to be tailored to run on specific platforms. But since the web applications cannot perform client-side processing, they limit the user experience by turning the client computers into "dumb" terminals. Web mails, online transactions are examples of web applications.

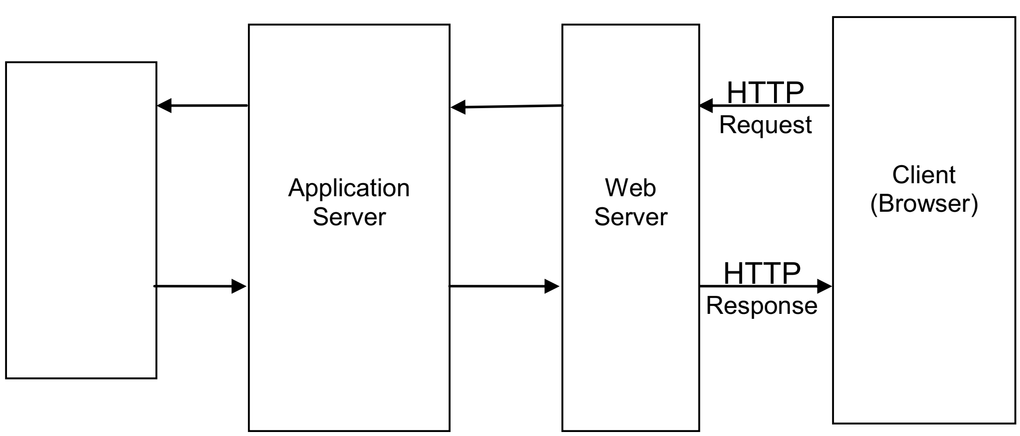

Figure 1.8 : Internet Based Architecture

1.3.1.4 Cloud Computing

As the technology has evolved from Mainframe-based large proprietary (Computer Programs that are exclusive property of their developers or publishers, and cannot be copied or distributed without complying with their licensing agreements) systems to Client-Server architecture based open systems to Open Source software based solutions, software vendor's business has also evolved over the period of time. Cloud-based software services typically mean that the consumer does not own the hardware and software, but still gets the desired service. It is an IT delivery model that offers large-scale, shared infrastructure and computing resources as a service through self-service pay-per use access. Although it leverages recently developed technology, cloud computing is a business, not a technical trend.

Here is some background for the evolution of these services. As the new software vendors tried to establish themselves in the market, they created solution differentiators which provide unique value to the consumers. An example is Salesforce.com, which from the inception offered a hosted Customer Relationship Management (CRM) solution, while its established competitors (Siebel, SAP, PeopleSoft etc) had their traditional (also called On Premise, meaning at the customer site in its dedicated environment) CRM solution. Another reason is that software vendors started targeting a niche customer segment called Small & Medium Business (SMB). SMB customers are relatively new in business, so need to establish the core IT systems in place and also have lesser financial strength, as a result are more open towards cloud-based solution.

An early example of cloud based computing is web-based emails (hotmail, yahoo, gmail etc), Chat (AOL, MSN etc). Here the required computer resources are provisioned centrally in the cloud (internet) and shared by the user pool. These days, more often, software is bundled with the required shared infrastructure to provide a solution stack to the consumer.

Key features of cloud computing are:

- **Infrastructure sharing:** Cloud computing enables dynamic sharing of resources so that demands can be met cost effectively.
- **Scalability:** To handle ever increasing workload demands and support the entire enterprise, cloud computing must have the flexibility to significantly scale IT resources.
- **Self service:** Cloud computing provides customers with access to IT resources through service-based offerings. The details of IT resources and their setup are transparent to the users.
- **Pay-per-use:** Because cloud resources can be added and removed according to workload demand, users pay for only what they use and are not charged when their service demands decrease.

There is another term that is associated with cloud computing:

- Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) – also referred to as On Demand software. This is a software solution delivery model where the software and the associated data are hosted centrally (in the cloud) and are accessed by the consumer through a thin client such as a web browser. Common applications for this are business applications such as – Accounting, Collaboration (Email, Messenger, Web meeting etc), Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), Human Resource Management etc.

Key benefits of Cloud-based solutions are:

- Lower upfront cost to get started, lower time-to-market (as it takes less time to get a customer going on a cloud solution), allows the company to focus on the core business and not worry about hiring and constantly training its staff on the new technology etc.

- On the flip side for a Cloud-based solution, certain segment of customers such as large Banks and Financial institutions, Insurance companies may have security constraints in letting their data reside outside its premises (in their own data centers).

1.3.2 Evolution of Software Design Paradigm

As the software evolved in its complexity, architecture and use, and as the programming languages got better, styles of software programming also changed and improved.

One of the longest standing goals of software design is reusability which leads to increased reliability, accelerated development and easy maintenance. Over the years, software languages and software design paradigms which have evolved, all encourage compartmentalization of functionality to achieve this goal. Similar functionality is grouped together into small, independent and reusable units. These units can be used in any application for the purpose for which they were originally intended.

The first step towards compartmentalization was moving from line by line non structured program design to procedure-oriented program design.

1.3.2.1 Non-structured Design Paradigm

Non-structured programming is historically earliest programming paradigm. A non structured program usually consists of sequentially ordered statements, usually one in each line. The lines are usually numbered or labeled to allow the flow of execution to jump to any line in program. There is no concept of procedures in non structured program; hence there are no independent reusable units in this programming paradigm. The program flow in non-structured programming would be as follows:

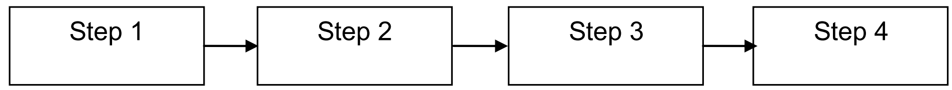

Figure 1.9: Program flow in Sequential Non Structured Programming

Example of code in non structured programming is:

```
        INTEGER i
        i=12
1       GOTO 10
2       CONTINUE
        i = i - 1
        IF (i = 0) GOTO 99
10      PRINT*, "Line 10"
        GOTO 2
99      CONTINUE
```

The above fragment of code simulates a loop using GOTO statement for transfer of control. Note that the lines are labeled/ numbered so that they can be used with GOTO. The program executes the statements sequentially. The code simulates a loop to decrease the value of variable i by 1 till it reaches zero.

The initial value of i is 12. Until the value of i reaches zero, it continues to print the text “Line 10”.

1.3.2.2 Structured and Modular Design Paradigm

Structured design paradigm introduced the concept of selection and repetition of statements in code execution along with the line by line execution. It allowed writing of procedures and functions. These are the terms used for a block of code that is written to perform a single task. Procedures and functions were the beginning of compartmentalization and hence reusability of program code.

Procedures and functions which were for similar purpose were grouped together to get a module. A big software application consisted of multiple modules, each performing a particular task.

Structural design allowed modules to be reused in the form of code libraries.

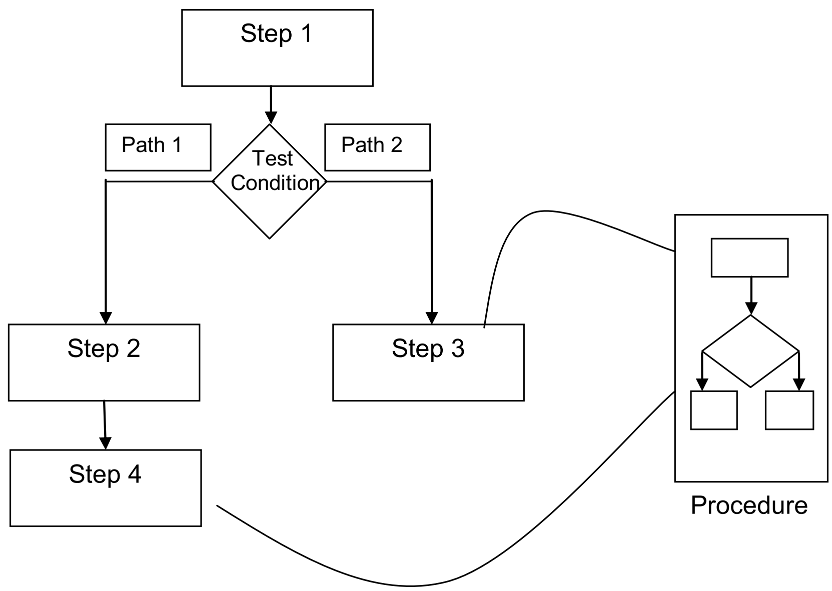

Figure 1.10 : Structured Programming with Procedure

As shown in Figure 1.10, same procedure is invoked from step 3 and step 4. There is also a selection of path to be followed. The two paths would be either steps 1,2,4 or steps 1,3.
The sample pseudo code for the above flow could be:

Steps from Figure 1.10	**Code Corresponding to Steps fromFigure 1.10**
Step 1	Accept user input in X
Test Condition – Path 1	If X is even then
Step 2	Add 1 to X
Step 4	Call procedure PrintPrime(X)
Test Condition – Path 2	Else
Step 3	Call procedure PrintPrime (X)
Procedure	Procedure PrintPrime (Y)
The procedure again has multiple steps. Note that in this case Step 3 and Step 4 are same – Call to the procedure PrintPrime()	Accept Y and Check if Y is prime number If Y is prime Display “Y is prime number” else Display “Y is not prime number”

1.3.2.3 Object Oriented Design Paradigm

The next leap forward towards compartmentalization and reusability was arrival of object oriented-design that introduced the concept of an object as an atomic unit of functionality.

Object oriented design is built on the premise that programming problems can be modeled in terms of the objects in the problem domain. In this design, any object of interest in the real world is an object in the program code. This helps to effectively model the real world and interactions of items within it. As the objects in the real world interact with each other, similarly, the objects in the program interact through their interfaces or messages which are very well defined and contained in the objects. An object exposes the interface that can be called on by other objects that need the object's functionality. Because an object is a self-contained entity and because its interface is well-defined it is highly reusable across many applications.

For example, school and student are objects in real world. They would be considered as objects in object oriented design also and they would interact with each other through messages.

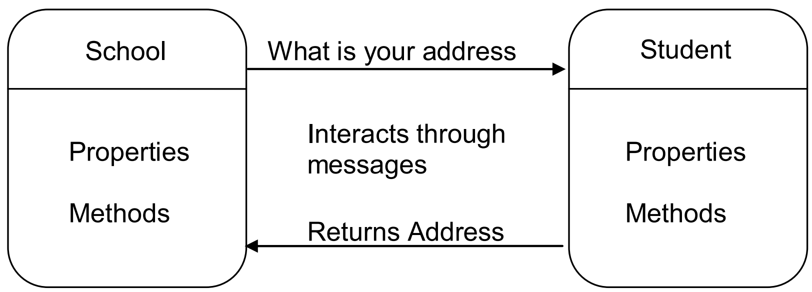

Figure 1.11: Object Oriented Programming

In the Figure 1.11 each object has its own properties and methods which constitute the interface of the object.

Encapsulation is one of the basic principles of object-oriented programming (OOP) and refers to an object's ability to conceal its data (properties) and methods. Encapsulated objects only publish the external interface so any user interacting with them only needs to understand the interface and can remain ignorant as to the internal specifications.

As the applications grew complex, code became more modular and reusable. The applications were being broken up into pieces that were distributed across many machines. Breaking applications into multiple parts and distributing them across multiple platforms presented a new set of reusability problems.

1.3.2.4 Component Based Paradigm

The concepts of Object Oriented paradigm were extended to component based programming. Component Based Development owes many concepts to object-oriented methods. It gives a more abstract view of software systems than object-oriented methods. This model prescribes that programming problems can be seen as independently deployable black boxes (components) that communicate through contracts.

The meaning of component or component based programming is intuitive: programs are broken down into primitive building blocks, which may be flexibly “plugged together” according to well-defined protocols.

The idea behind component based programming is to develop software systems by assembling a set of independently developed components off-the-shelf (COTS) in a ‘plug and play’ manner. For example, a Shopping cart website application may use off the shelf credit card authorization component.

Components exist at different sizes varying from single objects inside a library to whole applications. In most cases, however, components are larger entities and contain several objects.

Components are regarded as part of the starting platform for service-orientation – whereby a component is converted into a service.

1.3.2.5 Service Oriented Paradigm

Service-Oriented Programming builds on Object oriented programming, adding the premise that problems can be modeled in terms of the services that an object provides or uses.

A service is a unit of functionality defined by a set of message exchanges that are expressed using an implementation neutral grammar. It is a behaviour that can be implemented or provided by any component for use by any component based on message exchange.

A service, unlike an object, is an abstract entity whose implementation details are left largely ambiguous. The only implementation details spelled out are the messages the service exchanges or message exchanges. This ambiguity, coupled with the requirement that the messages be defined by an implementation neutral grammar make a service highly reusable and easy to integrate into a complex system.

1.3.3 Evolution of Programming Languages

As the software architecture moved from mainframes to Internet based and design paradigms evolved from non-structured to service oriented, Programming languages evolved to support the architecture and the design paradigms. As design became more and more compartmentalized so that the application could be distributed onto multiple machines, and individual components could be reused, more and more programming languages were designed to make support these ideas. For example COBOL is one language that evolved from procedural to object oriented.

1.3.3.1 Procedural Language

Procedural programming could also be called linear programming as one thing happens and then the next. Each instruction is executed in order from the top of the file to the bottom. It focuses on the idea that all algorithms are executed with functions and data that the programmer has access to and is able to change. Some languages which support procedural programming are C, FORTRAN, VB, etc.

Let us consider an example to understand how a procedural language works. You need to create forms for online inventory system for an automobile parts manufacturer. You are asked to design two separate forms: one to process information about cars and other about trucks.

For cars, we will need to record the following information:

- Color
- Engine Size
- Transmission Type
- Number of doors
- Make

For trucks, the information will be similar, but slightly different. We need:

- Color
- Engine Size
- Transmission Type
- Cab Size
- Towing Capacity
- Make

We will code as follows:

```
/*Declare the Global variables*/

Var Color
Var EngineSize
Var Transmission Type
Var Make

MainProg()
Begin
    If requested for car
        Call CarProcedure()
    If requested for Truck
        Call TruckProcedure()
End
CarProcedure()
Begin
```

```
        /*Declare the Local variables*/
        Var NumberOfDoors

    Process Car Information
End

TruckProcedure()
Begin
        /*Declare the Local variables*/
    Var CabSize
    Var TowingCapacity

    Process Truck Information
End
```

If we need to add form to process information for bus, then we need to change the MainProg() and add code for Bus Form. But if there is a change in the processing of all the vehicles, then we need to make changes to all the forms. If we need add any make specific information for cars, then we need to create multiple forms, one for each make. Also, we need to be careful about any changes to the global variables as all the forms are accessing them.

1.3.3.2 Object Oriented Language

Object Oriented Programming is more abstract than procedural programming because it looks for patterns and reusability. The same code can be loaded and executed many times to accomplish a task without having to retype it.

Before we consider above example in object oriented, let us understand few terms and concepts associated with object oriented programming. There are three main concepts that any language needs to support to be an object oriented language.

Encapsulation: is a mechanism through which a protective wrapper is created to hide the implementation details of the object and the only thing that remains externally visible is the interface of the object. (i.e.: the set of all messages the object can respond to). Encapsulation prevents code and data from being arbitrarily accessed by other code defined outside the wrapper.

Inheritance: is the process by which a new class is created using an existing class. It is a way to compartmentalize and reuse code since it allows classes to inherit commonly used state and behavior from other classes. The new classes are called the derived classed and the main class is called the parent class.

Polymorphism: Polymorphism is the characteristic of being able to assign a different meaning specifically, to allow an entity such as a variable, a function, or an object to have more than one form. It is the ability to process objects differently depending on their data types and to redefine methods for derived classes.

Following are the few terms that will help you understand object oriented programming:

- A class is a set of functions that work together to accomplish a task. It can contain or manipulate data, but it usually does so according to a pattern rather than a specific implementation. An instance of a class is considered an object.
- An object receives all of the characteristics of a class, including all of its default data and any actions that can be performed by its functions. The object is for use with specific data or to accomplish particular tasks. To make a distinction between classes and objects, it might help to think of a class as the ability to do something and the object as the execution of that ability in a distinct setting.
- A method simply refers to a function that is encased in a class.
- A parameter is a variable that is passed into a function that instructs it how to act or gives it information to process. Parameters are also sometimes called arguments.
- A property is a default set of data stored in a class. A class can have multiple properties and the properties can be changed dynamically through the methods of the class.

Smalltalk, C++, Java, C# are some of the examples of object oriented languages. Now let us see how we create classes and use them for the automobile parts inventory management system example.

```
Class Vehicle
{/*Data*/
        Var Color
        Var EngineSize
        Var TransmissionType
        Var Make
/*Methods for each data*/
    Color()
    {
        Store and update color;
    }

        EngineSize()
        {
            Store and update EngineSize;
```

```
        }

        TransmissionType()
        {
            Store and update TransmissionType;
        }

        Make()
        {
            Store and update Make;
        }
}
Class Car Inherits Vehicle
{/*Data*/
        Var NumberOfDoors

/*Methods*/
    NumberOfDoors()
        {
                Store and update NumberOfDoors;
        }
}

Class Truck Inherits Vehicle
{/*Data*/
        Var CabSize
    Var TowingCapacity

/*Methods*/
    CabSize ()
        {
                Store and update CabSize;
        }

        TowingCapacity ()
        {
                Store and update TowingCapacity;
        }
}
```

Now in this case, if we need to add form to process information for bus, then we just add one more class Bus() which is again inherited form the Vehicle class. And if we need add any make specific information for cars, then again we can add make specific classes which can be inherited from the Class Car() We need not worry about mistakenly modifying any global variables. If there is change in processing of all the vehicles, then instead of making changes at all the places, we just modify the Vehicle() class.

1.3.4 Evolution of Software Licensing

Software licensing has kept pace with the evolution of software solutions offered by the vendor or the solution provider community.

1.3.4.1 Introduction to Software Licensing

Until early 1970's, sharing of software was the accepted norm. Hardware came bundled with software products which could be freely redistributed and the access to source code allowed its improvement and modification.

In late 1960's, the situation changed after the software cost increased and manufacturers started to unbundle the software and hardware. A growing amount of software was now developed for sale. In late 1970's and early 1980's companies began imposing restrictions on programmers through copyright. They achieved financial gains by selling rights of use of software rather than giving the source code. This led to introduction of **software licensing** which governed the usage and redistribution of software. During this time most of the companies developed **proprietary software** that was actually the property of the company, came without the source code and the users basically bought the right to use it in the way specified under the license agreement.

In early 1980's the seeds for free and **open software** were sown as a deviation from the proprietary software. The open source software comes with source code and a license that allows modification and free redistribution.

We will study in the following section, about different types of licenses that evolved with software over the period of time.

1.3.4.2 Types of Software Licensing

The licensing type generally depends on whether the software is open source software, is meant for individual use or enterprise wide commercial use:

Individual License: allows you to install the software only on a single stand alone machine. It may be a **perpetual license** or **Subscription based.** Perpetual license allows you to install and use the software indefinitely. Subscription based license allows you to use the license for the specified time, after which you may renew the subscription or remove the software.

Open Source License: It grants you the right to freely modify and redistribute the software.

Commercial License: These are mostly for the large enterprises that use software for commercial purposes.. Following are the main licensing models:

- **Traditional model :** This includes single user-single license, multi users-shared license, temporary or fixed-period licenses. This has mostly been used for large proprietary mainframe applications.
- **Transaction-based model :** Here, the pricing is based on providing a committed business service, for ex, processing payroll for a global company as part of HR offering and this can be priced per employee. Larger the employee base at a given location, lower the price / employee can be. This model came into existence with the evolution of software architecture from mainframes to internet based. As mentioned before, when a company provided a particular business service, its client could access the system from anywhere over the Internet and they need not bother about maintaining the database or the software system. The service provider then charges them for each transaction/ record processed through their system.
- **Rental model :** This has come into picture as Software as a Service (SaaS) and Platform as a Service (PaaS) models have evolved over a period of time. Here, the buyer need not need make upfront investment in hardware and software, rather these come as bundled service to them. Few examples where these are prevalent are – Finance & Accounting (Core Finance), Human Resources (Core HR), Analytics (Business Intelligence/Reporting), Procurement etc. There are also scenarios where the software vendor provides subscription of a given solution (ex. Windows Azure, Salesforce.com, Siebel On Demand, Amazon Web Services etc) on a periodic (ex. monthly, annual) basis.
- **Technology Partnerships :** Such agreements provide the consumer un-limited access to vendor's technology. Such contracts are typically multi-year in nature where the consumer pays a fixed annual fee, which can be adjusted in the subsequent years based on the actual usage. For example, a large corporate customer deciding to use Oracle suite of ERP (Finance, HR), database, CRM, Business Intelligence/ Reporting solutions can get into a long-term multi-year partnership.

Check Your Progress 1

1. Compare and contrast the following:
   a. Mainframe and File Sharing architecture
   b. Client server and Distributed architecture
   c. Structured and Non Structured Programming

   …………………………………………………………………………………

   …………………………………………………………………………………

   …………………………………………………………………………………
2. Describe the following terms:
   a. Software Reusability
   b. Software Reliability
   c. Encapsulation

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3. What do you understand by Software-as-a-Service? How is it different from Cloud Computing?
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4. What is pay-per-use licensing?
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1.4 TYPES OF SOFTWARE

There is a wide variety of software available today. And there is no clear cut distinction in certain software systems. Still, most computer software can be broadly classified as:

- System software
- Programming software
- Application software

At times the categorization is vague and some software may fall into more than one categories.

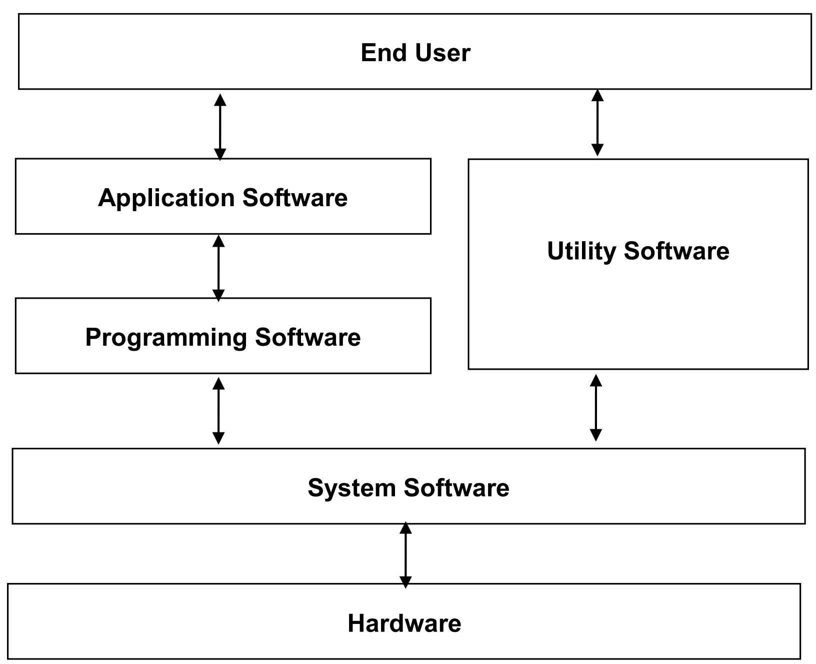

Figure 1.12: Types of Software and their interrelationship

1.4.1 System Software

System software helps run the computer hardware and system. It is designed to control the operations of a computer and coordinate all external devices like communication devices, printers, keyboards, display units, etc. It manages all the computer resources like memory and processor time in optimal and stable manner.

System software provides a useful link between user and computer. It also assists the computer in the efficient control, support, development and execution of application software. System software is essential for computer hardware to be functional and useful.

Some common types of system software are:

a) Operating Systems

Operating System is the software that manages all the computers' resources to optimize its performance provides common services for efficient execution of various application software and acts as an interpreter between the hardware, application programs and the user.

An operating system is essential for any computer to be useful to us. When a user or a program wants the hardware to do something, the request is always communicated to and processed by the operating system.

Operating systems performs 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.

For large systems, the operating system has even greater responsibilities and powers.

Most operating systems perform the functions given below:

- Process Management
- Memory Management
- File Management
- Security
- Command interpretations

You will study in detail about the operating system in the following units in this block.

b) Server Programs

Server programs are dedicated computer programs that run as services and serve the needs or requests of other programs. These services may run on a dedicated hardware or on the same computer as the requesting program. Also, one on more services may run on the same computer hardware. Some common examples of different types of server programs are:

- Web server – for hosting websites.
- Print server – manage multiple print requests for multiple printers.
- File server – manages the storage and retrieval of shared computer files.
- Database server – provide database services to other computer programs.
- Mail Server – manages and transfers electronic mail messages.

c) Device Drivers

Device drivers are shared computer programs that provide an interface between the hardware devices and operating system or other higher level programs.

You need a specific software program to control each hardware device attached to the computer. It is very tedious to make any piece of hardware work. For example to write to a hard disk, you need to know the specific address available, wait till hard disk is ready to receive data and then feed it with data once it is ready. So instead of writing the same code for a device in multiple applications you share the code between applications. To ensure that the shared code is not compromised, you protect it from users and programs. Such a piece of code is called the device driver.

Device drivers are hardware dependent and operating system specific. They allow you to add and remove devices conveniently from your computer system without changing any of the applications using that device.
Common hardware components that require drivers are:

- Keyboards
- Mouse
- Printers
- graphics cards
- sound cards
- card readers
- CD/ DVD drives
- Network cards
- Image Scanners

d) Communications Software

In a networked environment, the communication software or network operating system allows computers to communicate with each other. It enables sharing and transferring of data across the network. It controls network operations and manages network security.

1.4.2 Programming Software

Programming software usually provides tools to assist a programmer in writing computer programs, and software using different programming languages in a more convenient way. It shields the application software programmer from the often complex details of the particular computer being used.

Programming Software includes the following:

a) Compilers

A compile is a program that translates the code written in a high-level programming language (called the source code) to the code in lower level language (the object code). The compiler translates each source code instruction into a set of, rather than one object code instruction. Generally, the object code is the machine language code.

When a compiler compiles a program, the source program does not get executed during the process, it only gets converted to the form that can be executed by the computer.

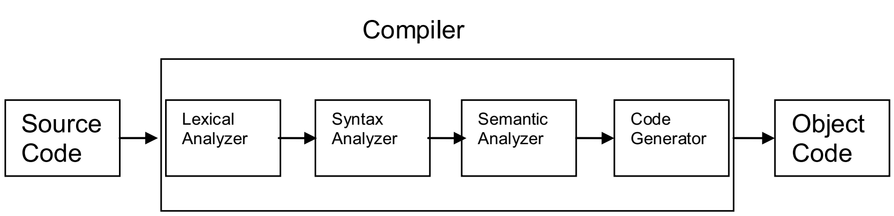

Figure 1.13: Compiler

b) Debuggers

A debugger or debugging tool is a computer program that is used to test and debug other programs (the target program).

Typically, debuggers offer functions such as running a program step by step (single-stepping) or breaking (pausing the program to examine the current state) at some event or specified instruction by means of a breakpoint, and tracking the values of some variables. Some debuggers have the ability to modify the state of the program while it is running, rather than merely to observe it. It may also be possible to continue execution at a different location in the program to bypass a crash or logical error.

c) Interpreters

Interpreter is another translation program. It takes the source code instruction, one at a time, translates and executes it.

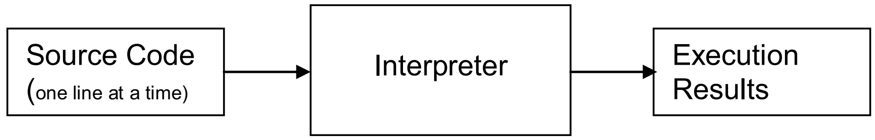

Figure 1.14: Interpreter

d) Linkers

A linker or link editor is a program that takes one or more Object file codes generated by a compiler and combine them into a single executable program.

When large software, involving many programmers is to be developed, then the modular approach is adapted. The software is divided into functional modules and separate source programs are written for each module. Each of these source files can then be compiled independent of each other to create a corresponding object file. Eventually, linker is used to combine all the object files and convert them into a final executable program.

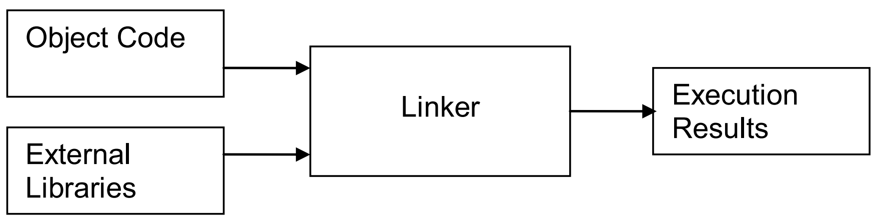

Figure 1.15: Linker

e) Text editors

A text editor is a type of program used for editing plain text files.

Many text editors for software developers include source code syntax highlighting and automatic completion to make programs easier to read and write.

Common text editors in Windows environment are Notepad and Textpad.

1.4.3 Application Software

Application software is designed and developed to accomplish one or more specific task or solve a particular problem.

Application software may be for commercial or scientific use. There is wide range of application software available for varied purposes. Some major categories of these applications include:

a) **Word Processing Software** can be used to create, edit, format, save, view or print any text based document like letters, memos, reports, etc. MS Word is an example of word processing software

b) **Spreadsheet Software** can be used to create any numeric based documents or as numeric data-analysis tool. For example it can be used to make budgets, financial statements, comparative charts, etc. MS Excel is an example of Spreadsheet software.

c) **Database Software** can be used to store, maintain, manipulate and organize a large set of data. For example, it can be used to maintain address, phone number directory, client directory, etc. Oracle is an example of database software.

d) **Presentation Software** like MS PowerPoint can be used to create and present slide show.

e) **Graphics Software** can be used to manage and manipulate pictures, photographs, movies, etc. Photoshop, Illustrator and MS Paint are examples of graphics software.

f) **Multimedia Authoring Application** can be used to create digital movies with sound, video, animation and interactive features. Mediator 9 is an example of multimedia authoring tool.

Other applications include:

- Entertainment and Education Software
- Industrial automation
- Business software like inventory management, airline reservation
- Video games
- Telecommunications
- Mathematical software
- Medical software
- Scientific software like molecular modeling, quantum chemistry software
- Image editing
- Simulation software
- Decision making software

Check Your Progress 2

1. Compare and contrast the following:
   a. System and Application Software
   b. Compiler and Linker
   c. Compiler and Interpreter

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………

2. Give an example of each of the following:
   a. Decision Making Software
   b. Education Software
   c. Industrial Automation Software
   d. Mathematical Software
   e. Simulation Software

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………

3. You bought a new printer. You attached it to the computer and plugged to the power, but it still does not work. What do you think must have happened and how can you resolve the issue?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………

4. List which software will be required to perform the following actions:
   a. You have write code in C++. What software you will use to write the code in?
   b. You have attached a new scanner to your machine to scan your photographs. What software you will use to get it working?
   c. You have bought a new PC. What is the first piece of software that is needed to be installed for it to be useful so that other software could be added?
   d. You have created a student registration system. What will you use to store the students data.

1.5 UTILITY SOFTWARE

Utility programs help manage, maintain and control computer resources. These programs are available to help you with the day-to-day chores associated with personal computing and to keep your system running at peak performance.

Some of utility programs are discussed below:

Anti-virus software

Computer viruses are software programs that are deliberately designed to interfere with computer operation; record, corrupt, or delete data; or spread themselves to other computers and throughout the Internet. Virus Scanning Software are utility programs designed to protect your computer from computer viruses, worms and trojan horses.

Historically, computer viruses were associated with self-reproducing executable programs that manipulated or even destroyed data on infected computers. They were known to spread by infected floppy disks, network or other hardware media. With the advent of internet, the viruses spread online as well. They can also spread through powerful macros used in word processor applications, like MS Word, or email programs where viruses are embedded in the email body itself and reproduce when the message is just opened or previewed.

To help prevent the most current viruses, you must update your antivirus software regularly. You can set up most types of antivirus software to update automatically.

Most anti-virus programs use one of the following techniques to identify viruses:

1. **Signature based detection**: This is the most common method. It compares the contents of the infected file to a known pattern of data. Because viruses can embed themselves in existing files, the entire file is searched.
2. **Heuristic-based detection**: This method is primarily used to identify unknown viruses by looking for malicious code or variations of such code.
3. **File emulation**: This is another heuristic approach in which the infected program is run in a virtual environment and the actions it performs are recorded. The actions are analyzed to check for any malicious actions and carry out disinfection actions accordingly.

No matter how useful antivirus software can be, these can sometimes have some drawbacks.

- Antivirus software can impair a computer's performance. Active anti-virus programs can cause conflicts with other programs.
- A "false positive" is when antivirus software identifies a non-malicious file as a virus. When this happens, it can cause serious problems. For example, if an antivirus program is configured to immediately delete infected files, a false positive in a essential file can render the operating system or some applications unusable.
- Most popular anti-virus programs are not very effective against new viruses. The reason for this is that the virus designers test their new viruses on the major anti-virus applications to make sure that they are not detected before releasing them into the market.

- Some apparent antivirus programs are actually malware being sold as legitimate software, such as Win Fixer and MS Antivirus.
- Some commercial antivirus software agreements include a clause that the subscription will be automatically renewed. For example, McAfee requires users to unsubscribe at least 60 days before the expiration of the present subscription. Norton Antivirus also renews subscriptions automatically by default.
- Finally, antivirus software generally runs at the highly trusted kernel level of the operating system, creating a potential avenue of attack

Despite the drawbacks, anti-virus software have become a necessity these days. A number of popular anti-virus programs include those by Kaspersky, Symantec, McAfee, and Norton. The cost of the program increases with the increase in the number of virus detection and removal features and ease they offer.

Backup utilities

Backup refers to making copies of data so that these additional copies may be used to restore the original after a data loss event. All types of data could be backed up like pictures, word documents, files, executables or an entire database.

The main purpose is to recover data in the event of data loss or data getting corrupt. Other purpose could be to recover historical data.

A number of Backup software are available that assist you in taking backup of your important data on the computer. Selecting between various back-up software is not only a based on the cost but also on the software that meeting the requirements.

A backup software could allow automated scheduling of backup in addition to just creating copy of files. The software should be easy to install and maintain. It should be intuitive and easy to use. The restoring from the back-up should be simple. Accessing restored data should be automatic, and the backup should preserve original data files and paths. A backup software that can compress data helps in storing data in lesser space. Certain software also allows securing the backed-up data with passwords and encryption. Good documentation and technical support goes a long way in ensuring help is available when needed.

Backup could be taken on variety of media including hard drive, CDs, DVDs, floppy disks etc. It could also be taken on FTP locations, tape or online servers. A number of free and proprietary back-up software are available including those from Microsoft, Symantec, Apple, IBM, and Norton.

It is important to take backup of important data regularly and also verify that it can be restored successfully.

Diagnostic programs

A diagnostic program is a program written for the purpose of locating problems with the software, hardware, or both, or a network of systems. A diagnostic program provides solutions to the user to solve issues.

In practical experience, these tools do not usually identify the exact cause of the system problem, but they often provide some information about what is in the system and how it is working. Some of these are free or are included with common operating systems at no additional charge, while others are commercial products that range from affordable to rather pricey.

Here are some common software diagnostic tools.

- **Power-On Self Test (POST) :** This isn't a separate diagnostic utility; it is in fact built into your system BIOS and it runs every time you start up your PC automatically. It is often the best indicator of system problems. Don't disable its error-reporting functions unless you really need to.
- **MEM.EXE :** This simple utility, built into Windows operating system that provides you with details about your memory configuration, as well as what is currently using your memory.
- **Microsoft Diagnostics :** Better known as "MSD.EXE", this is a small DOS utility that takes a brief inventory of the contents of your PC and shows them to you in a text-based format. This is very useful for seeing what disks are in the system, how much memory is installed, and also for checking system resource usage. It will show you what type of BIOS you are using.
- **The Windows Device Manager :** This is the most useful tool for identifying system configuration and resource usage information.
- **Norton System Information :** This utility is similar to the Microsoft Diagnostics, only more detailed in its later versions. SI shows a great deal of information about what is in the PC, going well beyond what MSD gives you, but really is still an information utility as opposed to a true diagnostic. This program is part of Symantec's Norton Utilities.
- **Microsoft ScanDisk and Norton Disk Doctor :** These programs are used to check for hard disk problems. This includes file system corruption and hard disk read errors. They should be used when hard disk problems are suspected.
- **Scandisk** is a utility provided with Windows computers. Scandisk scans your disks to see if there are any potential problems on the disk, such as bad disk areas. Since disks are magnetic media, all disks, including your hard drive can be corrupted
- **Microsoft Disk Defragmenter** software assists you in keep reorganizing your disk drives. After files are saved, deleted and resaved again, the disk can become fragmented --- available space is in small blocks located throughout

the disk. Disk defragmenters gather those free spots and put them together to enable you to continue to save your data in the most efficient manner.

- **Norton Diagnostics :** This utility is meant to go beyond the System Information program and actually perform tests on the hardware to identify problems. It includes tests of the processor and motherboard and system memory, and will identify some types of resource conflicts. In reality, it is still quite limited in terms of the numbers of problems it will find.
- **QAPlus :** QAPlus from DiagSoft is a more advanced diagnostic suite that comes in several flavours, depending on what you need to do and how you want to do it. This is a more expensive package but can give you much more detailed information about your system and help identify problem situations as well.

File view programs

File view utilities let you see the contents of a wide variety of documents even when you don't have the application on your system

A file viewer is limited-functionality software it does not have a capability to create a file, or modify the content of an existing one. Instead, it is used only to display or print the content. File viewers do not edit files, but they are able to save data in a different file format.

All the fundamental types of file viewers are filters which translate binary files into plain text (one example antiword). Another common type of file viewer is a picture viewer that can display picture files of various formats. Common features here are thumbnail preview and creation, and image zooming.

The primary reason behind limited functionality is marketing and control. For example, a popular software program, Adobe Acrobat, can be used to create content for most computer platforms, under various operating systems. To ensure that people can access the documents created with Adobe Acrobat, the software publisher created a viewer program, the Acrobat Reader, and made it available for free. This viewer application allows the content created by the proprietary authoring software to be readable on all supported operating-system platforms, free of charge, thus making it a more attractive solution.

There are many products which can qualify as a file viewer: Microsoft Word viewer or Microsoft PowerPoint viewer, and the Open Office equivalents are examples. In a sense, a web browser is a type of file viewer, which translates, or renders, the HTML markups into a human-friendly presentation. Although HTML is plain text, viewing an HTML file in a browser and in a text editor produces significantly different results.

Google Docs is another very good example of online file viewer. Google Docs Viewer supports 12 new file types in, including all remaining Microsoft Office file types, Apple's Pages format, and Adobe's Photoshop and Illustrator files.

Computer performance enhancement utilities

A number of utilities are available to improve the overall performance of the computer system by letting you speed up your system or increase storage space. These utilities range from those that come packaged with the operating system or can be purchased separately.

Disk defragmenter utility reorganizes non contiguous files into contiguous files and optimizes their placement on the hard drive for increased reliability and performance.

There are many hardware and software **accelerators** available to enhance performance in a particular area. For example, download accelerators are software tools to increase the download speed, while graphic accelerators are coprocessors that assist in drawing graphics.

The Windows registry can quickly become crowded and hence slower to search when you remove unused programs that do not uninstall properly. There are utilities like Registry Mechanic or Registry Clean Expert that can help **clean Windows registry** to improve performance.

1.6 PERVERSE SOFTWARE

Perverse software is a program which causes hindrances in other programs execution in such a way resulting in modification or complete destruction of data without the user's intention or even sabotaging the operational system.

Perverse Software is also known as Malicious software or malware. It is a type of software that is designed to secretly access a computer system, without the owner’s consent, and damage the system. The impact can be as damaging as shutting down a business, pulling down computer network or significantly impacting regular use of individual computer systems etc. The damage done can vary from something as little as changing the author's name in a document to full control of one’s machine without the ability to easily find out.

Most malware requires the user to initiate its operation. For example, sending infectious attachments (it acts when users downloads them and runs the attachment) in e-mails, browsing a malicious website that installs software after the user clicks ok on a pop-up, and from vulnerabilities in the operating system.

Early infectious programs, such as Internet Worm and MS DOS viruses, were written as experiments and were largely harmless or at most annoying. With the spread of broadband Internet access, malicious software has been designed for a profit, for forced advertising. Here the malware keeps track of user’s web browsing, and pushes related advertisements.

Typical types of malicious software are - Computer virus, Computer Worm, Trojan horse, Rootkits, Spyware etc.

Here is brief information about the various types of malware:

Computer Virus

Computer virus is a small software program that is designed to enter a computer without users' permission or knowledge, to interfere with computer operation and to spread from one computer to another. A computer virus needs to attach itself to a document or program to infect other computers or programs.

Some viruses do little but replicate while others can cause severe harm or adversely effect program and performance of the system. They can destroy files, software, program applications, and cause the loss of data.

There are various types of computer virus that can be classified by their origins, techniques of attack, modes of spreading, forms of infections, hiding locations and the kind of damage caused. Examples of computer viruses are: Randex, Melissa.A and Trj.Reboot

Computer Worm

Computer Worm is a program that is very similar to a virus. It has ability to self replicate. It actively spreads itself over the network, copies itself from one disk drive to another or copies using email. It does not need user action to start it unlike virus. Examples of worms include: PSWBugbear.B, Lovgate.F, Trile.C, Sobig.D, Mapson.

Trojan Horse

When a program is disguised as something interesting and desirable, users are tempted to download and install it on their machine, without knowing what it does. This is when it does the damages by deleting files from the system or by further installing unwanted software. This is the typical technique of Trojan horse. For example, a file called "saxophone.wav file" on the computer of user who's interested in collecting sound samples may actually be a Trojan Horse. Trojan Horses unlike viruses do not reproduce by infecting other files, nor do they self-replicate like worms, but they are extremely dangerous to users computer's security and personal privacy. They make a computer susceptible to malicious intruders by allowing them to access and read files.

Rootkits

This is a technique using which the malware remains concealed in the system, and continues to do the damage in a concealed manner. Rootkits can prevent a malicious process from being visible (ex Task Bar in Windows operating system) in the list of running applications. Rootkits normally attempt to allow someone to gain control of a computer system. These programs are usually installed by trojans and are generally disguised as operating system files.

Trap doors

This is a way of bypassing normal authentication procedure (windows/ operating system user name and password) to access a system. Once a system is compromised (impacted by) by malware, one or more backdoors may be installed for easier future access to the system.

Logic Bombs/ Time Bombs

Logic Bombs are not programs in their own right but rather camouflaged segments of other programs. They are not considered viruses because they do not replicate. But their objective is to destroy data on the computer once certain conditions have been met. Logic bombs go undetected until launched, and the results can be destructive. For example, some malicious programs are sot off during days such as April Fools Day or Friday the 13th.

Spyware

While so far we have discussed the malware's intent to damage the computer system, spyware is designed for commercial gain. These programs gather information about the user in a concealed manner, show pop-up advertisements, redirects the search engine results to paid advertisements etc.

Keystroke loggers

This is a program, once installed on the system, which intercepts the keys when entering the password or the Credit Card number while shopping online. This can be used for Credit Card fraud.

Data-stealing

This is a web threat that results in stealing of personal and proprietary information to be used for commercial gains either directly or via underground distribution. Some popular examples of recent data-stealing cases are – steal and sell large number of credit card numbers from businesses such as TJX, OfficeMax, Sports Authority etc.

1.6.1 Ways to Counter Perverse Software

Some common ways of countering Malware are as following:

- Ensure that the operating system and any program one uses are up to date with patches/updates.

- Block unwanted email viruses by installing a spam filter and spam blocker.
- When browsing the internet, always watch what one clicks and installs. Do not simply click OK to dismiss pop-up windows.
- Install anti-virus software; scan and update regularly. It can, in most cases, remove and prevent viruses, worms, trojans, and (depending on the software) some spyware.
- Install anti-spyware/anti-adware; scan and update regularly. It will remove and (depending on the software) prevent future adware and spyware.

1.7 OPEN SOURCE SOFTWARE

Open Source Software (OSS) is software that comes with source code, and importantly also provides rights (typically reserved for copyright holders) to study, change and improve the software. This development happens in a larger collaborative environment, without any direct objective of the software's commercial success.

Primary objectives of the Open Source movement are as following:

- Encourage innovation at the grass-root level and facilitate collaborative software development involving individual talent than it being the prerogative of the large companies.
- Reduce the software cost.
- Improve quality and security
- Avoid forced lock-in to vendor's proprietary software.

Open Source Initiative (OSI) is the patron of the Open Source Definiton (OSD) and is the community-recognized body to evaluate and approve the software as OSD compliant. Some key criterion for OSD compliance are mentioned below:

- **Free Redistribution :** The license should allow any party to sell or give away the software as a component of a larger software distribution containing programs from multiple sources. The license shall not require a royalty or other fee for such sale.
- **Source Code :** The program must include source code, and must allow distribution in source code as well as in executable form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost preferably, downloading via the Internet without charge.
- **Derived Works :** The license must allow changes to the existing source code and must allow them to be distributed under the same terms as the license of the original software.
- **No Discrimination against specific applications :** The license must not restrict anyone from making use of the program in a specific scenario. For

example, it may not restrict the program from being used in a business, or from being used in drug research.

- **License must Not Be Specific to a Product :** The rights attached to the program must not depend on the program being part of a particular software distribution.
- **License must Not Restrict Other Software :** The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be open-source software.

Some examples of Open Source Software are:

Programming language

- PHP - Scripting language suited for the web

Operating System

- GNU Project — "a sufficient body of free software"
- Linux — operating system kernel based on Unix

Server Software

- Apache — HTTP web server
- Tomcat web server — web container
- MySQL – database, popular for applications built on LAMP stack (Linux, Apache, MySQL, PHP/PERL/Python)
- MediaWiki — wiki server software, the software that runs Wikipedia

Client software

- Mozilla Firefox — web browser
- Mozilla Thunderbird — e-mail client

Some typical challenges that used to be associated with the Open Source Software were lack of product support that typically comes with proprietary software, future upgrades, end-user training etc. Over a period of time, industry has evolved to overcome these challenges. For example, Red Hat Linux sells Linux operating system and provides product support, training as well. Further, it is important to note that Open Source Software is not always the best option for all the business needs. However, it does provide a good alternative to the proprietary software. One needs to do the required due-diligence to decide the right product for a specific situation.

Check Your Progress 3

1. Differentiate between open source and proprietary software?
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   ……………………………………………………………………………………….
2. Identify open source software from the following list?
   a. OpenOffice
   b. Filezilla
   c. MS Word
   d. Pidgin
   e. Confluence
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   ……………………………………………………………………………………….
3. What measure should you take to safeguard your computer from a virus attack?
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   ……………………………………………………………………………………….
4. Name a few computer performance enhancement utilities?
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1.8 SUMMARY

Software is the brain of computer systems. Any piece of hardware is useful till it has its associated software.

In this unit, we studied how software evolved over the years. Software grew in its size, usage, complexity, development techniques, design and architecture. In the early days software was developed for large centralized systems. It was generally bundled with the hardware, since the cost of software was negligible in comparison to the hardware. The source code was easily available for modification, improvement and redistribution. As the hardware developed, machines became smaller yet much more powerful, computer systems usage and software complexity increased considerably. Higher complexity resulted in higher software costs. Software now came at a price and with restrictive licenses.

One could no longer use, modify or redistribute it freely. Various licensing models evolved based on whether the software would be used by an individual or limited users or enterprise wide, whether it is for commercial or non commercial purposes, whether it is free software or proprietary software, or how often it is used. Companies have been selling these licenses to increase their revenues. The changing pattern of software distribution and sharing led to a movement for free and open source software.

We also learnt about different types of system, programming, application and utility software. We learnt how each one can be useful either to enhance a computer systems performance or to improve our productivity and efficiency in all our jobs. Availability of such wide variety of software makes computer systems infinitely useful in all kinds of work areas.

1.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. a) In the Mainframe architecture all operations and functionality are contained within the central (or "host") computer. Users interact with the host through 'dumb' terminals which transmit instructions, by capturing keystrokes to the host and display the results of those instructions for the user.

   File Sharing architecture is network (LAN) based where ‘intelligent’ PC’s or workstation’s downloads files from a dedicated "file server" and then runs the application (including data) locally.

   b) In Client Server architecture, the Client software requests for the service and Server software provides the service. The client and the server software may be on the same machine or two different networked machine.

   In the distributed systems, different parts or components of an application run on different networked machines. There are set of standards that specify how different distributed components communicate.

   c) In Structured programming statements are organized in a specific manner to minimize error or misinterpretation. It enforces logical structure of the program. Here large routines can be broken down into smaller, modular routines. It discourages GOTO statements.
   Non Structured programming is the earliest programming paradigm in which program usually consists of sequentially ordered commands, or statements, usually one in each line. It does not enforce any logical

structure of the program. Its needs discipline on programmers part to write readable and understandable code. Here the whole code is written in one module. It makes extensive use of GOTO statements that leads to spaghetti code.

2. a) **Software Reusability:** Ability of a computer program to be used repeatedly with little or no modifications in many different applications. For example code to authenticate credit card information can be used at all the places where payment is through credit card.

b) **Software Reliability:** Ability of a computer program to perform its intended functions and operations for the specified period of time, in the specified system's environment, without experiencing any failure. The less there is breakdown of the system, the more reliable it is.

c) **Encapsulation:** Ability to hide data and methods from outside the world and only expose data and methods that are required. It helps in hiding all the internal details from outside world. It also provides a way to protect data from accidental corruption

3. Software-as-a-Service (SaaS) is basically a software delivery model where customers can use the software application as a service on demand and pay for it per usage. It is based on the concept of renting application functionality from a service provider rather than buying, installing and running the software yourself.

Cloud computing is the broader concept of using the internet to allow people to access the technology enabled services. Those services must be 'massively scalable' to qualify as true 'cloud computing'.

Cloud computing is basically what SaaS applications run on.

4. With advances in networking technology, vendors began to introduce non-perpetual licensing models, such as subscription or pay-per-use licensing. In the pay-per-use, user is charged each time he/she uses the software, service or module and user does not own the software, rather uses it at on rent for the limited period. There is time based pay-per-use arrangement and transaction based pay-per-use arrangement.

In a time based pay-per-use arrangement, consumers are charged for the amount of time that they used non-owned copies of the software.

In a transaction based pay-per-use arrangement, usage charges occur because a software module has been used. The duration of use is irrelevant.

Check Your Progress 2

1. a) A system software is any computer software which manages and controls computer hardware so that application software can perform a task. Operating systems, such as Microsoft Windows, Mac OS X or Linux are prominent examples of system software. System software is an essential part of computer operations. Application software is a program that enable the end-user to perform specific, productive tasks, such as word processing or image manipulation.

   b) Compiler is a program the converts a source code in high level language to the object code in low level language.

   Linker is a program that uses multiple object files created by the compiler and predefined library object files, links them together and creates a single executable file.

   c) Compiler is a program that takes the whole source code in high level language and converts it into the source code in low level language. Any errors are reported at compile time for the complete code. Once the translation is complete, only the executable version of the code runs in the memory.

   An interpreter takes the source code in high level language one line at a time during run time, translates the instruction into low language code and executes it before proceeding to the next instruction. Hence the interpreted program remains in the source language and is converted into low level language only at run time. So the translator program also needs to be in the memory at run time.

   Since the compiler translated the whole program before it is run while interpreter translates one line at a time while the program is being run, compiled programs run faster than the interpreted ones.

2. Examples are as follows:

   a. Decision Making Software - Expert Choice, Decision Manager
   b. Education Software – Jumpstart, Reader Rabbit
   c. Industrial Automation Software – Computer aided manufacturing (CAM), Programmable Logic Controller
   d. Mathematical Software - Mathcad, Matlab
   e. Simulation Software – OpenModelica, Circuitlogix

3. The device driver for the printer may not have been installed. You can search for the driver for the particular printer on the internet and install it on your machine.

4. a. Text Editor (for ex TextPad)
   b. Device Driver for the scanner
   c. Operating System (for ex Windows Vista)
   d. Database Software (for ex MS Access)

Check Your Progress 3

1. Proprietary software refers to any computer software that has restrictions on any combination of the usage, modification, copying or distributing modified versions of the software. It is owned by an individual or a company (usually the one that developed it). Its source code is almost always kept secret. Advantages of proprietary software include: 1) Availability of reliable, professional support and training; 2) Packaged, comprehensive, modular formats; and 3) Regularly and easily updated. The disadvantages are: 1) Costly, and 2) has closed standards that hinder further development.

   Open source refers to a program in which the source code is available to the general public for use and/or modification from its original design free of charge. Open source sprouted in the technological community as a response to proprietary software owned by corporations. Advantages of Open source are: 1) Low cost and no license fees; 2) Open standards that facilitate integration with other systems; and 3) it is easily customizable. The disadvantages are: 1) Lack of professional support; 2) Evolving developer communities; 3) Lack of release co-ordination; and 4) Erratic updates.

2. OpenOffice (Word Processing Software), Filezilla (FTP Software), Pidgin (Instant Messaging Software)

3. a Install anti virus and anti spyware. Scan and update regularly.
   b. Keep the windows system updated with patches and updates.
   c. Browse and click only known and secure web sites. Avoid suspicious ones.
   d. Open email attachments from verified source only.

4. TweakVista, Boost Windows 2009, Registry Cleaner, WinUtilitites, System Optimize Expert.

1.10 FURTHER READINGS

Information Technology The Breaking Wave By Dennis P. Curtin, Kim Foley, Kunal Sen, Cathleen Morin, Tata- McGraw-Hill Edition.

Introduction to Computers By Peter Norton, Sixth Edition Tata McGraw-Hill Publishing Company Limited.

Computer for Beginners By Er. V. K. Jain, Pustak Mahal.

Introduction to Computer Science By I. T. L. Education Solutions Limited.

http://www.opensource.org/.

http://en.wikipedia.org/wiki/Malicious_software.

UNIT 2 OPERATING SYSTEM

Structure **Page No.**

2.0 INTRODUCTION

An operating system is system software which may be viewed as an organized collection of software consisting of procedures for operating a computer and providing an environment for execution of programs. It acts as an interface between users and the hardware of a computer system.

There are many important reasons for studying operating systems. Some of them are:

1) User interacts with computer through the operating system in order to accomplish his/her task since it is his/her primary interface with a computer.
2) It helps users to understand the inner functions of a computer very closely.
3) Many concepts and techniques found in the operating system have general applicability in other applications.

The introductory concepts of an operating system will be the main focus in this unit. The unit introduces several OS concept such as command interface, bootstrap loader, kernel, nanokernel, thin clients, multitasking and multiprogramming OS. To understand OS one needs to understand what kinds of services are provided by process management, I/O device management, memory management and file system. This topic is an important part of the unit. The end of unit goes into a brief history of evolution of OS, starting from serial processing, batch processing till date.

2.1 OBJECTIVES

After going through this unit, you should be able to:

- describe Operating Systems concepts;
- list components of an operatin system;
- Describes services provided by OS (Operating System) components;
- Describe in brief evolution of an operating system.

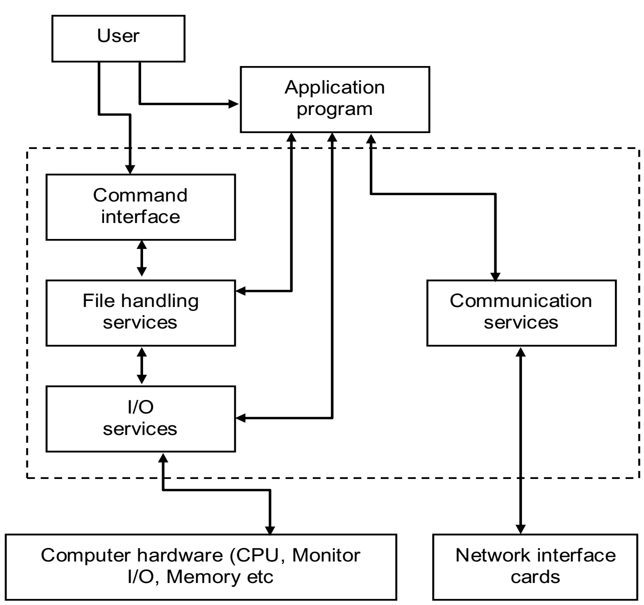
2.2 THE CONCEPT OF OPERATING SYSTEM

An operating system is an essential software component of a computer system. The basic objectives of an operating system are to make the computer system convenient to use and to utilize computer hardware in an efficient manner.

We can define an operating system as a large collection of software, which manages the resources of the computer system, such as **memory, processor, file system** and **input/output devices.** It keeps track of the status of each resource and decides which will have control over computer resources, for how long and when. In doing so, it provides two basic types of services:

1. It accepts requests from users and from the user's programs and executes their commands.
2. It optimally manages the hardware resources of the computer which may include CPU, main memory, hard disks, I/O devices, network interface card, etc.

The relationship between the various components of a computer system is shown schematically in Figure 2.1.



The figure 2.1 shows the **command interface** as part of the operating system. In some systems, this is viewed as a shell outside of the operating system.

In a real situation, the operating system does more complex tasks: It controls not only one I/O devise but many such devises; it allows many programs to share the H/W resources of a system and not one. There could be many CPUs in a system. Operating system has to optimally manage all of them. So how does operating system execute a command? In order to execute a command OS does the following steps:

- It accepts a command from a user through mouse clicks or from the keyboard. Through a port number it is able to recognize what is the source of input.
- It must interpret these commands and take actions accordingly.
- It must provide a file system that can interpret the name of the program being requested and determine the location of the file on secondary storage device for example.
- It must read the appropriate blocks from the device into memory. Only then can the operating system transfer control to the program being executed.

In case of multiple programs executing simultaneously, CPU does some extra jobs to allot the CPU time in an equitable way to each program, and also maintain the integrity of each program, etc.

With this example one can make out what kind of facilities operating system provides to
the users and programs:

- The operating system provides **interfaces** for the user (keyboard, mouse, clicks, and pen drive) and also for the user's programs.
- It provides file system support to manage huge volume of data in to secondary storage device.
- It provides I/O services that can be used by every program.
- It provides **boot-strapping** or **Initial Program Load (IPL) to start a computer**
- It manages all kinds of errors and also supports error recovery mechanisms
- It provides networking services.
- It provides the environment (allocation of memory, I/O devices and CPU time) for **concurrent processing.** As you are aware, a single processor is capable of executing only one instruction at a time. Concurrent processing is the means used to simulate the simultaneous execution of multiple programs to provide multitasking and multiuser support.

The operating system is commonly divided into **resident** and **non resident parts**. Some operating system services are critical to the operation of the system and must be **resident** in memory all the time. Others can be loaded into memory only when they are needed, and executed just like other programs.

The critical programs are loaded into memory by the **bootstrap loader** at start-up time and will remain resident as long as the computer is running. The bootstrap for most modern computers is stored in read-only memory; on some computers, part of the resident operating system will also be contained in ROM, so that it is permanently resident in memory and always available for use. The memory resident components of an operating system are commonly known as the **kernel** of the operating system. For example, the operating system program accepts user commands must always be present, as well as the programmes that handle request from the user systems and manage resources in a multitasking system. On the other hand, an operating system command that formats a new disk is only used occasionally; it can be loaded and executed only when it is required. Today, the trend is towards design of **nano kernel** or **micro kernel**. The essence of these kernels is to keep the basic kernel smaller.

Most people assume that the operating system is stored on a disk that is connected directly to the computer, but this is not necessarily true. If the computer is attached to a network, it may obtain its programs, including the operating system, from another computer on the network. This has led to the concept of the diskless workstation, a personal computer that relies completely on the network for its data and program storage and access. **Diskless workstations** are also known as **thin clients.** The size of the kernel and the particular services provided within a kernel vary from one operating system to another operating system, depending on the organization and capabilities of the system, as well as by the type of system.

- UNIX, WINDOWS 2000, WINDOWS XP and Linux are examples of operating systems that operate on a variety of different hardware platforms (i.e., microprocessor). There is a strong advantage providing a standard operating system that works on different hardware platforms. Such a system provides portability for programme as well as for file, therefore it is easy for the users to move comfortably from one machine to another. They are also called **multiuser** and **multiprogramming** or **multitasking operating** system which makes it possible for many users or tasks to share the computer resources, providing fuller utilization of the system resources.
- The operating system extends the capability of the computer to include features that require special coordinated hardware and software that is invisible to the user. These features include virtual memory, cache memory, multiprocessing.
- Systems can also be categorized by the degree of activity between the user and the system during program execution. As a student, you are probably most familiar with **online, interactive systems.** "Online" simplify means that the user is connected directly to the computer. When the system is interactive, the user interacts directly with the program to provide input data and guidance during program execution. This is called **online processing.** Interactive systems are sometimes known as **conversational systems.**
- Many business tasks such as banking operations are performed more effectively in a batch, where the data input for the program is collected together into a file on disk or tape. It does not make sense to have a user enter

data one record at a time if an entire set of data is to be sorted, for example. Instead, the user *submits* the program(s), or **job(s),** to the computer for processing. This type of processing is known as **batch processing.** The user does not interact with the program during batch processing. The OS system user interface provides a means for the user to get work done more quickly and efficiently. This is especially true for the user interface such as **menu**, icons found on modern operating systems. The modern operating systems combine **graphical user interface** simplicity with sophisticated text command input capability to provide the user with powerful access to the facilities of the computer.

Check Your Progress 1

1. Define the following terms:

   (i) Online Processing:

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   (ii) Batch Processing:

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2. How does multiprogramming improve performance of a system?

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2.3 OPERATING SYSTEM SERVICES

In this section we consider basic services supported by an operating system. There are many building blocks to be considered, not all of which will necessarily be found in any particular operating system. Therefore, we will consider few essential ones.

- Command processor and user interface
- File management system
- Input/output control system
- Process management
- Memory management

2.3.1 Command Processor and User Interface

To the user, the most important and visible services provided by the OS is the user interface and the capabilities that it provides to execute commands which may not be a part of OS.

Instead these systems consider the user interface as a separate shell that is provided with the operating system and that interacts with the kernel to provide the necessary-user command capabilities. In UNIX, three different shells, the C shell, the Bourne shell, and the Korn shell are in common use, and many other shells for UNIX are available. Each of these shells provides different command structures and different capabilities.

Different types of user interface exist. The most common are the **graphical user interface,** or **GUI,** and the **command line interface**. The graphical user interface accepts commands primarily in the form of drop-down menus, mouse movements, and mouse clicks. The command line interface relies on typed commands which provide direct access to various methods within operating system such as File system, I/O system, and network services. UNIX allows certain class of users called **superusers** to use some kind of commands for changing the platform or access rights.

Command languages extend the power and flexibilities of the operating system and simplify use of the system for less sophisticated users.

2.3.2 File Management

The concept of a file is central to the effective use of a computer system. A file is generally loosely defined as a collection of related information such as students records employee database. It might contain graphical usage. A file may be organized internally into records or it may simply be a stream of bytes. A file constitutes a *logical unit* of storage, that is, logical to the person or program using the file.

The file management system provides and maintains the mapping between a file logical storage needs and the physical location where it is stored. Users and programs simply access the files by the name, and the file management system handles the details The file management system identifies and manipulates files by the names provided by their users determines the physical requirements of the file, allocate space for it, stores it in that space, and maintains the information about the file so that it may be retrieved partially or in full, later. The file management system keeps track of the available space on each device connected to the system. The user and the user's program need not be aware of the underlying physical storage issues.

The file management system allows the retrieval and storage of files by name, keeps track of the mappings, allocates and frees space, allows the mounting and unmounting of file structures, and provides other functions required to maintain the structures of the file system.

- Directory structures for each I/O device in the system and tools to access and move around these structures. The directory structure provisions are made to move easily from one structure to another.
- It also protects files and limit file access to authorized users.

File management systems are particularly important in systems in which secondary storage devices are shared in common by multiple users, since they provide a directory system that assures that there is no duplicate use of physical storage.

2.3.3 Input/Output Services

Every operating system, large or small, provides input/output services for each device in the system. The operating system includes I/O device driver programs for each device installed on the system. These drivers provide services to the file management system and are also available, through the API, to other programs for their use. The I/O device drivers accept I/O requests and perform the actual data transfers between the hardware and specified areas of memory.

Devices drivers for newly installed devices are added and integrated into the operating systems. In Windows, this capability is known as **plug-and-play**.

2.3.4 Process Control Management

A **process** is an executing program. It is considered the standard unit of work within a computer system. *Every* executing program is treated as a process. This includes not only application programs, but the programs within the operating system itself. The process concept considers the program, together with the resources that are assigned to it, including memory, I/O devices, time for execution, and the like. When admitted to the system, each program is assigned memory space and the various resources that it initially requires to complete its work. As the process executes, it may require additional resources, or it may release resources that it no longer needs. The operating system performs various functions with processes, including scheduling and memory management, by providing the various services. Processes must often be synchronized, so that processes sharing a common resource do not step on each other's toes by altering critical data or denying each other needed resources. Systems also provide communication capability between different processes. Processes may cooperate with each other by sending messages back and forth using **interprocess messaging services.**

In multitasking operating system. OS determines which job will be admitted to the system and in what order. This process is called job scheduling. Many modern systems further break the process down into smaller units called **threads.** A thread is an individually executable part of a process. It shares memory and other resources with all other threads in the same process, but can be scheduled to run separately from other threads.

2.3.5 Memory Management

The purpose of the memory management system is to load programs into memory in such a way as to give each program loaded the memory that it requires for execution.

In multiprogramming operating system there are many programs residing in the memory simultaneously in the memory.

The memory management system has three primary tasks. It attempts to perform these tasks in a way that is fair and efficient to the programs that must be loaded and executed.

1. It keeps track of which parts of the memory are currently being used and by which process into memory together with the space being used and also keeps track of available space.
2. It maintains one or more queues of programs waiting to be loaded into memory as space becomes available, based on such program criteria as priority and memory requirements.
3. When space is available, it allocates memory to the programs that are next to be loaded. It also de-allocates a program's memory space when it completes execution. The de-allocated space is made available for other programs.

Check Your Progress 2

1. What are the important components of an OS?

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2. What is job scheduling?

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3. What is a thread?

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2.4 A BIT OF HISTORY

In attempting to understand the key requirement for an operating system and the significance of the major features of a contemporary operating system, it is useful to consider how operating systems have evolved over the years.

Serial Processing

During the late 1940s to the mid-1950s, the programmer interacted directly with computer hardware; there was no operating system. These machines were run by operators from a console, consisting of displays lights, toggle switches, some form of input device and a printer. Programs in machine code were loaded via a card reader.

This mode of operation could be termed **serial processing**, reflecting the fact that users have access to the computer in series. Gradually, various system software tools were developed which included libraries of common functions, linkers, loaders, debuggers, and I/O driver software to attempt to make serial processing more efficient.

Simple Batch Systems

Early machines were very expensive, and therefore it was important to maximize machine utilization. To improve utilization, the concept of batch operating system was developed. It appears that the first batch operating system (and the first operating system of any kind) was developed in the mid-1950s by General Motors for use on an IBM 701. The concept was subsequently refined and implemented on the IBM 704 by a number of IBM customers.

The central idea behind the **batch processing** system was the use of a piece of software known as the **monitor**. With the use of this type of operating system, the user no longer had direct access to the machine. Rather, the user submitted the job on cards or tape to a computer operator, who batches the jobs together sequentially and places the entire batch on an input device, for use by the monitor. Many important breakthroughs in operating system design occurred in the early 1960s which laid the foundation for design of modern operating system.

In 1963, Burroughs design of Master Control Program (MCP), which included design of many of the features of modern systems such as support for multiprocessing (with two identical CPUs) as well as multitasking capabilities.

IBM introduces OS/360 as the operating system for its new System/360 in 1964. OD/360 provided a powerful language to expedite batch processing known as **Job Control Language**. It introduced a simple form of **multiprogramming** or multitasking feature that facilitated loading several jobs into main memory, so that other jobs programs could use the CPU when one job was busy with I/O. By this time, disks were also becoming available. To take its advantage the OS introduced features to cards onto disk while the CPU executed its jobs; thus, when a job completed, the OS could load another job from disk into memory, ready to run. This improved the OS scheduling capability. Multiprogramming or multitasking is the central theme of modern operating system.

Time Sharing System

With the use multiprogramming, the batch processing can be quite efficient. However, for many jobs, it is desirable to provide a mode in which the user interacts directly with the computer. Indeed for some jobs, such as transaction processing, an interactive mode is essential.

Today, the requirement for an interactive computing facility can be, and often is, met by the use of a dedicated microcomputer. That option was not available in the 1960s when most computers were big and costly. Instead time sharing was developed. Just as multiprogramming allows the processor to handle multiple batch jobs at a time, multiprogramming can be used to handle multiple interactive jobs. In this latter case, the technique is referred to as time sharing, because the processor's time is shared among multiple users. In time sharing system, multiple users simultaneously access the system through terminals, with the operating system interleaving the execution of each user program in a short burst or quantum of computation.

Both batch processing and time sharing use multiprogramming. The key differences are shown in the following table.

Table 2.1 : Multiprogramming versus Time Sharing

	Multiprogramming	**Time Sharing**
Principal objective	Maximize processor use	Minimize response time
Source of directives to operating system	Job control language commands provided with the job	Commands entered at the terminal

MIT, Bell Labs, and GE formed a partnership to develop a major time-sharing system. The system, was called MULTICS (Multiplexed Information and Computer Service), and although MULTICUS never became a full fledged operating system but many of the most important multitasking concepts and algorithms were developed by the MULTICS team.

- During 1960-1970, many other developments in OS design took place:

  (a) Hierarchical approach to OS, for example the THE OS designed by Dijkstra.

  (b) It also showed the advantages of modular programming design in the implementation of OS.

Development of UNIX

- The original UNIX development was performed on a Digital PDP-7 minicomputer and later moved to a PDP-11 minicomputer, the forerunner of the VAX computer. Originally, the system was written in assembly language, but at the later stage the operating system was largely rewritten in C.
- UNIX introduced many important OS concepts which have become a trend in OS design today, including the hierarchical file system, the shell concept, redirection, piping, and the use of simple commands that can be combined to perform powerful operations. The authors Ken Thompson and Denis Ritchie of

the OS also developed techniques for interprocess communication, and even provided for networked and distributed processing.

- UNIX earned a reputation for power and flexibility. Because it was written in C, it was also easy to **port** it that is to make it run on other computers. As a result of these factors, UNIX became an important operating system for universities and was ultimately adopted, in many versions.
- Another important innovation, some would say the most important development in making the computer accessible to nontechnical users, was the development of the concept of graphical user interfaces.

Development of Personnel Computer Operating System

- The next important breakthrough in computer use occurred in 1982, with the introduction of the IBM personal computer. The IBM PC was designed as a stand-alone, single-user computer for the mass market. The IBM PC was supplied with a reasonably easy-to-use operating system, PC-DOS, which was developed, and also later marketed, by Microsoft as MS-DOS. PC-DOS was actually derived from an earlier personal computer operating, CP\M (Control Program for Microcomputers).

Other Developments during 1980-1990s

- The evolution of MS-DOS into Windows 2000, a GUI-based operating system capable of supporting a wide range of users and applications, from the individual working at a PC to a networked enterprise system capable of managing every aspect of a large organization. This capability was formerly limited to large, mainframe-based multiuser systems.
- The development of Linux operating system client-server configuration model, which took place at a number of different universities during the 1980s, and the use of these microkernels, particularly Mach, as the basis for the development of new operating systems of unparalleled power, stability, and simplicity.
- The development of the Distributed Computing Environment, plus object-based extensions that make distributed processing practical.
- Creation of the JAVA Virtual Machine and other aspects of the JAVA language and environment as a means to share and execute objects in a way that is truly machine independent and network transparent.
- There have been many other less obvious developments in operating system technology, both subtle and sophisticated, that have impacted computer system design and operation.

2.5 SUMMARY

This unit has laid down to foundation for understanding the OS concepts which will be discussed in advanced operating system courses. OS accepts requests from users and from users programs and executes their cards in optional manner. The unit introduced several OS concepts such command interface, boot straping, concurrent processing, nanokernals, microkernals, thin clients, multitasking, multiprogramming operating system. To understand an operating system are needs to understand the services provided by the OS. It briefly describes services provided by command processor, file management system, I/O control system, process management and memory management. In the last section of the unit we trace the evolution of OS since 1940s onwords.

2.6 ANSWERS TO CHECK PROGRESS

Check Your Progress 1

1. (i) Online simplfy mens that the user is directly connected to the computer and when the system is interchanges, the user interacts directly with the program to provide important data and other works.

   (ii) In batch processing, an user directly interact with the system. Rather than they collect their programs or job(s) in a file or a disk or tape and submit it for later execution. Many business tasks such as banking and insurance operations are performed much effectively in a batch.

2. Multiprogramming improves performance by overlapping CPU and I/O operation on a single machine.

Check Your Progress 2

1. The following are the important components of an OS:
   - Command processor
   - File management system
   - Process management
   - Memory management

2. In multitasking OS system, OS determine which job well be admitted into a system and in order. This process is called job scheduling.

3. A thread is an individually executable part of a process. It shares memory and other resources with all other threads in the same process but can be scheduled from other threads.

2.7 FURTHER READINGS

William Stalling, Operating Systems, 4th edition, Prentice Hall of India – 2003

Irv Englander, Architecture of Computer Hardware and System Software, Wiley 2000

UNIT 3 CONCEPT IN PROGRAMMING LANGUAGE

Structure **Page No.**

3.0 INTRODUCTION

A Programming Language is used to design and describe a set of instructions and computations to be executed by a computer. To do programming, one should have knowledge of i) a particular programming language ii) algorithm to solve the problem. An algorithm is finite number of steps, which perform some computation on the input and produce the desired output in a finite amount of time. Once an algorithm is chosen, the next step for a solution using a computer would be to write a program using the algorithm. A program is defined as a collection of Statements or Sentences written in a particular programming language. Further, to obtain the output from a Program, it is required to be compiled or interpreted so that the computer can understand it.

3.1 OBJECTIVES

After going through this unit, you will be able to :

- need for Programming;
- flow chart and Example Program;
- elements of Programming Languages such as variable, constant, data type, arrays and expression etc.;
- describe looping and decisions; and
- differentiate between Assembler, Compiler and Interpreter.

3.2 PROBLEM, ALGORITHM, PROGRAM AND PROGRAMMING LANGUAGE

A **Problem** is to carry out a particular task. For solving the problem, some input has to be given to the system. The system will process or manipulate the input and produce the desired output. An algorithm describes the steps required to solve a problem. Once an algorithm is obtained for solving a problem, a Program has to be written which a computer can execute so as to accomplish the given task, thereby solving the problem at hand. The program can be in any suitable programming language and is not dependent on the algorithm in any way.

Algorithm: Once a problem has been defined precisely, a procedure or process must be designed to produce the required output from the given input. Since a computer is a machine that does not possess problem-solving judgmental capabilities, this procedure must be designed as a sequence of simple and unambiguous steps. Such a procedure is known as an algorithm.

The steps that comprise an algorithm must be organized in a logical, clear manner so that the program that implements this algorithm is similarly well structured. Number of steps in the algorithm should be finite, they should be executed in finite amount of time and they should give the desired output. Algorithms are designed using three basic methods of control:

a) Sequential : Steps are performed in a strictly sequential manner, each step being executed exactly once.

b) Decision/Selection : One of several alternative actions is selected and executed.

c) Repetition : One or more steps is performed repeatedly.

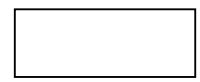
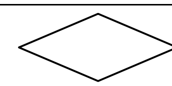
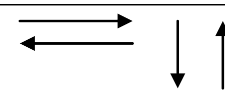
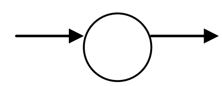
Any algorithm can be constructed using basic methods of control.

Programs to implement algorithms on the computer must be written in a language that the computer can understand. It is fruitful, therefore, to describe algorithms in a language that resembles the language used to write computer programs. This is called pseudo code. It is not a programming language with a rigid syntax, but is similar to one. The idea is that it should be easy to write a program by looking at the pseudo code..

Let us take few problems to illustrate how to express the solution to a problem in the form of an algorithm. We will also see how algorithm can be diagrammatically represented using flow chart, and also how a program can be written based on the algorithm.

For providing a solution to any problem some input from the user is required. In the following examples the number n that is expected from the user should be an integer. In the program, it will be declared of the required type only, referred as data type of the variable. A Detailed description of variable and data type is given in a later section.

Flowcharting: A Flowchart is a graphical representation of an algorithm. It can be compared to the blueprint of a building. Just as a building contractor refers to a blueprint for the construction of a building, similarly a programmer refers to a flowchart for writing the program which describes what operations are to be carried out and in what sequence to solve a problem. Flowcharts are usually drawn using some standard symbols. The Basic flowchart symbols are as below:

Terminal	Start, End	
Computational or processing	Process	
Input/Output Operation	Input-Output	
Decision making or Branching	Decision	
Flow Lines	Flow Direction	
Joining of two parts	Connector	

The number n is expected to be an integer.

Example 1

Problem statement: To find out whether a given number is even or odd.

Algorithm:

Step 1 Start

Step 2 INPUT the number n

Step 3 Find the remainder on dividing the given number by 2

    if (remainder = 0) then

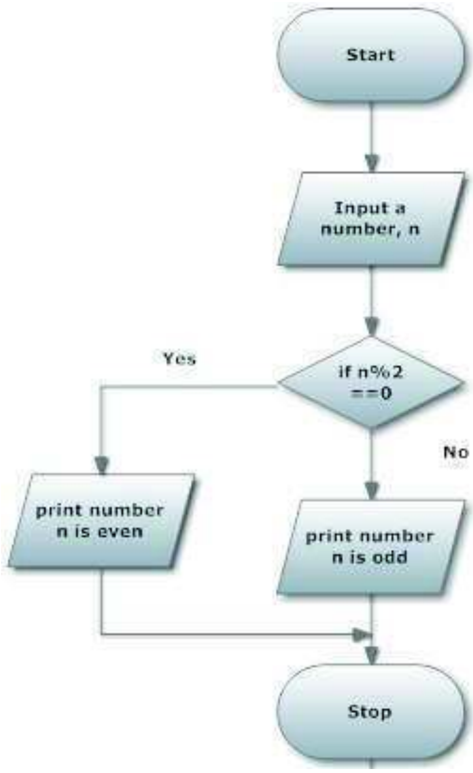
    print “number is even”

    else

        print “number is odd”

Step 4 End

Representing this algorithm through flowchart helps in easier and better understanding of the algorithm :



The program to implement this so that it can be run on a computer can be written in any of the known programming languages. For example, here C has been used as the Programming language for writing the program:

```
#include<stdio.h> /* including header file that has definition of inbuilt functions
*/
void main()
{ /*  To mark beginning of block */
    int n; /* variable declaration */

    printf("Enter the number"); /* predefined output function in header file to
display the message on standard output device */
    scanf("%d",&n); /* predefined input function for taking an input from the user
*/
    if (n %2 ==0) /* if else condition to check a expression is true or false and
branch accordingly as per syntax of C programming */
    {
        printf("Number %d is even",n);
    }
    else
    {
        printf("Number %d is odd",n)
    }
} /* to mark the end of block */
```

Example 2

Problem: To find the product of first n natural numbers.

Step 1 Start

Step 2 Input number n

Step 3 Initialize product=1

Step 4 Initialize the counter, i=1

Step 5 Compute product=product * i

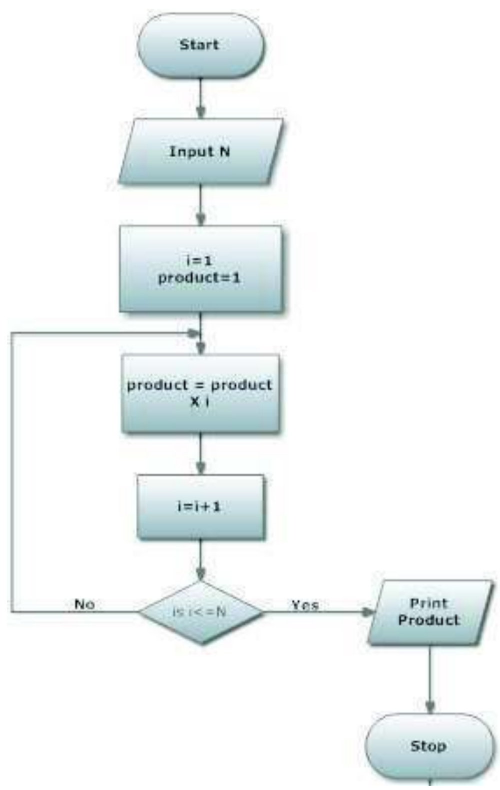
Step 6 Increment counter i by 1 i.e i=i+1

Step 7 Check counter <= n if yes go to step 5

Step 8 Print Product of first n natural numbers as product

Step 9 End

We now express this algorithm as a flowchart for better understanding **of the algorithm**



Here is the C program corresponding to the above algorithm:

```
#include<stdio.h>

void main()
```

```
{
    int n,i;
    int prod=1;
    printf("Enter number n :");
    scanf("%d",&n);
    for(i=1;i<=n;i++) /* For loop construct for repeating a set of statement  n
number of times */
    {
        prod=prod *  i;
    }

printf("Product of first %d natural numbers is = %d",n,prod);
}
```

Example 3

Problem: To find the sum and average of marks obtained by 20 students in some subject of a course.

Algorithm:

Step 1 Start

Step 2 Initialize an array s for 20 students marks i.e s[20]

Step 3 initialize sum=0

Step 4 initialize counter=0

Step 5 Compute sum=sum+s[counter]

Step 6 increment counter =counter+1

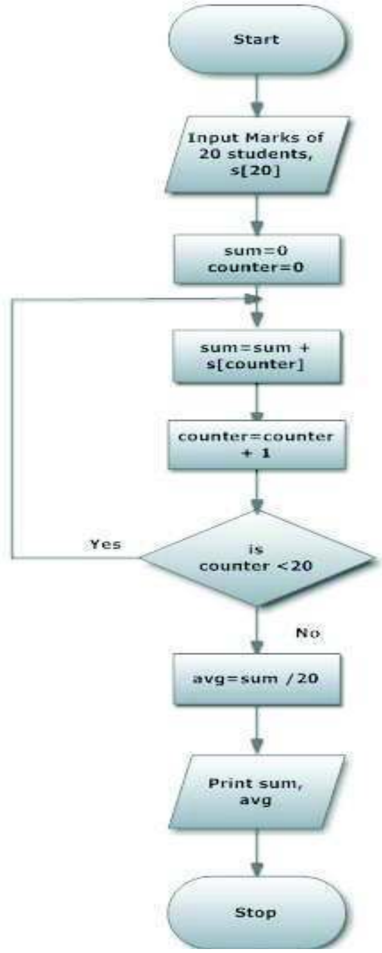
Step 7 check counter <20

Step 8 if yes goes to step 5

Step 9 avg=(sum/20)

Step 10 Print sum and average

Step 10 End



Here is the corresponding C program:

```
#include <stdio.h>

void main()
{
    int i, sum; /* declaring variables */
    int s[20]; /* declaring array to refer set of  memory locations of same data
type with one name */
    float avg;

    sum=0; /* assignment statement */

    printf("Enter marks for 20 students");
    for(i=0;i<20;i++)
    {   printf("%d =",i+1);
        scanf("%d",&s[i]);
    }
    i=0;
    while(i<20) /* while loop construct to repeat set of statement till the condition
is true */
    {
        sum=sum+s[i];  /* arithmetic statement for addition */
```

```
        i++; /* increment statement */
    }
    avg=sum/20;
    printf("Sum of marks for 20 students:= %d",sum);
    printf("Average marks of 20 students:=%.2f",avg);
}
```

Check Your Progress 1

1) Write an algorithm for solving the following problems:
   a) To calculate the area of a rectangle.
   …………………………………………………………………………
   …………………………………………………………………………
   b) To find the sum of the first n natural numbers
   …………………………………………………………………………
   …………………………………………………………………………
2) Draw a flowchart for a) and b) in Question 1
   …………………………………………………………………………
   …………………………………………………………………………
   …………………………………………………………………………

3.3 CONCEPT OF PROGRAMMING LANGUAGE

In order to communicate with other human beings, one needs some language or a medium. In the same way for solving problems, a programming language is required in order to communicate with the computer. A Programming Language is used to design and describe a set of instructions/actions for the computation that we wish to be executed by the computer.

First an algorithm is designed which solves the problem in question. In the next step, the algorithm is expressed in the form of a program. For this one should have a sound knowledge of some programming language. A program written in a particular Programming Language can control the behavior of a computer and perform a designated task to generate the desired output for any given input.

Program and Programming Language : A Program is defined as a collection of statements/ instructions that enable the computer to solve a problem. The process of writing a program is called programming. Statements in a program should be well formed sentences. Each Programming Language has some basic building blocks called the primitive building blocks. These blocks are defined by basic components that have an associate Syntax and Semantics. Syntax provides structure and semantic provides meaning to it. Different computer programming languages have different advantages and disadvantages to their use. Hence different application domains based on their requirement and functionality may choose any one of the available programming languages suitable for the task.

Syntax provides the structure and how to formulate the phrase or sentence w.r.t grammar of the language. It tells us about which composition is allowed from the character set of the language. Each sentence must be a well formed sentence according to the grammar of the language. The grammar is expressed in a Number of rules that will be finite and these allow the formulation of any number of sentences. A language is defined in the form a quadruplet L(T,N,P,S) where T is set of terminals, N is a set of non terminals, P is set of productions or rules and S is the start symbol. For any language we must have an alphabet/character set, operators and rules. To form a grammar w.r.t a language rules need to be formed. The basic structure of rule is LHS and RHS with some set of terminal and non terminal symbol.

Syntax comprises grammar and vocabulary whereas syntactic analysis is known as parsing. Semantics provides the meaning for the formulated /composed phrase or word or sentence. Semantic function can be incorporated inside the logic of a compiler or interpreter which evaluates ordering of statements for execution.

S-> A
A->Ab | b i.e any word with sequence of any number of occurrence of character b

Start symbol:
Here S is start symbol. Any sentence will start with start symbol only.
In respect of BNF notation it is as follows:
L(T,N,P,S)
T={b}
N={A}
P={S->A,A->Ab}
S=Start sybmol

Example grammar:

Program: statement
Statement: stmt| stmt
Stmt: var=expression
Var:a|b
Expression: term +term | term-term
Term: var/const

e.g x=y+2

Similarly

Sentence: subject,verb,object
Subject: noun/article

e.g Ram ate biscuits.

Here each symbol on the left is described in terms of its components. Thus a program consists of statements, which are of the form of an assignment of a variable to an expression, and so on.

Any number of sentences can be formed with the help of a grammar defined for a language. The grammar should be unambiguous. otherwise during syntactic analysis at some point of time it can have more than one meaning.

3.4 ELEMENTS OF PROGRAMMING LANGUAGE

Learning a programming language requires understanding of concepts such as representation of different types of data in the computer, the various methods of expressing mathematical and logical relationships among data elements and the methods for controlling the sequence in which operations can be executed for inputting the data, processing it and generating the output data.

3.4.1 Variables, Constants, Data type, Array and Expression

These are the smallest components of a programming language.

For writing a program, one must know how to use the internal memory of a computer. A Computer memory is divided into several locations where each location has its own address. Memory organization can be represented diagrammatically as below:

Cell1
Cell2
Cell3
Cell4
CellN

Each location or cell can hold some information. In order to store, retrieve or manipulate data from a specific memory location, we must have some identifier for a particular location. .

Variable: As referencing memory by its physical address is very tedious, variable names are used. A variable is a symbolic name given to a memory location. Once a variable is assigned to a memory location, the programmer can refer to that location by variable name instead of its address. Variable is the connection between a name and a value.

It is composed of a name, attribute, reference and a value. Attribute means the type of value a variable can hold.

For example the following programming code in C declares variables a & b.

```
int a,b;
char c;
```

In the above declaration, a & b are the variable name, which refer to a memory location where integer values can be stored. Instead of address of the memory location, variable names a and b will be used to refer to a memory location in order to store or retriever update its value.

Similarly, c is a variable name given to a memory location where a character value can be stored. Further c will be used to refer to the memory location in order to store or retrieve or update its value.

Constant : In contrast to a variable, which is used as identifier for a value and which can change, constants are identifiers that are used for values, which cannot be changed. In other words constants are symbols used to refer to quantities which do not change throughout the life of a program. No assignment can be done to a constant.

A numeric constant stands for a number. This number can be an integer, a decimal fraction, or a number in scientific (exponential) notation. Some of the operations which can be performed with numeric constants are addition, subtraction, multiplication, division and comparison.

A string constant consists of a sequence of characters enclosed in double/single quote marks. Chopping off some of the characters from the beginning or end, adding another string at the end (concatenation), copying are some of the operations that performed on the string constants. All these operations can be done on variables also.

For example in the C programming language
-integer constant is declared as:
const int a=2; /* the value of a cannot be changed throughout the program*/
-string constant is declared as:
char const *str; /* str ,string can not be altered by string library functions*/

Data Type: Anything that is processed by a computer is called data. There are different types of data that can be given to the computer for processing. A data type is a classification identifying the typeof data. It determines the

- Possible values for that type,
- Operations that can be performed on values of that type,
- The way values of that type can be stored in memory,

In each programming language there are some primitive data types. For example in the C programming language they are: Please note that these sizes can be compiler or machine dependent in the case of this language. For other languages such as Java, the sizes are defined by the language itself.

- **int,** both signed and unsigned integers, 2 bytes in size.
- **float, floating point numbers**, up to 4 bytes in size.
- **double, floating point number with double precision.** These are organized in 8 bytes (64 bits)
- **char, character type** size of 1 byte (8 bits) It is used to form the strings i.e sequence of characters.

Array : In programming, when large amount of related data needs to be processed and each data element is stored with different a variable name, it becomes very difficult to manage and manipulate. To deal with such situations, the concept of array is used.

An array is a set of elements of same data type that can be individually referenced by an index. Usually these are placed in contiguous memory locations. Generally two types of array are used:

- One dimensional array
- Two dimensional array

One dimensional array: A one-dimensional array is a structured collection of elements that can be accessed individually by specifying the position of a component with index/ subscript value. The index would let us refer to the corresponding value. value at that .

Like a regular variable, an array must be declared before it is used. A typical declaration for an array in C++ is:

type name [elements];

where type is a valid data type (like int, float...), name is a valid identifier or variable name and the elements field (which is always enclosed in square brackets []), specifies how many of these elements the array will contain. Therefore, in order to declare an array named as marks, that will store marks for 5 students, int marks[5];

marks [0]	marks[1]	marks[2]	marks[3]	marks[4]
50	70	80	90	63

Two dimensional Arrays : A two-dimensional array is like a table, with a defined number of rows, where each row has a defined number of columns. In some instances we need to have such an array of arrays. It will have two dimensions and data is represented in the form of rows and columns.

Type name [elements] [elements];
For example int a [3] [3]; /* lets one dimension depict location and other dimension represent sales in a day or a week or a month*/

	Column1	Column 2	Column 3
Row1	a[0][0]	a[0][1]	a[0][2]
Row2	a[1][0]	a[1][1]	a[1][2]
Row3	a[2][0]	a[2][1]	a[2][2]

Expression : An expression is a combination of variables, constants and operators written according to the syntax of the programming language. In the C programming language every expression evaluates to a value i.e., every expression results in some value of a certain type that can be assigned to a variable. Every computer language specifies how operators are evaluated in a given expression. An expression may contain

i) arithmetic operator:

ii) relational operator

iii) logical operator

Assignment : It is composed of variable name, an assignment operator of the language and a value or variable or some expression as per composition allowed based on rules defined in grammar.

e.g temp=5;
 temp=temp+1;
This means to add 1 to the current value of the variable temp and make that the new contents of the variable temp
temp = a+b ;

Arithmetic : These types of expressions consist of operators, operands or some expression. The following is the list of arithmetic operator.

+(addition),
-(subtraction),

*(Multiplication),
/(Division),
% (modulo),
++(increment by 1),
--(decrement by 1)
Here are some examples of arithmetic expressions.
e.g. x=y+z; /* addition of y and z will be stored in x */
i++; /* i will be incremented by 1 i.e i=i+1 */
y=x%2; /* remainder after x divided by 2 will be stored in y */

Logical, relational and equality : these types of expression result in a Boolean representation i.e. each expression will result in either True or False. It is composed of operands and relational/logical/equality operator.

The following is the list of operators in the C programming language

== (equal to)
!= (Not equal to)
< (less than)
<= (less than equal to)
> (greater than)
>=(greater than equal to)
&& (logical AND)
|| (logical OR)
! (logical NOT)

Relational expressions result in one of the truth value either TRUE or FALSE. They are capable of comparing only two values separated by any valid relational operator.

e.g.

Let x=1, y=3
x==1 /* evaluates to true as x has value 1 */
x!=y /* evaluates to false */
x<y /* evaluates to true */
(x<2) && (y> 5) /* evaluates to true */

Bit Wise: Bitwise operators modify variables considering the bit patterns that represent the values they store.

& AND (Binary operator)
| inclusive OR (OR)
^ exclusive OR (XOR)
<< shift left.
>> shift right.
~ one's complement

e.g. let a=2 (0000 0010),b=5(0000 0101)
c=a&b; (0000 0000) /* c=0*/

3.4.2 Conditional and Looping Statement

Conditional statement: An If statement is composed of three parts. The first part should be keyword w.r.t language to convey to the computer that it is if statement. And a Boolean expression. The second and thirds part can be a statement or group of statements as defined in rules of grammar of language.

Generally, an if statement is evaluated and executed in the following sequence: first it evaluates the boolean expression. If the expression is true, the statements in the second part are executed. Otherwise if it is *false*, the statements in the third part are executed. The third part is optional; if it is absent and the expression is false, then the program control simply moves on to the next statement in the sequence.

For example,

```
if (n %2 ==0)
    {
        printf("Number %d is even",n);
    }
else
    {
        printf("Number %d is odd",n)
    }
```

Looping Statement: The purpose of a loop structure is to repeat certain tasks until some condition is satisfied. Several variations of a loop structure are available in each programming language to handle different situations.

A program loop consists of two segments, one is the body of the loop and the other is the control statement. The control statement tests certain conditions and then directs the repeated execution of the statements contained in the body of the loop. The test may be either to determine whether the loop has repeated the specified number of times or to determine whether the particular condition has been met.

Thus a loop consists of :

- Initial condition
- Execution of set of statements inside the loop
- Test the condition
- Again execute the statements if the condition is met else go to the next statement in the sequence

There are three variants of looping statements in the C programming language are:

- For loop
- While loop
- Do while loop

In this brief introductory unit, we will not go into the details of the distinctions between these three types of loops.

e.g 1

```
for(i=0;i<20;i++)
    {   printf("%d =",i+1);
        scanf("%d",&s[i]);
    }
```

e.g 2

```
    i=0;
    while(i<20)
    {
        sum=sum+s[i];
        i++; /* increment counter */
    }
```

Basic structure or keywords may vary in different languages. Also loop structure may be structured or not as it might not have control variables. Most of the languages do have control variables in their loop structure.

3.4.3 Subroutine and Functions

In a program, it is often necessary to repeat a statement or group of statements at several points to accomplish a particular task. Repeating the same statement in a program each time makes a program lengthy and reduces readability. These problems could be sorted out if the necessary statements could be written once and then referred to each time they are needed. This is the purpose of a subprogram. Basically there are two different types of subprograms, called functions and subroutines.

Making subprograms allows tackling small pieces of a problem individually. Once each piece is working correctly then the pieces are integrated together to create the complete solution of the problem. To implement functions and subroutines, we require writing the main program that references all of the subprograms in the desired order and also writing the subprograms. This can be done in any order that is convenient.

The following steps take place during the execution of subprograms:

1) Temporarily halt the execution of the calling program i.e main program.
2) Execute subprogram.
3) Resume execution of the calling program at the point immediately following the call of the subprogram.

Subroutine : A subroutine is a type of subprogram, a piece of code within a larger program that performs a specific task and is relatively independent of the remaining code.

It is also called a procedure, routine or a method.

A subroutine has no value associated with its name. All outputs are defined in terms of arguments; there may be any number of outputs.

In most cases, a subroutine needs some information about the circumstances in which it has been called. A procedure that performs repeated or shared tasks uses different information for each call. This information consists of variables, constants, and expressions that you pass to the procedure when you call it.

A parameter represents a value that the procedure expects you to supply when you call it. You can create a procedure with no parameters, one parameter, or more than one. The part of the procedure definition that specifies the parameters is called the parameter list.

An argument represents the value you supply to a procedure parameter when you call the procedure. The calling code supplies the arguments when it calls the procedure. The part of the procedure call that specifies the arguments is called the argument list. For example here is a subroutine to find the sum of three numbers

```
SUBROUTINE sub1(A,B,C, SUM)
      REAL A,B,C,SUM
      SUM = A + B + C
   RETURN
END
```

The subroutine sub1 in the main program will be invoked as follows
CALL sub1(A,B,C, SUM)

Function : The purpose of a function is to take in a number of values or arguments, do some calculations with those arguments and then return a single result.

Each language has different rules to define a function. In the C programming language the basic block for function is given as:

return value function name (argument list)
{
statement;
}

Functions can be called from the main program or from anywhere else, even from within itself. Program control will transfer to function definition statement as soon they are called and then return back to next statement immediately after the calling point.

e.g

```
#include<stdio.h>
void main()
{
int x, y;
printf("Enter number");
scanf("%d",&y);
x=funname(y);
if(x==1)
printf("Number %d is even",y);
else
printf("Number %d is odd",y);
}

int funname(int a)
{
    if((a%2)==0)
    return 1;
    else
    return 0;
}
```

Library function: These are the functions supplied with the programming language. The code or definition of library functions does not have to be written in a user program while writing it. Coding or definition of these function are defined in header or library files which are required to be included in program.
e.g.

```
#include<stdio.h>
```

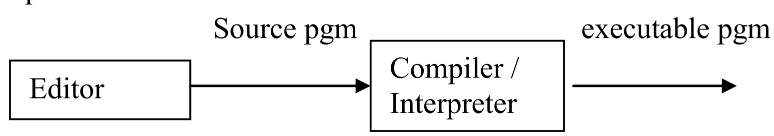
printf(),scanf() etc. are functions defined in stdio.h header file.

Similarly every programming language has a set of library or header files.

3.5 EDITOR, ASSEMBLER, INTERPRETOR & COMPILER

To write a program in any of the programming languages requires an editor.
This is a program that is used to create text files. While saving the program, filename and extension as per programming language is required to be given e.g in C programming language f1.c, in C++ f1.cpp or f1.C, in Java f1.java etc. The extension may also depend on the conventions of the operating system used, for instance, in unix the extension for a C++ program is .C while for Windows it would be .cpp.

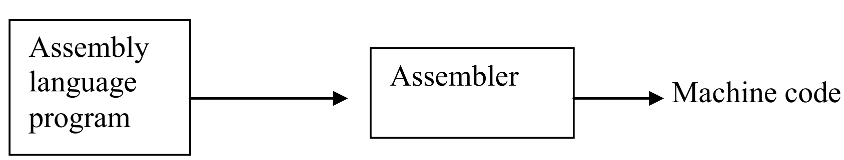
There are different types of editors. Some of the programming languages have some specific built in editors.



A Programming Language is different from machine language, which is understood by a computer in the sense that it can be directly executed. Hence a program in any higher level programming language like C requires a translation process that can translate the source program into machine code so that it can be executed by the computer.

As you may already know from a previous unit, programming languages can be low level languages or high level languages.

Assembly language is a low level programming language similar to machine language, but far easier to write and understand because machine language binary instructions and operands are replaced by mnemonics that are comprehensible to humans. Just As a program written in programming language requires a translator to translate the source program in machine code, a program written in assembly language uses the utility named as assembler for translation purpose. Assembly language is the most basic programming language available for any processor. With assembly language, a programmer works only with operations implemented directly on the physical CPU. Assembly language lacks high-level conveniences such as variables and functions, and it is not portable between various families of processors.



High level programming languages provide:

- Good readability
- Portability

- Easy debugging
- Easy software development

Hence Programming languages translators are broadly divided into two categories:

- Compilers
- Interpreters

Compiled Language : An additional program called a compiler translates a program written in a programming language; into a new file that does not require any other program to execute itself, such a file is called an executable.

e.g. C, C++, Pascal are languages that are typically compiled

Compilers produce better optimized code that generally runs faster and compiled code is self-sufficient and can be run on their intended platforms without the compiler present.

Interpreter : An interpreter is a program that translates each statement in the programming language into machine code and runs it. Such an arrangement means that to run the program one must always have the interpreter available.

e.g Basic , Prolog, Perl are languages that are typically interpreted.

Programs in any language can be interpreted or compiled. So there are basic compilers available as well. Compiled code runs faster and does not need the compiler at run time, whereas interpreted code is slower and needs the interpreter every time the program has to be run.

Check Your Progress 2

1) What is the need of programming language?
……………………………………………………………………………………..
……………………………………………………………………………………..
……………………………………………………………………………………..
2) What is the purpose of looping statement s in a programming language?
……………………………………………………………………………………..
……………………………………………………………………………………..
……………………………………………………………………………………..
3) What are basic operators in any of the programming language?
……………………………………………………………………………………..
……………………………………………………………………………………..

4) What is the purpose of using an array in a programming language?

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

3.6 SUMMARY

This unit helps in understanding the requirement of programming languages. Broad classification of programming languages is discussed. Any programming language allows one to translate an algorithm to a computer program for solving the given problem.

Basic constructs of programming languages are described which include description of syntax and semantics. Various control structures for any programming language like conditional statements, arrays, loops and subroutine are discussed. To execute a program in programming language, firstly we should have a program then it should be in the form that is understood by computer. Hence editor is required to write a program. Then program requires compiler or interpreter to translate it into machine code so that it can be understood by computer.

3.7 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. a) Algorithm to calculate area of a rectangle

Step 1: Read length of the rectangle.

Step 2: Read breadth of the rectangle.

Step 3: Calculate Area = length X breadth

Step 4: Print area.

Step 5: END

1. b) Algorithm to find sum of the first n numbers

Step 1: read the number (n)

Step 2: initialize fact=1,i=1

Step 3: repeat 4,5 until i<=n

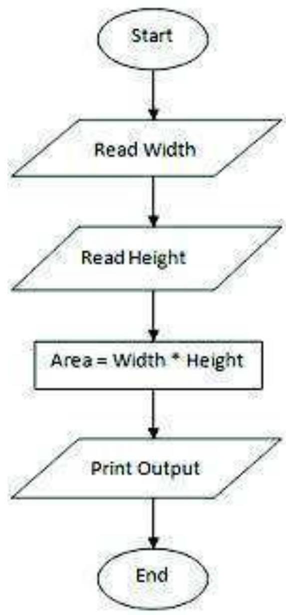
Step 4: fact=fact+i

Step 5: increment i by 1 i.e i=i+1

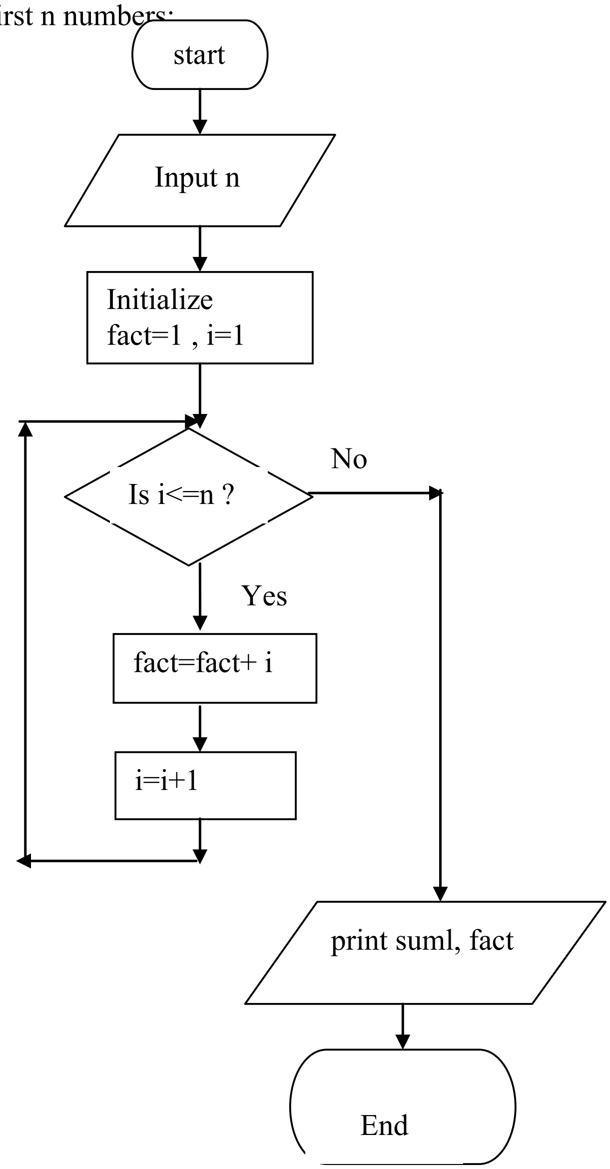
Step 10: Print "Sum of n given numbers is", n , fact

Step 11: END

2. (a) Flowchart to compute area of a rectangle:



(b) Flowchart to find sum of first n numbers:



Check Your Progress 2

1. To solve any problem computer has to be given instructions. Instructions cannot be given in any natural language, which we use (like English, Hindi etc). So it is required to have a programming language to write the program to solve the given problem with the help of a computer.

2. If in a program, a set of statements has to be executed more than once at a particular place, then looping statements are used.

3. The operators in any programming language are broadly classified into the following types:

   a) **Arithmetic operators:** Operators, which are used to perform arithmetic operations such as addition, subtraction, multiplication, division etc.

   b) **Logical Operators:** Operators under this category are AND, OR, NOT.

   c) **Relational Operators :** >,<,=, not = ,<=, >= these are the relational operators.

4. In programming, when large amount of related data need to be processed and each data element is stored with different variable name, it becomes very difficult to manage and manipulate. To deal with such situations, the concept of array is used. Array provides a simple & efficient method to refer, retrieve & manipulate a collection of similar data by a single name.

3.8 FURTHER READINGS

Terrence W. Pratt , Marvin V. Zelkowitz "Programming Languages Design and Implementation", Fourth Edition, 2002, PHI.

Ellis Horowitz "Fundamentals of Programming Languages", Second Edition, 2000 Galgotia.

R.G Dromey "How to solve by computer", PHI.

UNIT 4 COMPUTER APPLICATIONS

Structure **Page No.**

4.0 INTRODUCTION

In the previous units, we have learnt the basics of computer software and the evolution of software. We also learnt the basic definition of Open Source Software. As we go further we will learn in detail this concept and how it is governed by the Open Source definition.

In this unit, we introduce the concept of Open Source software, its philosophy and copyrights. We will also discuss its licensing arrangements under the Open Source Definition.

Any computer application development comes under the umbrella of a Project Management process, which is supported by Project Managers. We will also study the role of a Project manager and his responsibilities for development of successful computer software. We will also see how the role and processes followed by a Project Manager influence the success of a project and its team.
It is essential that we learn all the basics of Office Application software like Word processing, Spread sheets, emailing etc. so that we are capable of handling all types of roles and responsibilities when we enter the industry.

4.1 OBJECTIVES

By the end of this unit, you will know:

- the basics fundamentals of Open Source Software;
- the Project Management process;
- handling of a word processing or spreadsheet file;
- creation and modification of a database; and
- using emails to communicate with others.

4.2 CONCEPTS OF OPEN SOURCE SOFTWARE

Open Source Software is a computer software which is available along with the source code and software license that permits the code to be studied, modified and improved. It is often developed in public and collaborative manner.

The free software philosophy formulated by Richard M. Stallman in 1983, historically preceded the open source movement by a decade and provided some of the key technological, legal and ideological foundations of the open source movement.

The best-known philosophers of the free software movement besides Richard Stallman are Eric Raymond, Bruce Perens, and Eben Moglen.

Open source development, follows the model of the bazaar. In an open source development model, roles are not clearly defined. The best features and functionality evolve into popular use much as good ideas evolve into popular use in the marketplace of ideas. Development is a collaborative process, resources are not scarce, and no one person or organization directs the project. The users are treated like co-developers and so they should have access to the source code of the software.

The Open Source Initiative (OSI) was formed in 1998 with a mission to harmonize the workings of the free software movement and commercial software development. The purpose of the OSI was to "build bridges among different constituencies in the open-source community."

The OSI is the organization responsible for certifying software licenses as open source licenses. Its website (*www.opensource.org)* gives a list of all the certified licenses in existence. OSI previously certified almost any license agreement that fit the open source definition. However, recently it announced a change in policy that requires any newly certified license agreement not only to fit the open source definition but also to be substantially different from existing certified licenses. This is a part of the "nonproliferation" movement in open source.

4.2.1 Introduction

There are two competing definitions. The free software definition was authored by Richard Stallman and is more normative in nature. The open source software definition was authored by Eric Raymond and is more descriptive in nature.

4.2.2.1 Free Software Definition

The Free software definition is based on the following four freedoms:

1. The freedom to run the program, for any purpose.
2. The freedom to study how the program works, and adapt it to your needs.

3. The freedom to redistribute copies so you can help your neighbor.
4. The freedom to improve the program, and release your improvements to the public, so that the whole community benefits.

4.2.2.2 Open Source Definition

The other definition is the Open source definition promulgated by OSI. This broader definition includes permissive software licenses. The elements are:

- Free redistribution
- Source code available
- Derivative works permitted
- Integrity of the author's source
- No discrimination against persons or groups
- No discrimination against fields of endeavor
- Distribution of license with derivative works
- License must not be specific to a product
- License must not restrict use of other software
- License must be Technological-natural

4.2.2 Open Source Development Model

The Open source development model is a collaborative model. It anticipates the participation of many developers in the development of a single product or module. Theoretically, any open source project can have hundreds or thousands of contributors. In practice, however, this is rarely the case. Most open source projects are relatively small, involving the work of one contributor or a small number of contributors. Some open source projects, such as Linux or Apache, are very large development projects. Nevertheless, although they may have many contributors, these projects have a small number of gatekeepers, or "committers," who decide what contributions will be checked in to the official source tree.

In this sense, the model is not a pure model of the bazaar. It is more like a free market with a specialist's desk. In well-known open source projects, these gatekeepers include some of the most respected computer scientists in the world. The gatekeeper decides which modifications to be included in the source tree, based on technical considerations, including security and stability of the code and compatibility with other technology, and the desires of the community at large on issues such as features and functionality.

The most popular open source utility used by the gatekeeper is the Concurrent Versioning System (CVS), which is licensed under GPL. A revision control system allows only designated persons to check code into the source tree. It also keeps track of published versions, what was added, changed, or deleted and when, and who made the change; it further helps reconcile conflicting changes.

The main features of Open Source development model are:

- **Users should be treated as co-developers**

The users are treated like co-developers and so they should have access to the source code of the software.

- **Early releases**

The first version of the software should be released as early as possible so as to increase one's chances of finding co-developers early.

- **Frequent integration**

Code changes should be integrated (merged into a shared code base) as often as possible so as to avoid the overhead of fixing a large number of bugs at the end of the project life cycle. Some open source projects have builds where integration is done automatically on a daily basis.

- **Several versions**

There should be at least two versions of the software. There should be a buggier version with more features and a more stable version with fewer features. The buggy version (also called the development version) is for users who want the immediate use of the latest features, and are willing to accept the risk of using code that is not yet thoroughly tested. The users can then act as co-developers, reporting bugs and providing bug fixes.

- **High modularization**

The general structure of the software should be modular allowing for parallel development on independent components.

- **Dynamic decision making structure**

There is a need for a decision making structure, whether formal or informal, that makes strategic decisions depending on changing user requirements and other factors.

Most well known open source software products follow the bazaar model as suggested by Eric Raymond. These include projects such as the Linux kernel, Firefox, Apache, the GNU Compiler Collection and Perl.

4.2.3 Open Source Licensing

License defines the rights and obligations that a licensor grants to a licensee. Open Source licenses grant licensees the right to copy, modify and redistribute source code (or content). These licenses may also impose obligations (e.g., modifications to the code that are distributed must be made available in source code form; an author attribution must be placed in a program/ documentation using that Open Source, etc.).

All open source licenses, by definition, freely allow the licensee to exercise all of the rights of copyright with respect to the licensed software. Some open source software licenses contain explicit license grants, and some contain implicit ones.
All open source licenses contain broad warranty disclaimers and limitations of liability. Most also include disclaimers of any license grant under any trademark of the licensor—not that any such grant would necessarily be implied in the first place.

When an author contributes code to an Open Source project (e.g., Apache.org),he/she does so under an explicit license (e.g., the Apache Contributor License Agreement) or an implicit license (e.g., the Open Source license under which the project is already licensing code). Some Open Source projects do not take contributed code under a license, but actually require (joint) assignment of the author's copyright in order to accept code contributions into the project (e.g., OpenOffice.org and its Joint Copyright Assignment agreement).

Placing code (or content) in the public domain is a way of waiving an author's (or owner's) copyrights in that work. No license is granted, and none is needed, to copy, modify or redistribute a work in the public domain.

Examples of free software license / open source licenses include Apache License, BSD license, GNU General Public License, GNU Lesser General Public License, MIT License, Eclipse Public License and Mozilla Public License.

Check Your Progress – 1

1. Give the names of a few Open Source Software applications ?

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2. What are the advantages of using Open Source Software ?

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3. How is the Open Source Code maintained with the developers distributed across geographical regions ?

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4. Give name of other industries besides software, where the concept of Open Source is being implemented ?

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4.3 PROJECT MANAGEMENT SOFTWARE

Project management is the discipline of planning, organizing, and managing resources to bring about the successful completion of specific project goals and objectives.

4.3.1 Introduction

A project is a temporary endeavor, having a defined beginning and end, undertaken to meet particular goals and objectives, usually to bring about beneficial change or added value. The temporary nature of projects stands in contrast to other business functions which are repetitive and permanent or semi-permanent undertaken to produce products or services.

The primary challenge of project management is to achieve all of the project goals and objectives within the preconceived project constraints. Typical constraints are scope, time, and resources. The secondary—and more ambitious—challenge is to optimize the allocation and integration of inputs necessary to meet pre-defined objectives. Typical development phases of a project are:

1. Project initiation stage
2. Project planning or design stage
3. Project implementation stage
4. Project monitoring and controlling systems
5. Project completion stage.

4.3.2 Project Manager – Role and Responsibility

A project manager is a professional in the field of project management. Project managers have the responsibility of planning, execution, and closing of any project. The project manager is the person accountable for accomplishing the stated project objectives within the allotted time. Key project management responsibilities include creating clear and attainable project objectives, building the project requirements, and managing the triple constraint for projects, which is cost, time, and scope.

4.3.3 Software Project Management

Software project management is the art and science of planning and leading software projects. It is a sub-discipline of project management in which software projects are planned, monitored and controlled.

The purpose of project planning is to identify the scope of the project, estimate the work involved, and create a project schedule. Project planning begins with requirements that define the software to be developed. The project plan is then developed to describe the tasks that will lead to completion.

The purpose of project monitoring and control is to keep the team and management up to date on the project's progress. If the project deviates from the plan, then the project manager can take action to correct the problem. Project monitoring and control involves status meetings to gather status from the team. When changes need to be made, change control is used to keep the products up to date.

By applying the project management cycle, one can make sure that everything gets done on time and that the project objectives are being achieved.

4.3.4 Project Management Software

Project management software covers many types of software, including scheduling, cost control and budget management, resource allocation, Timesheet management, collaboration software, communication, quality management and documentation or administration systems. These are used to deal with the complexity of large projects.

The different project management activities which can be performed using the Project Management Software are:

- **Scheduling**

One of the most common purposes is to schedule a series of events or tasks. The complexity of this schedule can vary considerably depending on how the tool is used. Some common challenges include:

1. Events which depend on one another in different ways
2. Scheduling team members tasks along with the resources required by them commonly termed resource scheduling
3. Dealing with uncertainties in the estimates of the duration of each task

- **Calculating critical path**

In many complex schedules, there will be a critical path, or series of events which depend on each other, and whose durations directly determine the length of the whole project. Some software applications (for example, Dependency Structure Matrix solutions) can highlight these tasks, thus helping in optimization of effort.

- **Providing information**

Project planning software provides information to various stakeholders of the project and can be used to measure and justify the level of effort required to complete the project. Typical information might include:

1. Tasks lists for team members
2. Allocation schedules for resources
3. Overview information on how long tasks will take to complete
4. Early warning of any risks to the project
5. Information on workload, for planning holidays
6. Historical information on how projects have progressed, and in particular, how actual and planned performance are related
7. Optimum utilization of available resources

- **Timesheet Management**

A good timesheet management system in place, is essential both for the customer projects as well as internal activities within the organization. Timesheets not only help the Project Manager in managing the project in a better manner but is also useful for maintaining employee records for payroll calculations as well as helps in improving the overall productivity of the organization.

A timesheet is a record of the number of hours an employee spends in completing a certain task. This task could be associated with a customer project or with internal business activities. The timesheet not only provides the number of actual hours that the employee may have spend on the task but also mentions details of the task involved and the kind of operations that the task involved completing.
Another benefit of a good timesheet management system is that it can help management track the efficiency of employees and find ways in which they can improve the productivity in various areas. Further, timesheet management systems can also help employees evaluate their own performances and understand how they can perform their tasks better.

Various Timesheet management software are available like Timesheet Reporter, Ace Project, Time Reporting, Qtime and Time Control. Many of the Project Management tools also have a timesheet management module.

4.3.5 Tools for Project Management

Project Management software tools are of three types:

Desktop applications : These are software packages installed on the PC. E.g. MS Project, Gantt Project

Web-based Services : These are websites which offer on-line internet applications that support project management. No separate hardware or software is required as the application is installed on some web server from where it is accessed. E.g. iTeam Work

Web based Systems : These are web based software which are installed in your own hardware and accessed through intranet network. E.g. dot Project
In this section, the main features of MS Project software are described:

4.3.5.1 Microsoft Office Project

One of the most widely used software for Project Management used all over the world is MS Project. It is used for planning, managing and organizing resources for all kinds of projects. It uses a powerful scheduling engine to help align different projects and tasks with available resources.

Project requires all information about the overall project, the individual tasks needed to complete the project and the resources needed. For each task, the duration of task, its dependencies and constraints are also required. Once it has all the necessary information, it can calculate the start date and finish date for each task.

The resources responsible for completing each task helps in Project staffing and management of these resources across projects.
After project scheduling if at any point of time, the information about the project changes, the task and resources can be updated and the project schedule is adjusted.

The main features of MS Project 2007 are explained below:

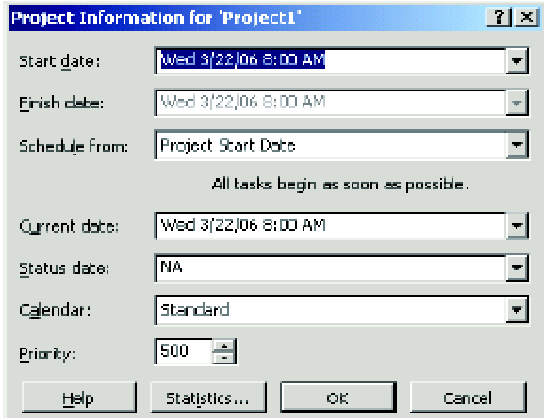
4.3.6 Create and Schedule Project

Most of the projects are scheduled based and the project start date and the finish date is calculated on the basis of the last task to be completed. However, there might be projects where the finish date is known, and there is a need to calculate the project start date so that it is completed on schedule date. Both kind of projects with known start date or known finish date can be scheduled using MS Project.

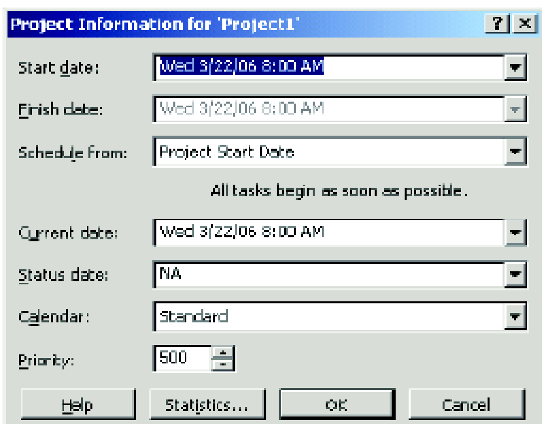
1. Click the File Tab, and then click New

2. Select Blank Project and click Create

3. On the Project Tab, in the properties group, click Project Information



4. Schedule the project in the project Information dialog box. To schedule from Start date, select Project Start date in the Schedule from box and then chose the start date. To schedule from the finish date, select the Project Finish Date in the Schedule from box and choose the finish date.



4.3.7 Define File Properties for the Project

1. Open the project

2. Click on File Tab, and then click Info

3. Choose Project Information and then Advanced Properties

4. On the Summary tab, give the relevant project information

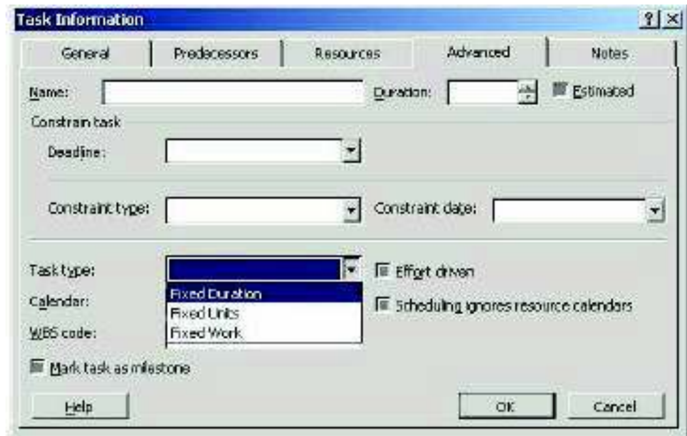
4.3.8 Add Tasks to the Project

Tasks are created to break the project work into smaller pieces. Tasks are activities of the project.

1. On the View tab, in the Task Views group, choose Gantt chart option

2. In the Task Name field, type a task name. The Task IDs are automatically created.

3. It is also possible to create multiple tasks using the Task Form View. To do this, On the View Tab, in the Split View group, select Details. The window is split to display the Gantt chart on the top and Task view form at the bottom. In the Task Form view, type the task information like Name, Duration, assigned resources and predecessor tasks.



4.3.9 Create Milestones

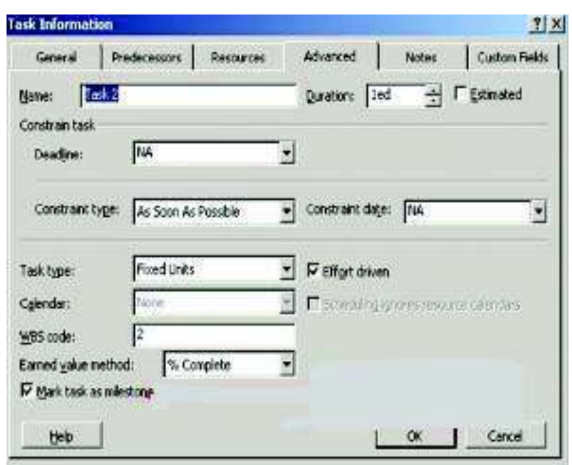
Any major event in a project is marked as a Milestone and is used to monitor the project's progress. Any task with zero duration is marked as milestone. Any other task of any duration can also be a Milestone in the project.

1. On the View Tab, in the Tasks View tab, click Gantt chart.

2. Type the name of the new milestone in the Task Name field

3. Type 0 in the Duration field of the milestone task to create the task as milestone

4. To create a task with greater than zero duration as Milestone, select the task and then on the Task tab, choose the Task Information from the Properties group. Select the Mark Task as Milestone check box. In the task Information dialog box, click Advanced tab and then give the duration of the Milestone.



Check Your Progress 2

1. What is a Milestone in a project?

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2. What is a critical task in a project?

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3. What information can help me analyze my projects progress?

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4. What is the difference between Lead time and Lag time?

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4.4 OFFICE APPLICATIONS

This section will introduce the world of office applications that are used widely by all of us to carry on our day to day tasks like writing a project document, preparing our monthly budget, corresponding with each other on email or scheduling our daily calendar.

4.4.1 Word Processing

A word processor (more formally known as document preparation system) is a computer application used for composition, editing, formatting and printing of any sort of printable material.

4.4.2 Introduction

Word processing was one of the earliest applications for the personal computer in office productivity. Although early word processors used tag-based markup for document formatting, most modern word processors take advantage of a graphical user interface providing some form of "What You See Is What You Get" editing. Most are powerful systems consisting of one or more programs that can produce any arbitrary combination of images, graphics and text, the latter handled with type-setting capability.

Microsoft Word is the most widely used computer word processing system; Microsoft estimates over five hundred million people use the Office suite, which includes Word. There are also many other commercial word processing applications, such as WordStar, WordPerfect, which dominated the market from the mid-1980s to early-1990s, particularly for machines running Microsoft's MS-DOS operating system. Open-source applications such as AbiWord, KWord, LyX and OpenOffice.org Writer are rapidly gaining in popularity. Online word processors such as Google Docs are a relatively new category.

Word processing typically implies text manipulation functions that extend beyond a basic ability to enter and change text, such as automatic generation of:

- batch mailings using a form letter template and an address database (also called mail merging);
- indices of keywords and their page numbers;
- tables of contents with section titles and their page numbers;
- tables of figures with caption titles and their page numbers;
- cross-referencing with section or page numbers;
- footnote numbering;
- Version control of a document using variables (e.g. model numbers, product names, etc.)

Other word processing functions include "spell checking" (actually checks against wordlists), "grammar checking" (checks for what seem to be simple grammar errors), and a "thesaurus" function (finds words with similar or opposite meanings. Other common features include collaborative editing, comments and annotations, support for images and diagrams and internal cross-referencing.

Text editors (modern examples of which include Notepad, BBEdit, Kate, Gedit), were the precursors of word processors. While offering facilities for composing and editing text, they do not format documents.

Later desktop publishing programs were specifically designed to allow elaborate layout for publication, but often offered only limited support for editing. Typically, desktop publishing programs allowed users to import text that was written using a text editor or word processor.

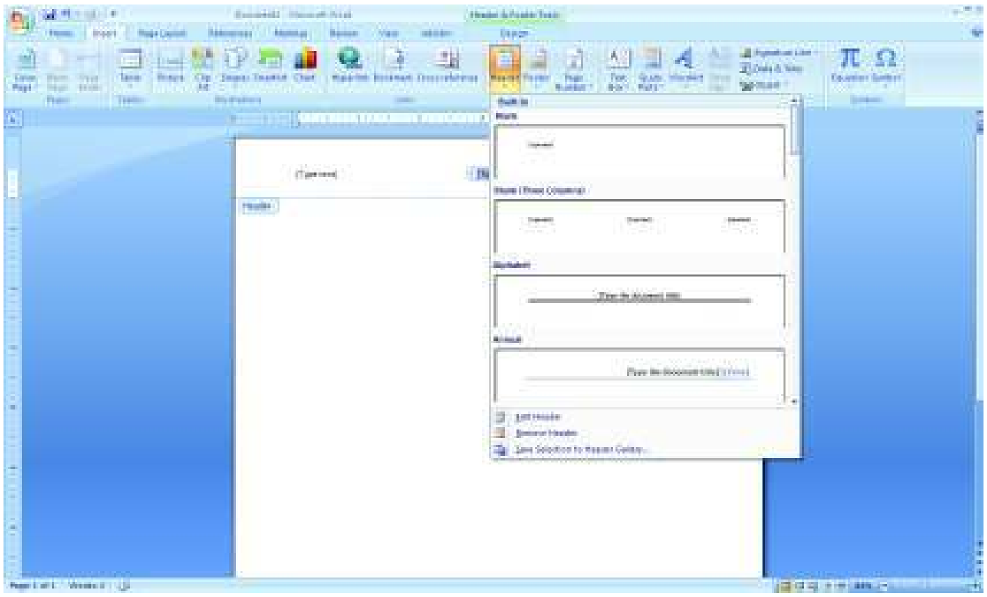
Almost all word processors enable users to employ styles, which are used to automate consistent formatting of text body, titles, subtitles, highlighted text, and so on.

A few features of Microsoft Word 2007 are described here.

4.4.3 Adding Header, Footer or Page Number to a Document

To add a graphic or text on the top or bottom of a document, a Header or Footer has to be added.

1. Click on Insert Tab, select the Header or Footer or Page Number from Header & Footer group.
2. You can select from the available gallery and choose the design required.
3. After selection, the same design chosen will appear in the document.



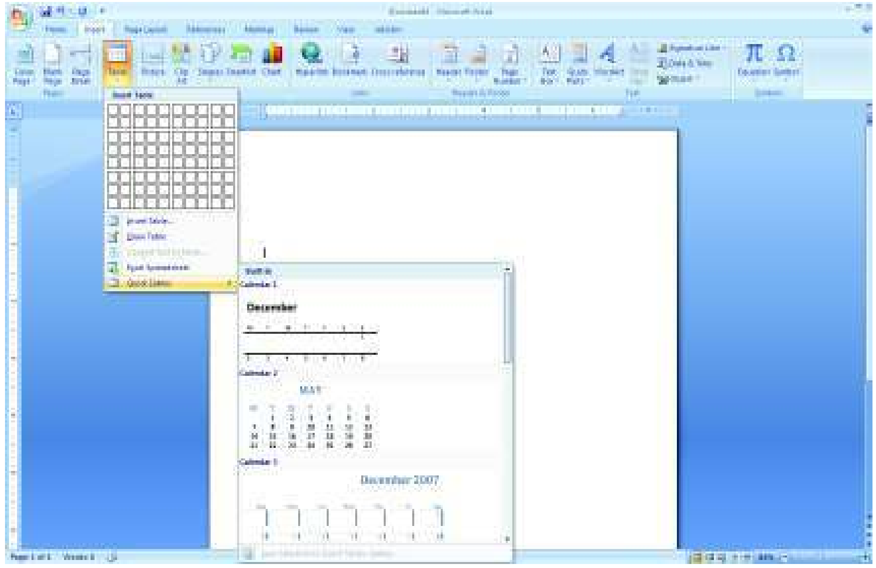
To add a customized design for the Header or Footer, double click on the Header or Footer area in the document. The same is opened in the design mode. After making the required changes to the design, close the Header/Footer area.

4.4.4 Creating a Table in Word

In Word, a Table can be inserted by either by choosing from a gallery of preformatted table templates or by using the table menu to choose the number of rows and columns that are required.

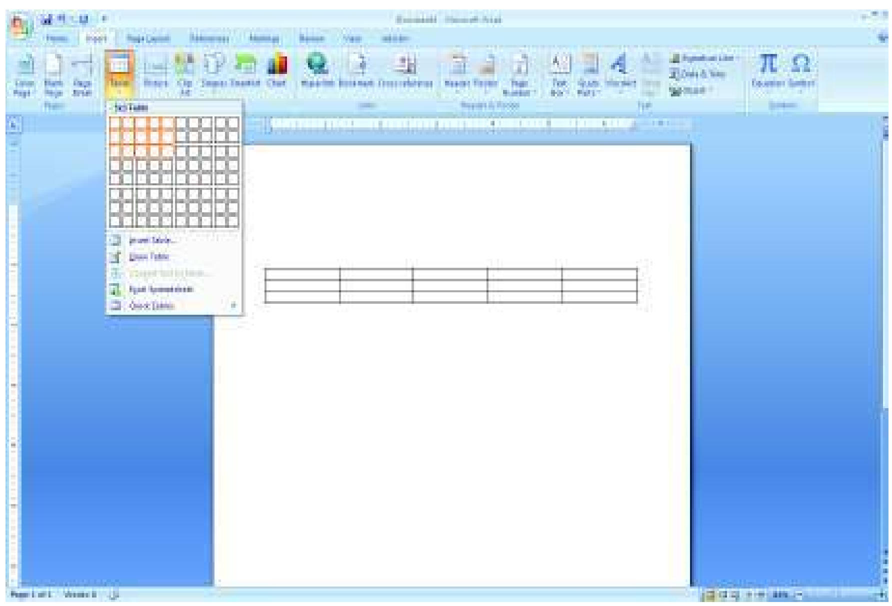
To Choose from gallery of table templates:

1. Click in the document where the table has to be inserted.
2. On the Insert tab, in the Tables group click Table, and then choose Quick table.
3. Choose the required template from the gallery displayed.
4. The chosen table will be inserted into the document.



To insert a simple table with required number of row and columns:

1. Click in the document where the table has to be inserted.
2. On the Insert tab, in the Tables group click Table, and then under Insert Table, select the number of rows and columns required in the table.
3. The table will be drawn on the document.

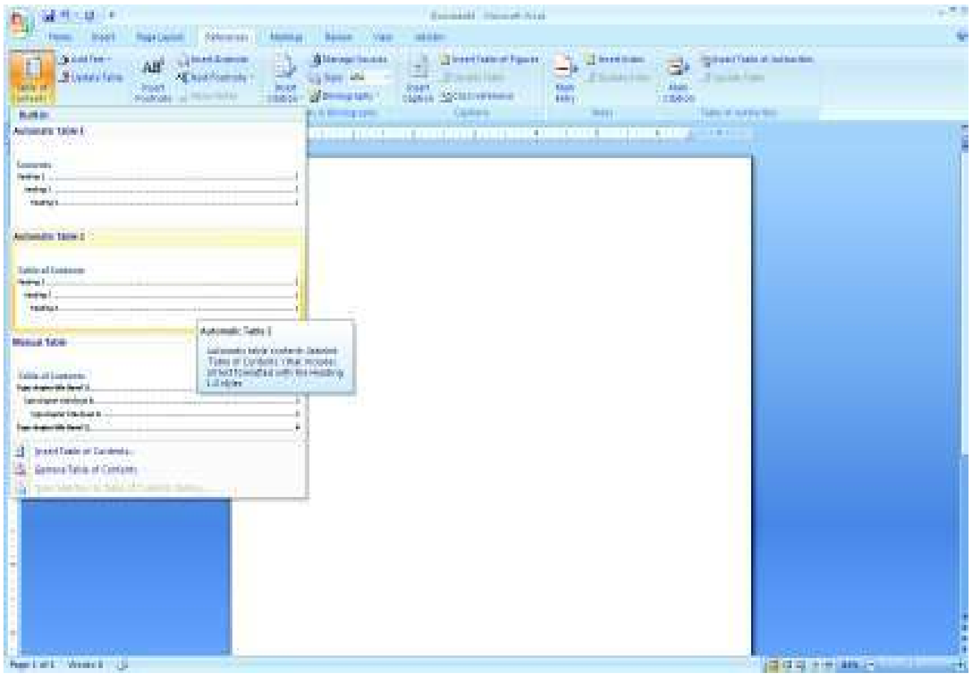


4.4.5 Creating a Table of Contents

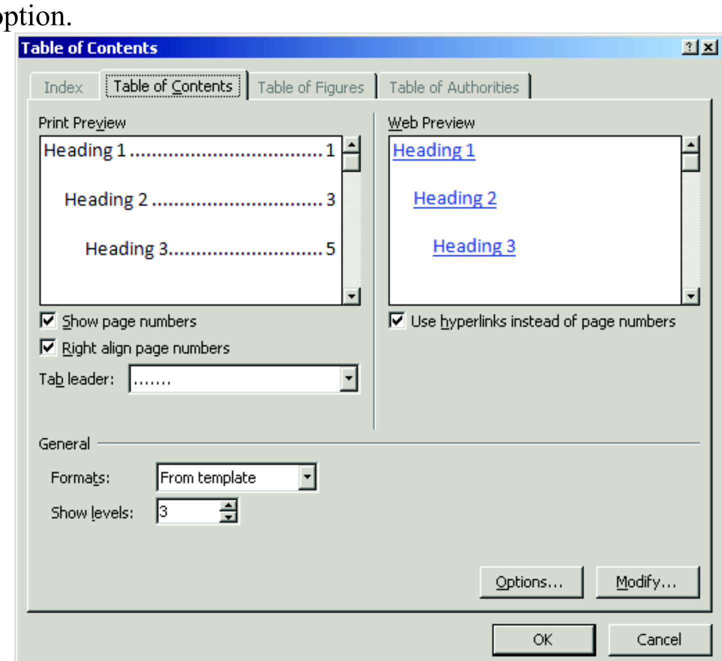
Table of Contents (TOC) is created by applying heading styles to the text that is to be included in the TOC. Word will search for those headings and create the TOC in the document. The Table of Contents can be selected from design gallery provided in word.

1. Select the text that is to be appear in the TOC

2. On the Home tab, in the Styles group, click the Style (Heading1, Heading2….) that you want to choose
3. Click the place in the document where the TOC has to be inserted.
4. ON the Reference Tab, click Table of Contents on the Table of Contents group
5. Choose the TOC Style that is required



In order to create a customized Table of Contents, ON the Reference Tab, click Table of Contents on the Table of Contents group and choose the Insert Table of Contents option.



Here it will be possible to change the heading levels, overall look of TOC etc.

4.4.6 Creating a memo for multiple recipients – Mail Merge

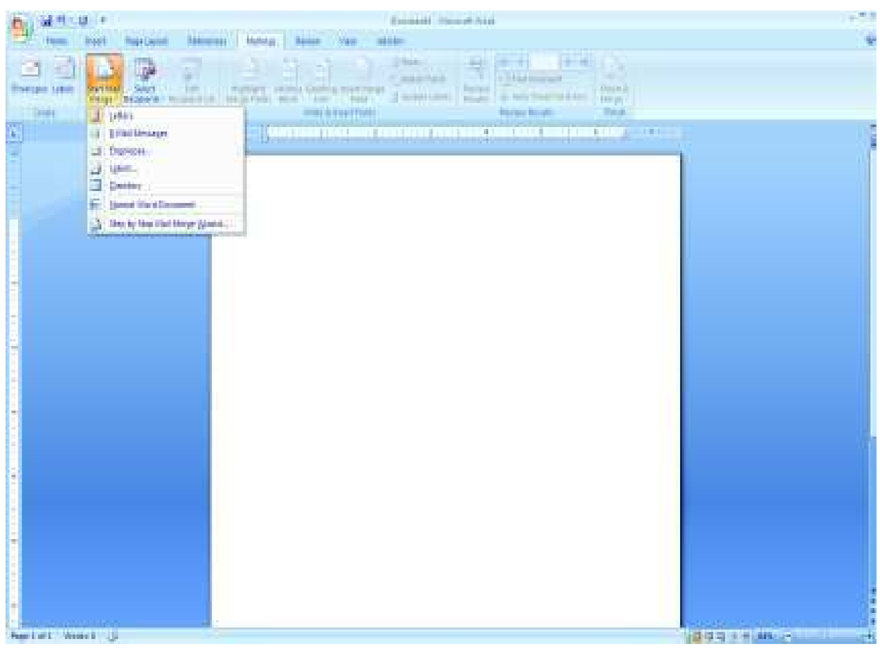
Mail merge is a software function describing the production of multiple (and potentially large numbers of) documents from a single template form and a structured data source. This helps to create personalized letters and pre-addressed envelopes or mailing labels for mass mailings from a word processing document which contains fixed text, which will be the same in each output document, and variables, which act as placeholders that are replaced by text from the data source. The data source is typically a spreadsheet or a database which has a field or column matching each variable in the template. When the mail merge is run, the word processing system creates an output document for each row in the database, using the fixed text exactly as it appears in the template, but substituting the data variables in the template with the values from the matching columns.

You use mail merge when you want to create a set of documents, such as a form letter that is to be sent many customers or a sheet of address labels. Each letter or label has the same kind of information, yet the content is unique. For example, in letters to your customers, each letter can be personalized to address each customer by name. The unique information in each letter or label comes from entries in a data source.

The mail merge process entails the following overall steps:

1. Set up the main document. The main document contains the text and graphics that are the same for each version of the merged document. For example, the return address or salutation in a form letter.

2. Connect the document to a data source. A data source is a file that contains the information to be merged into a document. For example, the names and addresses of the recipients of a letter.



3. Refine the list of recipients or items. Microsoft Office Word generates a copy of the main document for each item, or record, in your data file. If your data file is a mailing list, these items are probably recipients of your mailing. If you want to generate copies for only certain items in your data file, you can choose which items (records) to include.

4. Add placeholders, called mail merge fields, to the document. When you perform the mail merge, the mail merge fields are filled with information from your data file.

5. Preview and complete the merge. You can preview each copy of the document before you print the whole set.

Thus, Mail Merge is used to create documents that are essentially the same but have a few unique data elements that vary for each document.

4.5 SPREADSHEET

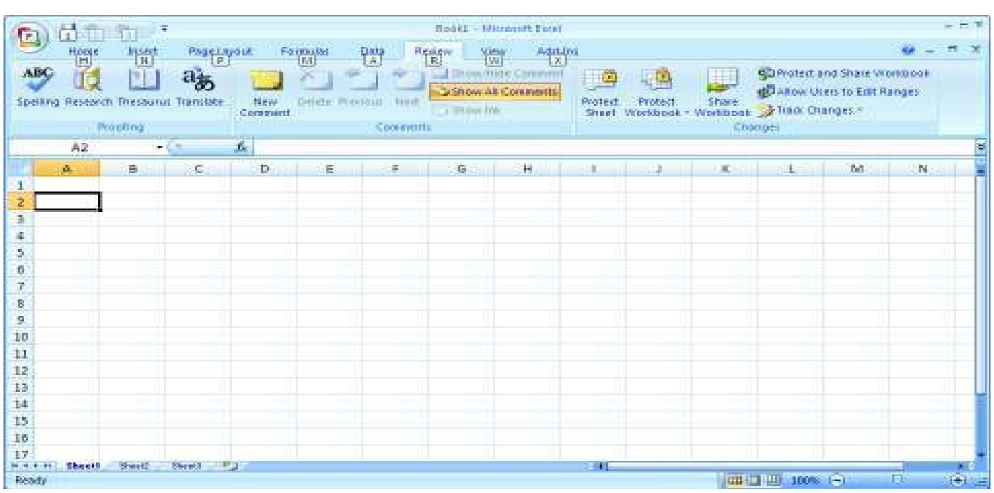
A Spreadsheet, as you all would know, is a grid made of columns and rows known as cells and is used for making tables and charts used for mathematical and statistical analysis as well as business calculations. One of the widely used spreadsheet software is MS-Excel. A few features of MS Excel 2007 are described below.

4.5.1 Introduction

Each cell on a spreadsheet can have any of the following data:

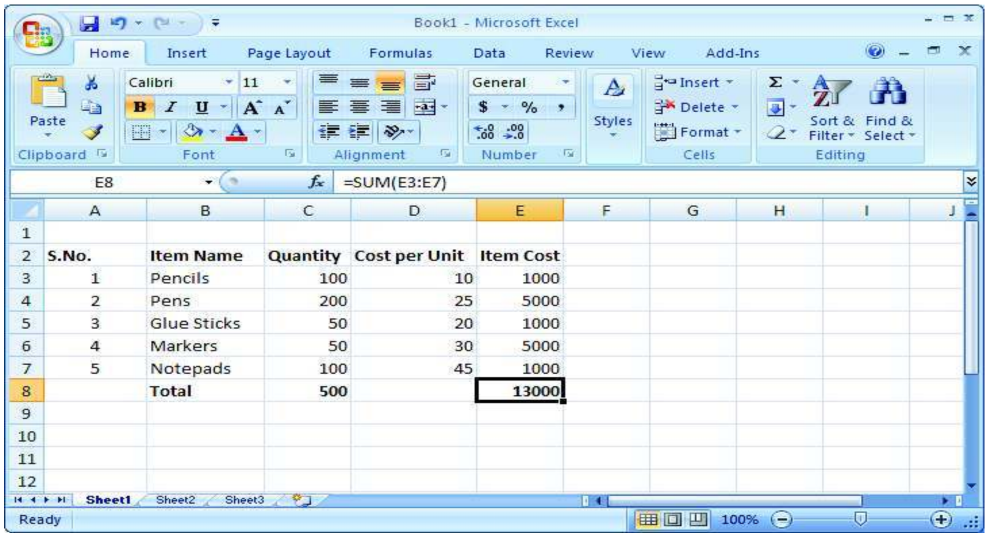
- Text or Labels
- Numbers or Constants
- Formulae which are mathematical equations to do all calculations

Each cell is designated with a name which is actually the COLUMN Name and ROW NUMBER.
E.g. A2 means the cell A21 is the intersection of column A and row 2



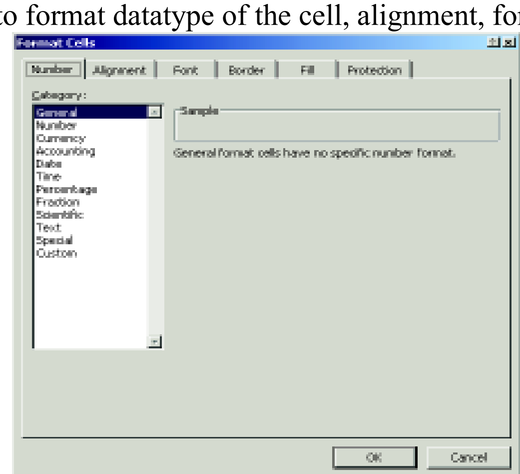
The following example shows the three basic types of data that a cell may have:

- Labels Text which simply is the column heading like cell B2, C2, C3 etc.
- Values which are constant fixed numbers entries like C3, C4, D3, E4 etc
- Formulas which are mathematical calculations as in the highlighted column E8. Formula cells always begin with an EQUAL SIGN (=). It is best to use the reference to data within the formula cells by giving the cell location. This helps in keeping the formula unchanged even if the values change.



4.5.2 Basic Features

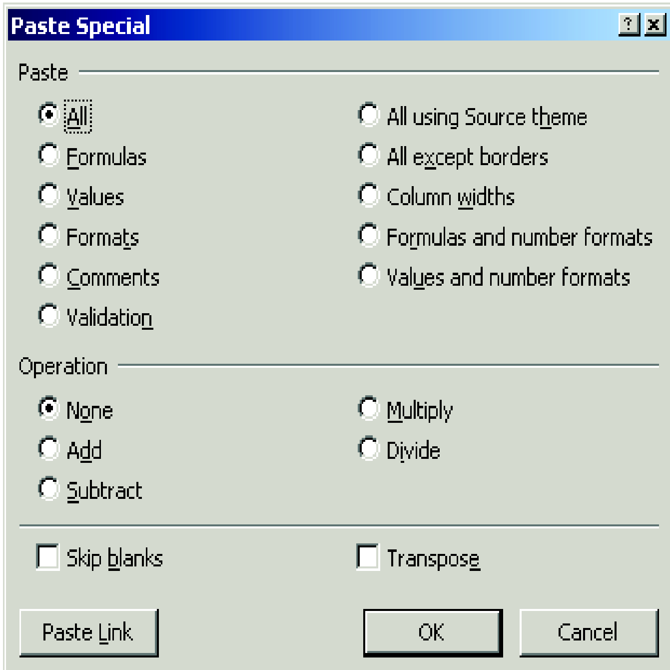
The spreadsheet consists of various sheets like sheet1, sheet2, sheet3 etc. within the workbook. These sheets can be can be given meaningful names. New sheets can be inserted and worksheets can be deleted from the workbook.
The format of the cells on the sheets can be modified using the Home->Cells->format->format cells option on the menu. This will give the following dialog box which is used to format datatype of the cell, alignment, font etc.



The contents of the cells can be cut, copied and pasted using the Home->Clipboard options. There is an option of “Paste Special” (Home -> Clipboard-> Paste -> Paste Special) which allows only to paste certain aspects of the cells copied to the clipboard.

Formulas : Only pastes the formulas from the cells on the clipboard.

Values : Will paste the values of the cells on the clipboard. If the cells copied contained formulas, only the results of the formulas will be pasted.

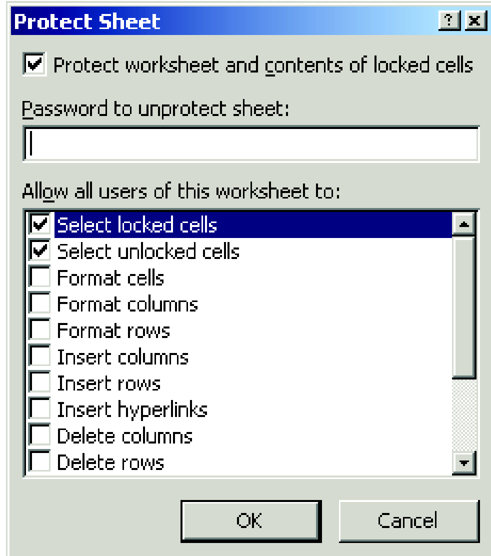


- **Column Widths** : Will paste only the column widths of the cells that you copied to the clipboard.
- **Operations** : This is useful if you want to scale a group of numbers or add/subtract a certain amount from each. Whatever value is copied to the clipboard, the current operation will be done using that number on the cells in which you are pasting to.
- **Skip blanks** : Will paste data, skipping any blank cells.
- **Transpose** : Will transpose the data and paste it (columns to rows, rows to columns).

It is possible to protect the cells so that the data cannot be changed or modified. By default all cells in a worksheet have the locked property turned on (the cell is capable of being protected). is also possible to protect worksheet or the whole workbook using password protection.

Protecting a Worksheet

1. Click Tools, click Protection, and click Protect Sheet.
2. Enter a password (only if desired).
3. Confirm password (only if entered).
4. Click OK.



Protecting a Workbook

1. Click Tools, click Protection, and click Protect Workbook.

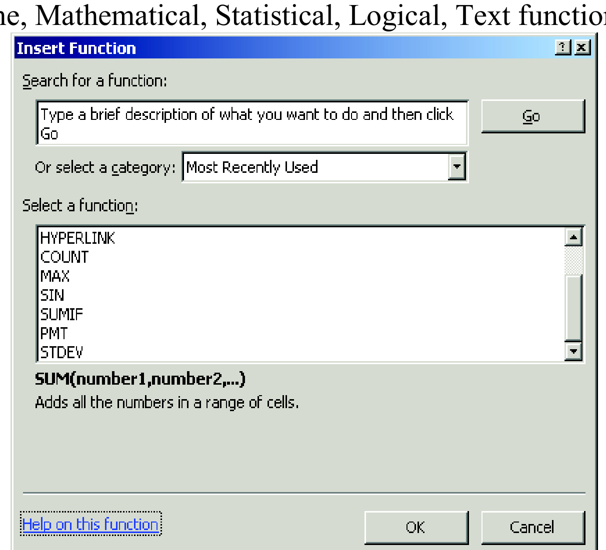
2. Enter a password (optional).

3. Choose to protect the Structure, Windows, or both.

4. Click OK.

4.5.3 Formulae and Functions

There are different categories of functions that can be incorporated in the sheets like Date & Time, Mathematical, Statistical, Logical, Text functions etc.



The different categories of functions are:

Date and Time:

MONTH - Converts a serial number to a month

YEAR - Converts a serial number to a year

NOW - Returns the serial number of the current date and time

Math and Statistical:

SUM – Adds its arguments
MEDIAN – Returns the median of the given numbers
SUMPROUCT – Returns the sum of the products of corresponding array components
COUNTIF - Counts the number of cells within a range that meet the given criteria

Text:

CONCATENATE – Joins several text items into one text item
RIGHT - Returns the rightmost characters from a text value
LEN - Returns the number of characters in a text string
EFT - Returns the leftmost characters from a text value

Logical:

IF - Specifies a logical test to perform
NOT - Reverses the logic of its argument
AND - Returns TRUE if all of its arguments are TRUE

Advanced Functions:

MATCH- Looks up values in a reference or array
INDEX - Uses an index to choose a value from a reference or array
SEARCH - Finds one text value within another (not case-sensitive)
REPLACE - Replaces characters within text

Database Functions:

DGET- Extracts from a database a single record that matches the specified criteria
DCOUNT - Counts the cells that contain numbers in a database
DSUM - Adds the numbers in the field column of records in the database that match the criteria
DPRODUCT - Multiplies the values in a particular field of records that match the criteria in a database

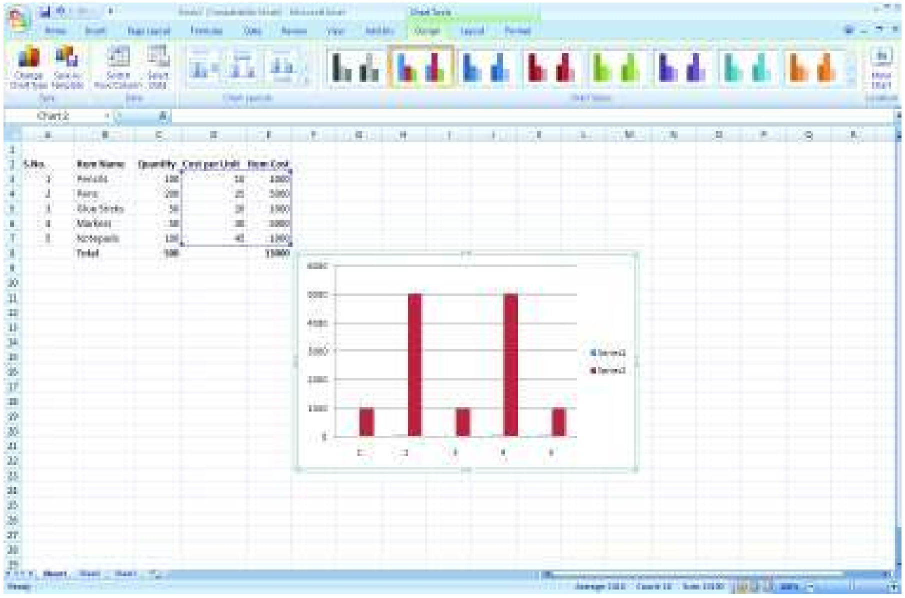
Lookup & Reference:

VLOOKUP - Looks in the first column of an array and moves across the row to return the value of a cell
HLOOKUP - Looks in the top row of an array and returns the value of the indicated cell
INDIRECT - Returns a reference indicated by a text value

4.5.4 Charting

Charts and Graphs can be created based on data in the sheets. To create a chart to represent data graphically:

1. Select the data
2. Go to Insert
3. Select the chart type from the options available like Bar, Line, Pie, Scatter etc.
4. The chart will get automatically populated with the selected data on which the chart is to be based.



4.5.5 Macros

A macro is a short program written using VBA that can be used to carry out a specific task. VBA is the language that Excel macros are written in. It is a programming language that is included with all of the Microsoft Office applications e.g. Word, Access, Power Point, Excel as well as others.
VBA is a subset of Microsoft Visual Basic, an extremely popular programming language that has been around for over 10 years. The Macro has to be recorded as follows:

1. Go to the Tools menu, go to “macro” and then “Record New Macro”
2. Assign a name to your macro if you'd like, as well as type a short description.
3. You can also assign a keyboard shortcut to it (so you can press a sequence of keys to run the macro).
4. Now click on OK. You'll be returned to Excel.
5. Simply perform the actions you want the macro to do.
6. Once you're done recording your macro, press the Stop button which should now be visible on your screen.

Once the Macro is recorded it can be executed in the following ways:

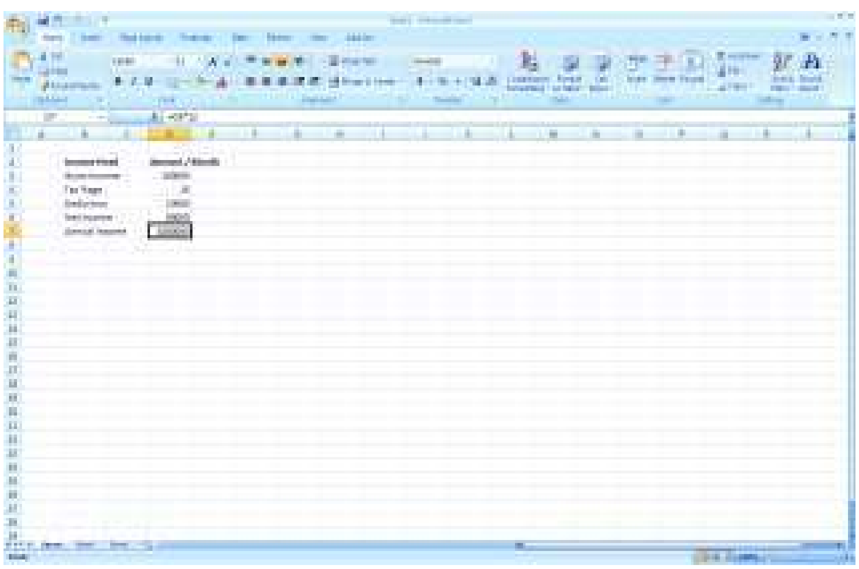
1. Run a macro by using the menu command
2. By pressing a CTRL combination shortcut key
3. Clicking a toolbar button or an area on an object, graphic, or control
4. Run a macro automatically when the workbook is opened.

4.5.6 A Small Example in Excel 2007

Take a small example given in the table below for calculation of Salary and Income tax deduction and compute the result in excel to give the net monthly and annual income as shown below:

Income Head	Amount per month
Gross Income	100000
Tax percentage	10%
Tax Deduction	Gross * Tax Percentage
Net Income	Gross – Tax Deduction
Annual Income	Net Income * 12

After calculation and writing the formulas in Excel 2007, we would get the following results:



4.6 DATABASE

Database is used to organize information into data in the form of tables. For example, a table with student’s data. Different tables are joined together on the basis of relationships. The table and relationships together form relational structure. Relational Structure helps in reduction of repetitive data, improves accuracy and provides better management of data.

4.6.1 Introduction

A Table is a database object that is used to store data about a particular subject like employees, students or products. In a Table, the columns are called fields or attributes and the individual records are called Tuples (rows). One of the most important advantage of a Relational table structure is the Primary key field in each table. A Primary key is a field or a combination of fields that make each record in the table unique. Primary keys help in removing duplicate data and creating relationships between different tables. Foreign Key contains values that correspond to the primary key of another table. A table can have one or more than one foreign key.

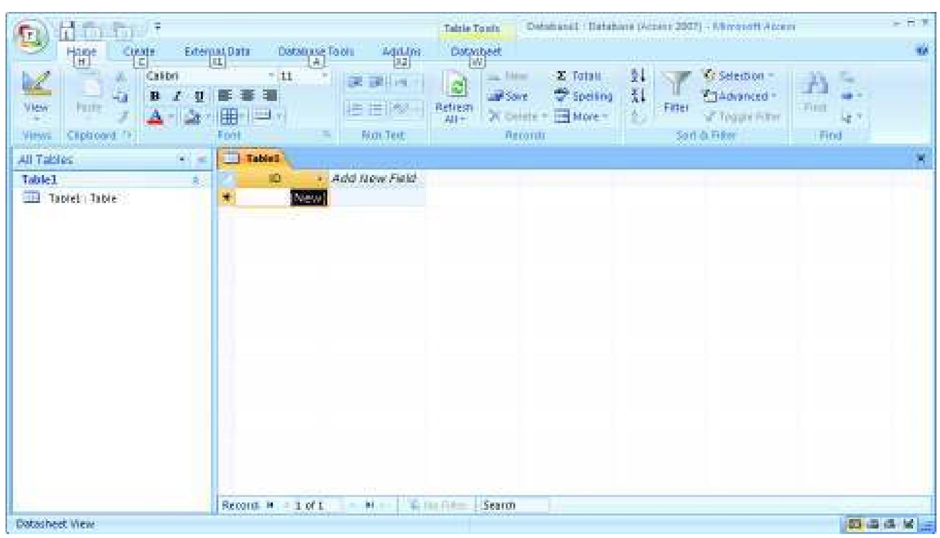
Every field has a datatype which indicates the type of data that filed will stores, such as text, numbers or external files.

The most commonly used database in the industry is MS-Access. Here, we will see how to manage a simple database in MS-Access.

4.6.2 Create Table in Database

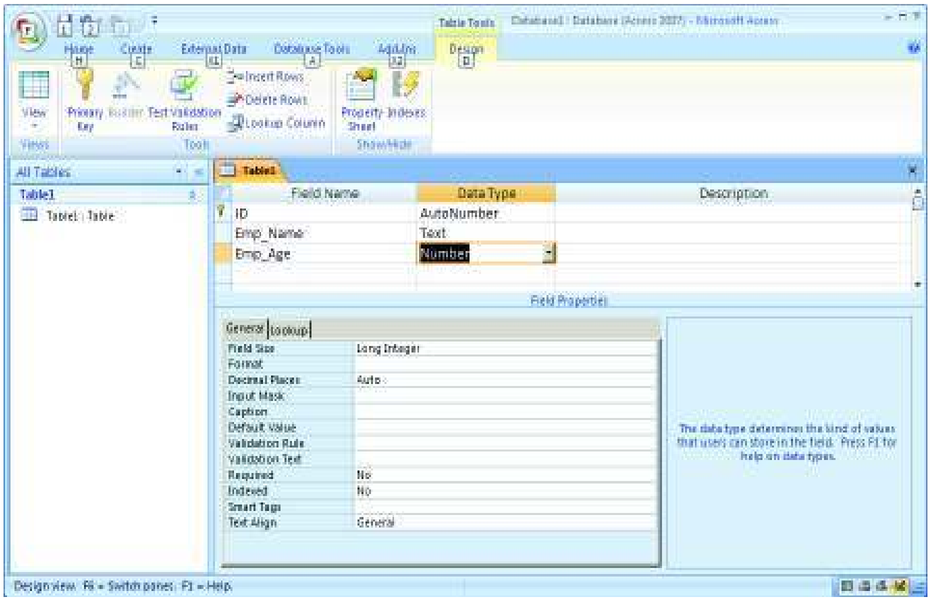
1. Click the Microsoft Office Button, and then click New.
2. In the File Name box, type a file name for the new database.
3. To browse to a different location to save the database, click the folder icon.
4. Click Create.

The new database opens, and a new table named Table1 is created and opens in Datasheet view. When you create a new table in Datasheet view, Access automatically creates a primary key for you and assigns it a field name of ID and the AutoNumber data type.



4.6.3 Add Fields to the Table

In order to add new fields to the Table, enter into Design view, On the Home tab, in the Views group, click View, and then click Design View. Here add the fields and set their properties like datatype, size, default value, input mask etc. The field which has to be made primary key is also set here.



When you create a new table in Datasheet view, Access automatically creates a primary key for you and assigns it a field name of ID and the AutoNumber data type. In Design view, you can change or remove the primary key, or set the primary key for a table that doesn't already have one.

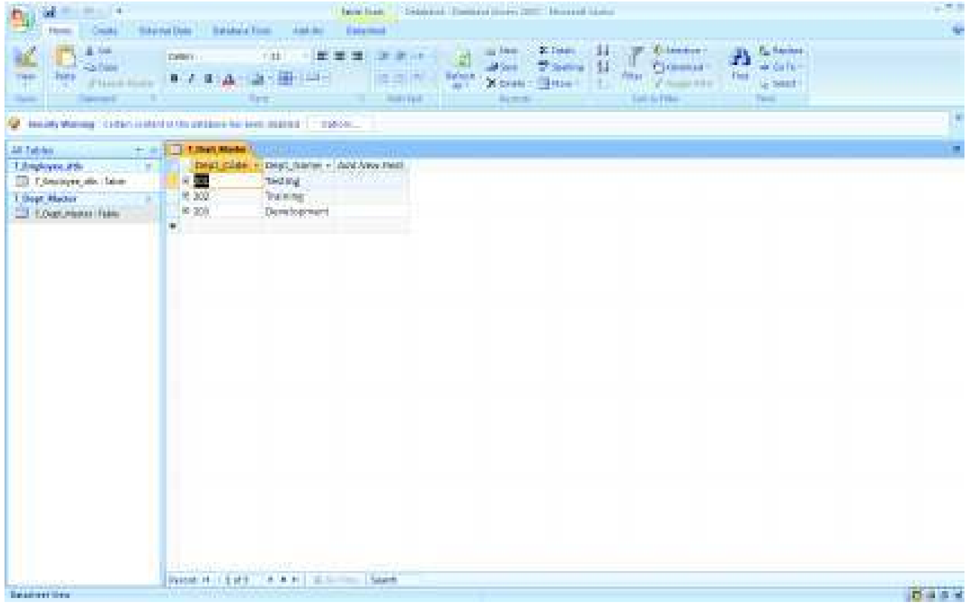
After the table is created, it is saved in the database by going to Microsoft office button and choosing the Save option.

4.6.4 Add Data in the Table

Once the Tables have been created, data has to be added to them.

1. Open the database to which data has to be added.
2. Select the table to which has to be inserted
3. The table opens in the datasheet view mode.
4. Add the data to the table record by record in the datasheet grid and save the table.

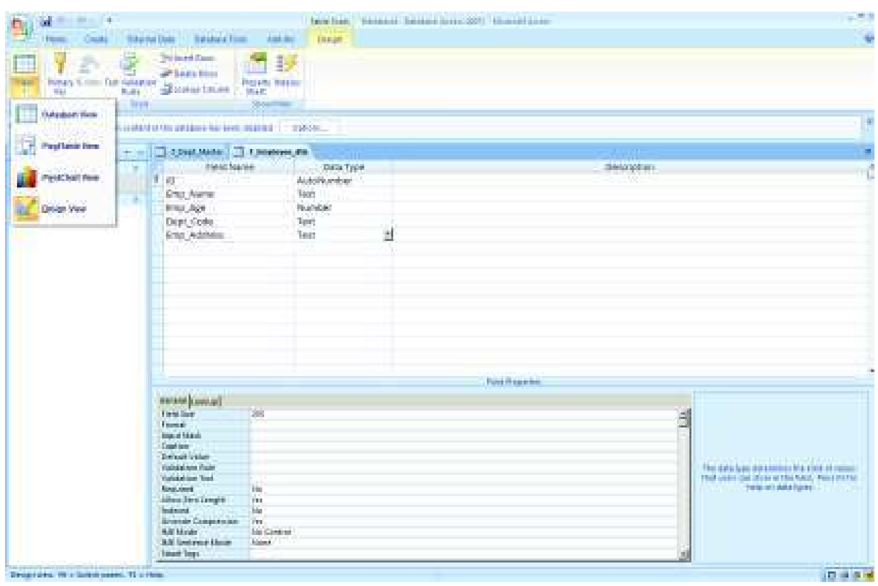
The data added can also be modified also in the datasheet view mode.



4.6.5 Add New Fields in the Table

To add new fields to the table, open the table in design view mode.

1. In the Home tab, in the Views group, click View, and then click Design View.
2. In the table design grid, add the new field
3. Define its properties like datatype, length, default value etc.
4. Save the changes made to the table



4.6.6 Set a Table's Primary Key

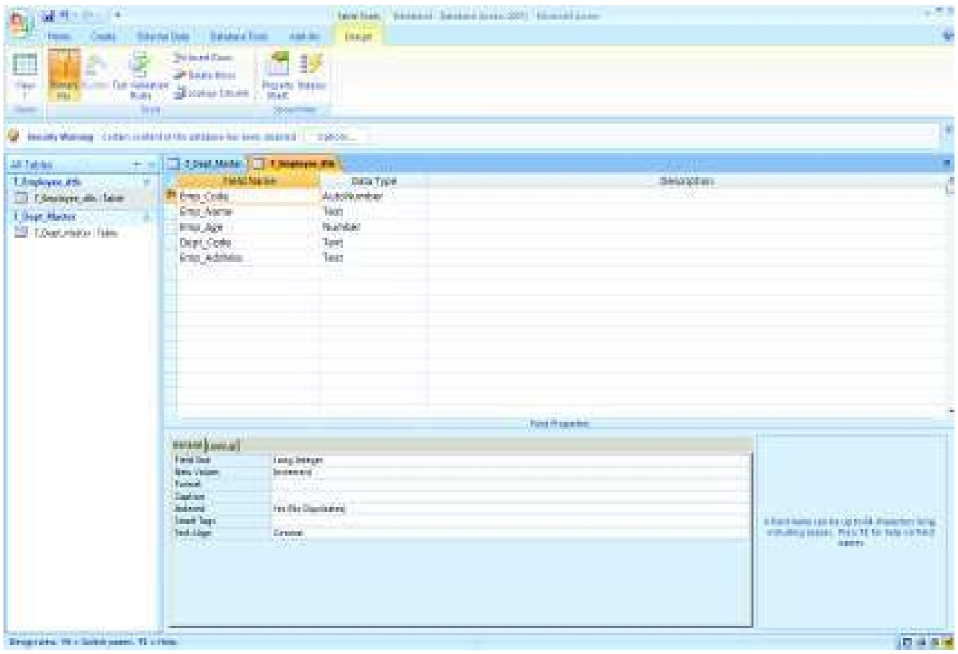
When a new table is created, Access automatically creates a primary key and gives a default field name ID and AutoNumber as its datatype. In Design view mode, it is possible to change, remove or set the primary key of a Table.

1. Select the table for which the primary key has to be set or modified.

2. On the Home tab, in the Views group, click view and then select the Design view mode.

3. In the Design grid, select the field or fields (by holding down CTRL to select more than one field.

4. On the Design tab, in the Tools group, click Primary Key. A key indicator appears on the left of the field or fields selected to indicate the field as primary key.



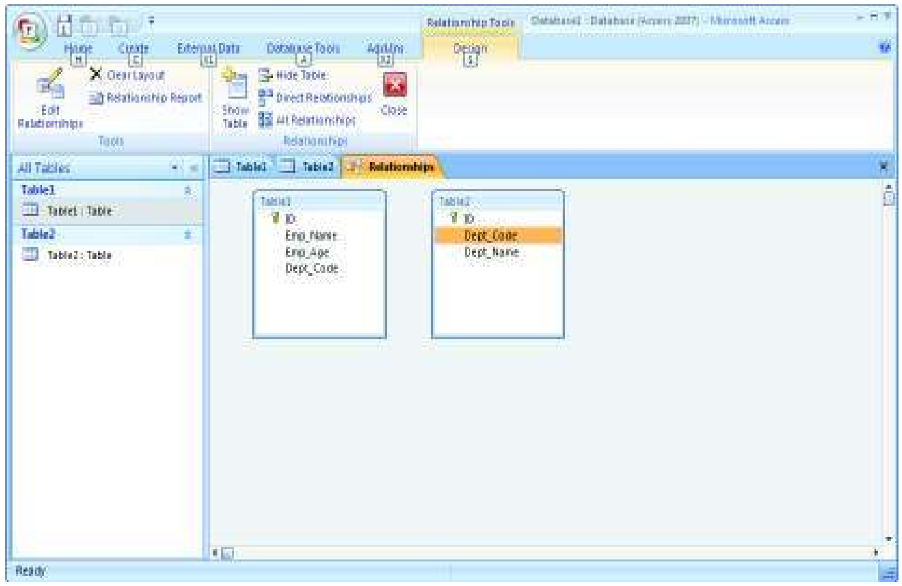
4.6.7 Defining Relationships

When you create a relationship between tables, the common fields are not required to have the same names, although it is often the case that they do. But, the common fields must have the same data type. If the primary key field is an AutoNumber field, however, the foreign key field can also be a Number field if the FieldSize property of both fields is the same. For example, you can match an AutoNumber field and a Number field if the FieldSize property of both fields is Long Integer. When both common fields are Number fields, they must have the same FieldSize property setting.

To create relationships between two tables,

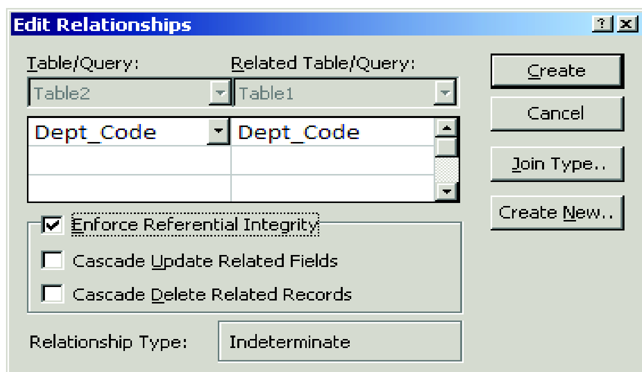
1. Choose Relationships under the Database Tools menu.

2. Then Choose the Table option and add the tables between which relationship has to be created.



3. Drag a field (typically the primary key) from one table to the common field (the foreign key) in the other table. To drag multiple fields, press the CTRL key, click each field, and then drag them.

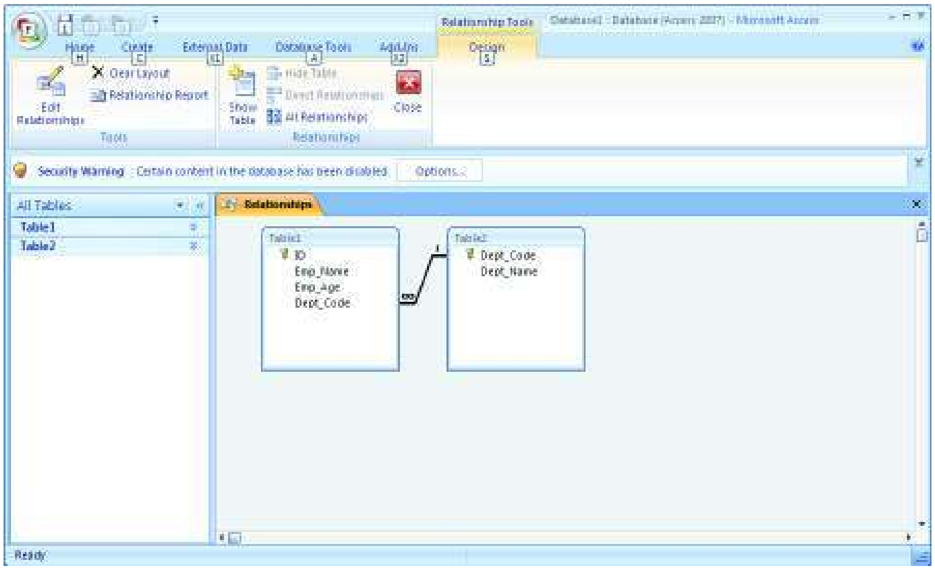
4. The Edit Relationships dialog box appears as below:



5. To enforce referential integrity for this relationship, select the Enforce Referential Integrity check box.

6. Click Create.

Access draws a relationship line between the two tables. If the Enforce Referential Integrity check box is selected, the line appears thicker at each end. In addition, the number 1 appears over the thick portion on one side of the relationship line, and the infinity symbol (∞) appears over the thick portion on the on the other side of the line, as shown in the following screen.

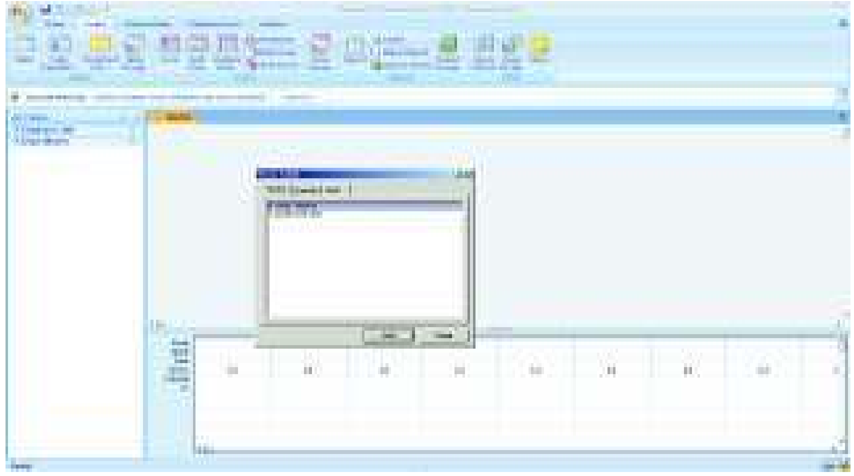


The purpose of referential integrity is to prevent orphan records and to keep references synchronized. Once referential integrity is enforced, Access rejects any operation that would violate referential integrity for that table relationship. This means that Access will reject both updates that change the target of a reference and deletions that remove the target of a reference. To propagate the referential updates and deletions so that all related rows are changed accordingly, see the Set the cascade options section.

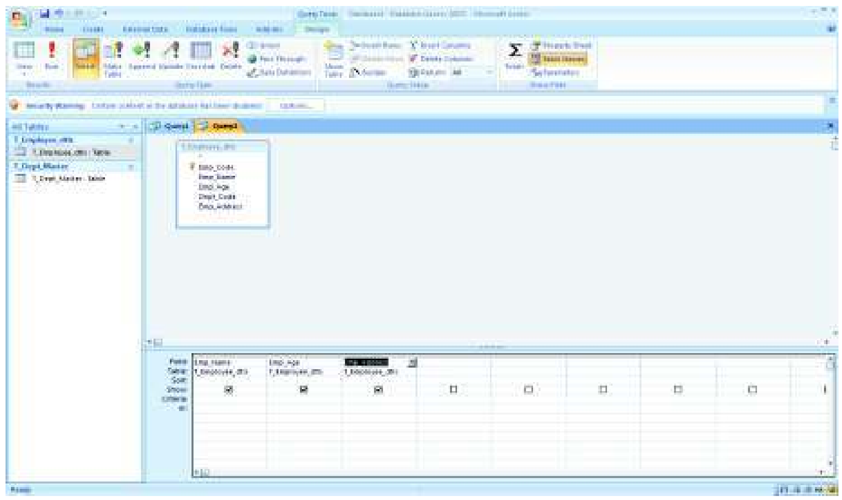
4.6.8 Defining Queries

When data has to be reviewed, added, changed or deleted from the database, a query is used. Queries are also used to answer very specific questions about the data that would be difficult to answer directly by just looking at the table data. Queries can be used to perform calculations on the data, to filter data and to summarize the data.

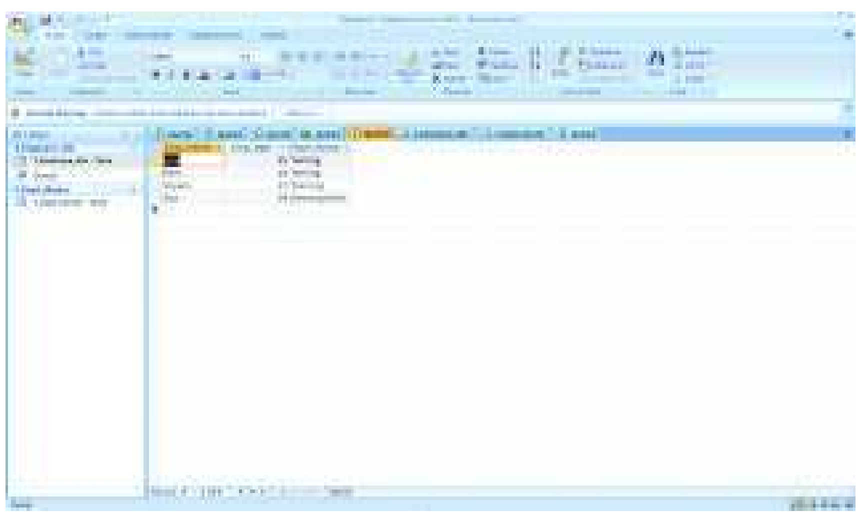
1. On the Create tab, in the query group, click query design. A show Table dialog box appears.
2. In the Show Table dialog box, choose the table on which query has to be based and close the show Table dialog box.



3. In the selected Table, double click the fields that have to be added to the query
4. On the Design Tab, in the Results group, click Run.



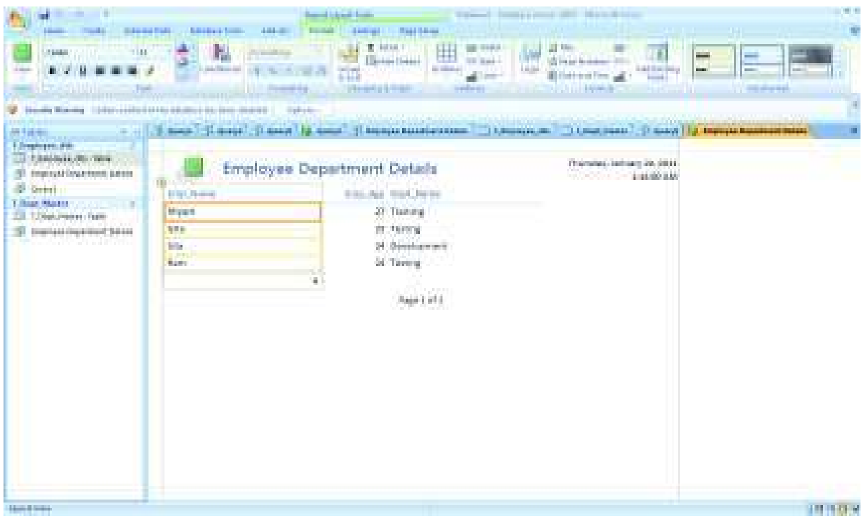
The query will be executed and the result is displayed in the grid as shown below.



4.6.9 Reports

A Report consists of information from tables and queries that is stored with a particular report design such as labels, headings and graphics.

1. In the Navigation pane, select the query or Table on which the report has to be based.
2. On the Create Tab, in the Reports group, click Report
3. The Report will be created and displayed



Once the report is created, its layout can be modified in the Report design view. Reports can be created using the Report wizard tool also.

4.6.9.1 A Small Example in Access 2007

We wil create a small database for employees in an organization using MS Access 2007. Make two tables T_Employee_dtls and T_Dept_master database tables with the following structure:

T_Employee_Dtls

Field Name	Datatype
Emp_code	Autonumber
Emp_Age	Number
Dept_code	Text
Emp_Address	Text

T_Dept_master

Field Name	Datatype
Dept_code	Text
Dept_Name	Text

Define Emp_Code and Dept_code as the Primary keys for the table

T_Employee_dtls and T_dept_master respectively. Then define the relationship between the two tables as explained above in section 5.3.7. Add data to the table and then define the following queries as explained above:

```
SELECT T_Employee_dtls.Emp_Name, T_Employee_dtls.Emp_Address
FROM T_Employee_dtls;
SELECT T_Employee_dtls.Emp_Name, T_Employee_dtls.Emp_Age,
T_Dept_Master.Dept_Name
FROM T_Dept_Master INNER JOIN T_Employee_dtls ON
T_Dept_Master.Dept_Code = T_Employee_dtls.Dept_Code;
```

Reports can be generated based on these queries or different queries can be written to generate various reports.

4.7 E-MAIL

Emailing is one of the most important utilities in today's world. It is used widely and utilized by almost each and every one of us not only as professionals but also in our personal lives. Emailing software like MS Outlook , Outlook Express etc, not only provides emailing facility but also used for scheduling appointments, maintaining contacts, setting task reminders, sending attachments with emails etc.

4.7.1 Introduction

Email Accounts can be from the Internet Service provider, employer, or webmail services like yahoo, Gmail etc. Outlook doesn't have its own accounts but uses these email accounts. Outlook uses POP configuration to access the web based servers for emails. Post Office Protocol (POP) is an application-layer Internet standard protocol used by local e-mail clients to retrieve e-mail from a remote server over a TCP/IP connection.

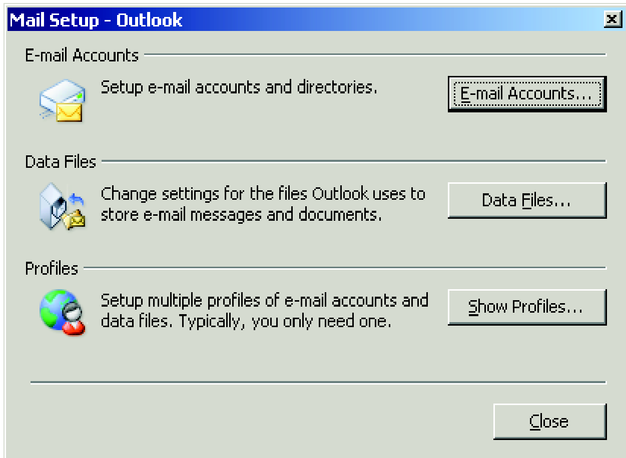
POP supports simple download-and-delete requirements for access to remote mailboxes. Although most POP clients have an option to leave mail on server after download, e-mail clients using POP generally connect, retrieve all messages, store them on the user's PC as new messages, delete them from the server, and then disconnect.

To send or receive email messages with Microsoft Outlook, these email account information has to be added. Email Accounts are contained in profiles. An email profile consists of email accounts, data files and settings as to where the emails are to be stored. There can be one profile or more than one profile depending on the requirement of the user. There can be one or more email accounts within a single outlook profile.

4.7.2 Creating Email Accounts and Profiles

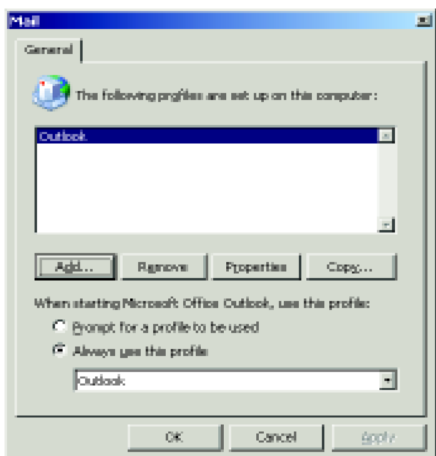
Before using Outlook, an Email profile and account has to be created.

1. In MS Windows, go to control panel and select Mail option.



2. Click Show Profiles

3. Click on Add and Type a name for the profile and then click OK



4. Add email account to use in your profile by following the directions on the screen.

4.7.3 Create a new Email Message

The most important feature of Email software is to send and receive emails. Once the email account has been configured, the same can be used to send and receive emails.

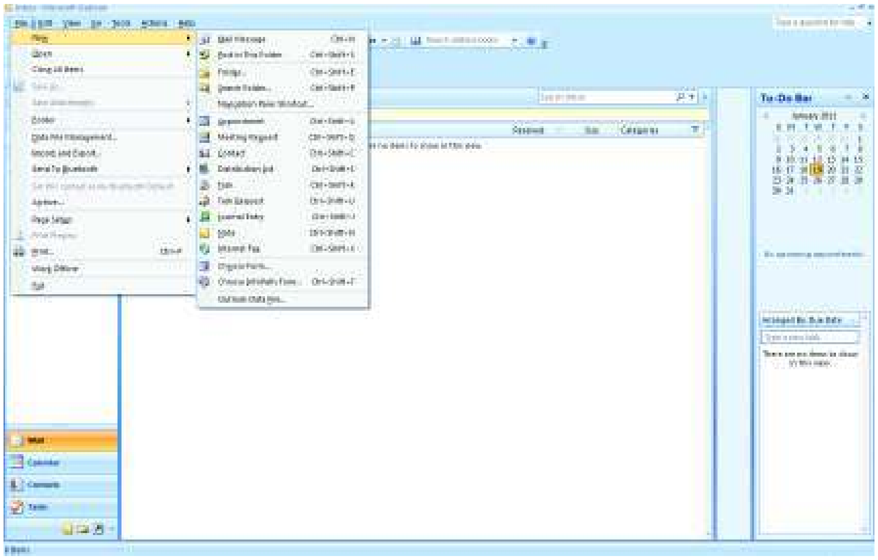
1. On the File menu, select, New ->Mail Message

2. In the Subject box, type the subject.

3. Add the recipient's name in the To, CC, Bcc box. Separate the names with semicolon.

4. To select the recipient's name from a address book, click the To or CC button

5. The level of importance for message can also be set which appears as an indicator by selecting High Importance or Low Importance in the Options group in the message tab. This is only an informational flag and does not expedite or affect actual message delivery.



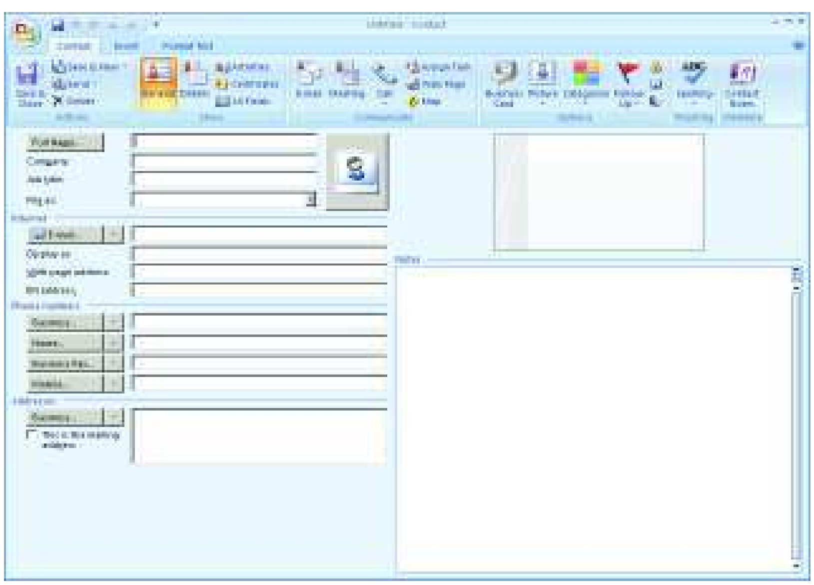
It is also possible to put file attachments along with the email message or include website links or links to documents present on a shared network.

4.7.4 Manage Contacts

New Contacts can be added to the Address Book. It is possible to make groups of Contacts and create distribution lists to ease selection of contacts when sending messages.

1. To add a new Contact, select File Menu, New->Contact

2. Fill in the Contact Details on the contact form that appears.



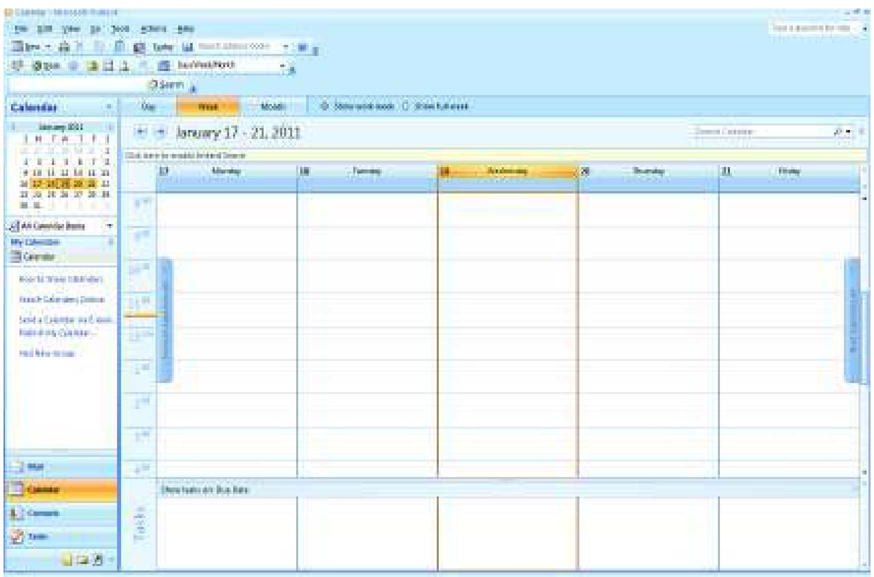
It is also possible to create a contact from an email message received. To do this:

1. Open or preview the email message that contains the Contact name that is to be added to the Contact List
2. Right Click the name of the sender and then Click Add to Contacts through the shortcut menu.

4.7.5 Calendar Management

Using the Calendar feature, one can schedule activities as appointments, meetings, events or tasks. This choice will depend on who is involved and how the entry should appear.

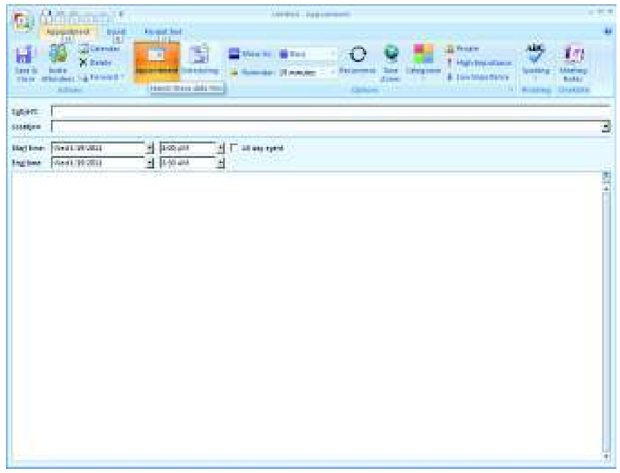
To view the activities of any day, click on Calendar in the Navigation Pane. And then choose the date for which the activities need to be shown.



It is possible to view the activities, day wise, month wise or week wise as required.

Right Click on the time and date the activity has to be set and choose the activity type whether it will be an appointment, meeting or event or task.

A meeting occurs only at a schedules time and includes other people and a meeting location. An Appointment is an activity where only one person is involved. A task is an entry that is seen in the calendar but doesn't need to be scheduled for a specific time. An event is an activity that lasts all day and do not occupy schedule time in the calendar but appear as banners on the top of the date specified for the event like conferences, business travels, holidays etc.



If any particular activity is occurring again and again, it can be set as a Recurring activity using the Recurrence feature. To set up a recurrence pattern, open the appointment and click Recurrence button in the Options group in the Appointment tab.

Check Your Progress 3

1. Is it possible to import data from Excel into Access?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………..

2. What is a signature of an email message?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………..

3. Is it possible to get a delivery receipt from the email recipient?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………..

4. Which of the following entry will be best entered as an event in your calendar?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………..

- A party that occurs from 4 pm to 6 pm
- Birthday
- A visit to the dentist

4.8 SUMMARY

In this unit, you have learnt about the concepts of Open Source Software. The history and philosophy behind this concept has briefly been described. The Licensing and copyright issues have been discussed. This is an upcoming concept in the industry and the idea of open source software is here to stay.

You have also been introduced to one of the most important roles of Project management which is essential for the success of any project. The different kinds of software which are used for project management of resources, time and scope of project have been discussed.

The essential tools of Office Applications which are used widely in the industry have been discussed. After reading this unit, you must have become familiar with the important features of these tools used for word processing, database management and emailing.

4.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. List of a few Open Source software applications are:
   - Web Browsing – Mozilla Firefox
   - Instant Messaging – Pidgin
   - Operating System – GNU/Linux
   - Email – Mozilla Thunderbird
   - Word Processing – OpenOffice.org
   - Graphics – Paint.NET
   - FTP - Filezilla
2. The advantages of using Open Source Software are:
   - The core software being free, using open source software reduces the total ownership cost for any organization
   - As new changes and evoluion is a constant process for Open Source Software, new upgraded versions of the software are available.
   - The organization doesn’t have to be dependent on any particular vendor as in case of commercial software for support and assistants. Help is easily available on the internet for troubleshooting
   - If necessary ,it is easier to customize and make modifications in the source code for Open Source Software

3. Revision control systems such as Concurrent Versions System (CVS) are used to track and centrally manage the source code files and changes made in the open source software.

4. The different industries where Open Source concept is being practiced are:

   Electronics: Open Source Hardware where the initial specifications are published and made available so that the hardware and the source code can redistributed without paying royalty or fees E.g.: SUN Microsystems's OpenSPARC T1 Multicore Processor.

   Beverages: Here the recipe is open source unlike other corporations producing beverages where the recipe is a closely guarded secret. E.g.: OpenCola

   Digital Content: Sites such as Wikipedia and Wiktionary where the content remains free to re-use and the source documents are readily made available to those interested and changes are accepted back into the system.
   Robotics: Here the blueprints, schematics and source code are released under the open source model.

Check Your Progress 2

1. A milestone is a reference point that marks a major event in a project and is used to monitor the project's progress. Any task with zero duration is automatically displayed as a milestone. You can also mark any other task of any duration as a milestone.

2. Tasks which cannot be delayed without affecting the project finish date are the critical tasks. A Critical must be completed on schedule for the project to finish on time. If a critical task is delayed, the project completion date might also be delayed. A series of critical tasks makes up a project's critical path.

3. Five pieces of task information help to analyze the project progress:
   - Duration
   - Work
   - Start date
   - Finish date
   - Cost

   Variations of each of these types of fields help you compare and evaluate your progress.

4. **Lead time:** An overlap between tasks that have a dependency.

   Lag time: A delay between tasks that have a dependency. For example, if you need a two-day delay between the finish of one task and the start of another, you can establish a finish-to-start dependency and specify a two-day lag time

Check Your Progress 3

1. Yes, it is possible to import data from Excel workbook into Access 2010. This can be done by copying data from an open worksheet and pasting into Access datasheet, or by importing a worksheet into a new or existing table, or linking the worksheet from an access database.

2. Signature is the way the senders name will appear at the end of the message. One can create a default signature to be added to all your outgoing messages, or you can insert a signature manually into outgoing messages on an individual basis.

3. A delivery receipt tells you that your e-mail message was delivered to the recipient's mailbox, but not whether the recipient has seen it or read it. A read receipt tells you that your message has been opened. In both cases, you receive a message notification when your message is delivered or read. The contents of the message notifications are then automatically recorded in the original message in your Sent Items folder.

4. Birthday’s happens all day long, and that's what an event is used to enter. The benefit of using an event is that you can show the event at the top of that day in the calendar. You'll remember, and the time in your calendar is still available for you to schedule.

4.10 FURTHER READINGS

Handbook of Research on Open Source Software: Technological, Economic, and Social Perspectives by Kirk St. Amant and Brian Still, Copyright 2007, Publisher Name: Igi Global, ISBN: 1591409993.

The Open Source Alternative: Understanding Risks and Leveraging Opportunities by Heather J. Meeker, Copyright 2008, Publisher Name: John Wiley & Sons, ISBN: 978-0-470-19495-9.

The Project Management Handbook – By Keith Posner and Mike Applegarth, Publisher: Management Pocket Books; 1st edition (April 1, 2000) | ISBN-10: 1579220045.

Microsoft Office Online Support, Website: http://office.microsoft.com/

UNIT 1 NETWORKING AND INTERNET

Structure

1.0 INTRODUCTION

As discussed in the previous blocks, the initial computers were designed as a machine that could perform monotonous arithmetic calculations with ease and lot of accuracy. The computing power of the computers kept on increasing every year while during the same time the technologies of message transfer were advancing. During the era of 1960-70, the computers were becoming faster, cheaper but more powerful and smaller in size. The number of application of the Computer also kept growing, however, the main breakthrough that enhanced the use of Computer was the advent of network of interconnected computers. The Computer Network made various computers to share information at a very high speed.

The Internet

In the year 1960, the Advanced Research Projects Agency (ARPA) of the U.S. Department of Defence and researchers from Universities and research centres developed a network called the ARPANET. The main goal of ARPANET was to share data and processing time over a set of computers connected through telephone lines and satellite links. This led to creation of one of most widely used network of networks – the Internet. The Internet could carry any digital signals such as text, graphics, sound, video and animation. Today, Internet has thousands of networks and millions of users, with the numbers expanding daily.

This unit introduces you to some of the basic fundamentals of Computer Networks and the Internet.

1.1 OBJECTIVES

After going through this unit, you should be able to:

- define the basic concepts of networking;
- discuss the basic models of networks;
- explain different types of networks;
- differentiate among different networking devices;
- explain the addresses used on the Internet; and
- explain the different advantages of networks.

1.2 WHAT IS A COMPUTER NETWORK?

A computer network can be simply defined as the interconnection of two or more independent computers. Applications of computer networks are found everywhere. They are used in our homes, schools, colleges, railway stations, offices and business. They help us to send an email, watch a live sports event at our computer, book rail/air tickets and do chatting with our friends. **But why do we need Networks?**

1.2.1 Advantages of using Computer Networks

We use a Computer Network for the following reasons:

a) **Resource sharing**: A network is needed because of the desire to share the sharable programs, data, and equipment available to anyone on the network without regard to the physical location of the resource and the user. You can also share processing load on various networked resources.

b) **High reliability**: A network may have alternative sources of supply (e.g., replicated files, multiple CPUs, etc.). In case of one resource failure, the others could be used and the system continues to operate at reduced performance. This is a very important property for military, banking, air traffic control, and many other applications.

c) **Cost-benefit advantage**: A network may consist of many powerful small computers, one per user. You can keep the data and applications on one or more shared and powerful file server machines. This is called the client-server model. Such model offers a much better price/performance ratio than old mainframes. At present many server services have been moved to Internet based resources set up by a third party and shared by many (called cloud). This allows users to use powerful server applications and data services without maintaining servers. Such system may bring down the cost further. However, such models still have several issues that are being debated.

d) **Scalability**: The ability to increase system performance gradually by adding more processors (incremental upgrade).

e) **Powerful communication medium**: Networks make cooperation among far-flung groups of people easy where it previously had been impossible.

In the long run, the use of networks to enhance human-to-human communication may prove more important than technical goals such as improved reliability.

One of the most popular application of network is the World Wide Web which is an application of Internet. Let us introduce you to internet in the next subsection.

1.2.2 The Internet

Internet is an interconnection of thousands of networks. It came into being in 1967. Internet has a very interesting history. You can trace the evolution of Internet at the website http://www.wikipedia.com . One of the major applications of the Internet is the World Wide Web (WWW). Internet and WWW (World Wide Web) are often used as synonyms of each other, which is technically not correct as the Web is a collection of interconnected documents and other resources. WWW was started in 1989 by Sir Tim Berners-Lee at Physics Laboratory (CERN).The WWW provides a "point-and-click" interface to text, images, sound and movies that has proven to be very easy-to-use. This feature was made available due to Hypertext that provides a "point and click" link to other documents on the WWW. To access the information on internet you require a software called web browser. Some of the popular browser software are - Internet Explorer, Mozilla Firefox, Google Chrome, Apple Safari etc.

The Internet is a collection of various services, tools, applications and resources. Some of the popular services on the internet are – browsing, searching, e-mail, chat, e-learning and lots more. Today, Internet has brought the world on your desktop. Right from news across the world, wealth of knowledge to shopping, purchasing the movie, railway or air tickets everything is at your mouse click. It has also become the most excellent business tool of modern scenario. Several activities can be performed if you have access to the Internet; like you can use it for learning or teaching, you can be part of an online distributed project, you can use it for publicity and advertisement, you can refer Internet for career or job consultation and so on. Unit 2 and Unit 3 discuss some of the services tools, applications and resources available on the Internet in more details.

Before we discuss more about Internet, first let us describe the process of data communication system that forms the core of computer network.

1.2.3 Data Communication System

In the connected world, a computer does not work as a standalone system but as part of a communication system. Besides computers, most of the large/complex systems like the navigation systems for ships or aircraft or rockets, the satellites and many other systems rely on the communication system. In the most fundamental sense, communication involves implicitly the transmission of data or information (the information is derived from data) from one point to another through a succession of processes. Data is transmitted over any communications medium as either digital or analog form. The most important factors affecting the transfer of a signal over a medium are noise and attenuation. Noise is the external disturbances whereas attenuation is defined as degeneration of the signal. A simple communication system can be represented by the block diagram shown in Figure 1.1.

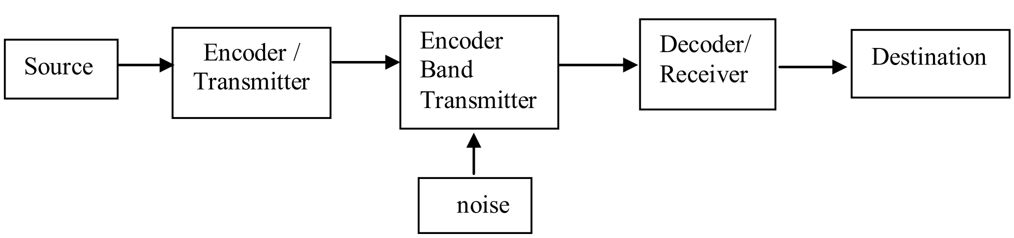


Figure 1.1 : A Simple Communication System
(Source: PhD thesis of Professor Manohar Lal)

The communication system essentially consists of five parts:

Source: Source produces a message or sequence of messages to be communicated to the receiver. The source output may be in many different forms such as a waveform, a sequence of binary digits, and a set of output from sensors in a space probe, or many other similar forms.

An Encoder: Encoder represents any processing of the source messages/ signals prior to transmission. The processing might include, for example, any combination of modulation (discussed in later section), data reduction and insertion of redundancy to combat the channel noise.

The Channel: Channel is the medium for transmitting signals from transmitter to receiver. It may be a telephone line, a high frequency radio link, a space communication link or a storage medium. A channel is usually subject to various types of noise disturbances, which on telephone line, for example, might take the form of a time-varying frequency response, crosstalk from other lines, thermal noise, and impulsive switching noise. A channel subject to noise is called noisy channel. An error-correcting code corrects errors due to noise.

The Decoder: A decoder represents the processing of a channel output received from the channel to produce an accepted replica of the input at the destination.

The Destination: Destination is the receiver. It may be the person or object for whom the message is intended.

An example of communication system: Suppose a student computer is connected through a modem to a telephone line. If she/he wants to send a file to his/her friend over a communication system, his/her computer is the source, the modem converts his digital file into analog signal that can be transmitted over the telephone line to the receiver's modem which at its end converts the signal back to the digital signal. The digital data then is accepted by the destination computer.

Some standard data transmission concepts are:

- The data in a communication system may be transmitted as analog or digital data over a single path serially or number of parallel paths.
- The data can be sent asynchronously when both the source and receiver are not following timing or synchronously when both sender and receiver agree on the sequence of arrival of data.
- Modes of Data Transmission: There are 3 modes of data communication:
  - Simplex
  - Half duplex
  - Full duplex

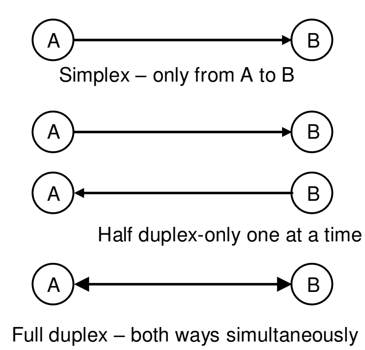


Figure 1.2 : Modes of transmission

Simplex Mode : In simplex mode of data communication, data flow is uni-directional. This means that data travels only in one direction i.e., from a sender to a receiver. The receiver cannot respond back to the sender. An example of simplex mode is keyboard, or a television station telecasting a program.

Half Duplex Mode: Half duplex communications occurs when data flows in both directions; although in only one direction at a time. An example of a half-duplex system is a Walkie-Talkie system used a two-way radio normally by Police. You may use the word "Over" to indicate the end of transmission, and ensure that only one party transmits at a time. In such systems sender and receiver both transmit on the same frequency.

Full Duplex Mode: In full duplex mode of data transmission, data is transmitted in both the direction simultaneously. This means that both the devices in a network can send and receive the data at the same time. It is like a two lane road with traffic moving in both directions at the same time. In this mode signals going in either direction share the capacity. Half of the bandwidth is used for sending data in one direction, while the other half is used for receiving data from other direction. An example is a telephone conversation.

- **Speed of transmission**: Speed of data transmission plays a major role in data communication. How fast data can be transmitted from place to place is sometimes called bandwidth. **Bandwidth** is a data transmission rate that tells the maximum amount of information (bits/second) that can be transmitted along a channel. It is measured in kilobits, kbps, 1,000 of bits per second, or megabits (Mbps), millions of bits per second. Actual transfers are considerably lower because of software and protocol overheads.
- **Some Sample Transmission Speed:** Dial-up modems are generally capable of a maximum bit rate of 56 kb/s (kilobits per second) and require the full use of a telephone line—whereas broadband technologies support at least double this bandwidth. Broadband usually has a high rate of data transmission. In general, any connection to the customer of 256 kb/s (0.256 Mb/s) or greater is more concisely considered broadband Internet.
- **Packet, and Circuit Switching:** This terminology has started from telephone network, where switching offices were places having switches that were used to create connection from one source to destination. Circuit switching involves creating a switched path for entire communication, for example, when you make a telephone call the connection is established by switching and is available for the whole communication. Whereas in packet switching a message is broken in small packet which are handed over from a source to destination through many small steps.

A Computer Network although works on the basic communication system, but is much more than that. It is characterized by a number of tasks that are mostly implemented with the help of networking software that takes care of addressing, routing and reliable delivery of messages. These software are implemented as a number of protocols which are discussed later in the Unit.

What should you know about a computer network?

A computer network requires that the computers must somehow be connected with each other. Thus, you require a physical connection between two or more computers. This connection may be through physical wired media or wireless medium. In addition, it will require certain devices that will enable the connection. These concepts are explained in brief in section 1.3 and 1.7

A related question here is: Are the computer in networks connected arbitrarily or there exists some architecture and structure? Section 1.4 and 1.5 provide details of some simple topological structures and network architectures for networks. It also details the classification of networks.

Another related point is how the data will be transmitted over these connections. We have provided some information on these points in section 1.2.3. For more details on these topics you should refer to the further readings.

Finally, one of the major issues is how two computers will be able to exchange information over the network. This will require discussion on the term protocols and networking software. Section 1.6 and 1.8 covers some basic concepts of these. For more details, you may refer to further readings.

1.3 DATA TRANSMISSION CHANNELS

The data transmission has to be done over a transmission channel or media. It can be classified as:

a) Guided Channels

b) Unguided Channels

1.3.1 Guided Media

Guided media provide a physical connection between two devices. A signal traveling through guided media is directed and contained within the physical limits of the medium. There are several different Guided media, however we define only the most popular as given below:

a) Twisted pair cable

b) Optic Fiber cable

a) Twisted Pair Cable

Twisted pair cable is still the most common transmission media. A twisted pair cable consists of two conductors which are normally made of copper. Each conductor has its own plastic insulation typically 1 mm thick. These cables are twisted together. The wires are twisted in a helical form, similar to a DNA molecule. Twisting is done to reduce crosstalk. Twisted Pairs (Figure 1.3) are very effective for relatively short distances (a few hundred feet), but can be used for up to a few kilometers. A twisted pair has a bandwidth to distance ratio of about 1 MHz per kilometer. The performance of the twisted pair can be substantially improved by adding a metallic shield around the wires. Shielded wires are much more resistant to thermal noise and crosstalk effects. Twisted pairs are used for long distance connections e.g. telephone lines which are usually organized as larger cable containing numerous twisted pairs.

Twisted pair cabling comes in several varieties, two of which are very important: Category 3 and Category 5. Category 5 has more twists per centimeter resulting in less crosstalk and a better quality signal.

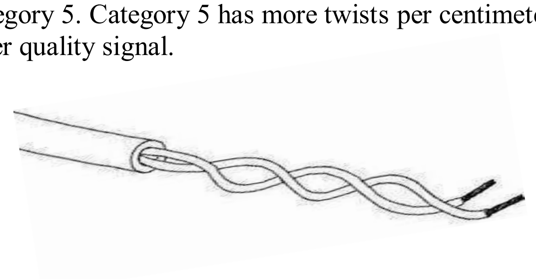


Figure 1.3: Twisted Pair Cable

b) Optical Fiber

An optical fiber consists of two concentric cylinders: an inner core surrounded by a cladding. Both the core and the cladding are made of transparent plastic or glass material as shown in the Figure 1.4, which transmit signals in the form of light. Optical fiber use reflections to guide light through a channel. The density of the core and cladding must differ sufficiently to reflect the beam of light instead of refracting.

The core is used for guiding a light beam, whereas the cladding (which has a different refractive index) acts as a reflector to prevent the light signal instead of electrons, it does not suffer from the various noise problems associated with electromagnetic signals. The signal is usually generated by a laser or Light Emitting Diode (LED). Optical fibers can provide bandwidth to distance ratios in order of 100s of MHz per kilometer. Like other cables, hundreds of optical fibers are usually housed within one cable.

They are being increasingly used as telecommunication carriers for long distance digital trunk lines. Current trends promise that they will replace twisted pair residential loops in the near future.

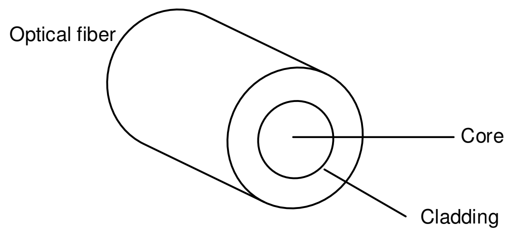


Figure 1.4 : Optical Fiber Cable

Advantages

1) Higher Band width – it can support higher band width and hence can transfer data at a higher rate.
2) Less signal attenuation – its transmission distance is greater than the twisted pair and it can run for 50Kms without regeneration.
3) Immunity to electromagnetic interface
4) These cables are much lighter than the copper cables
5) These cables are more immune to tapping than the copper cables.

Disadvantages

1) Installation or maintenance – it needs expertise which is not available everywhere.
2) Unidirectional – Propagation of light is unidirectional and we need two fibers for bidirectional communication.
3) Costly – the cables and interfaces used are relatively expensive.

1.3.2 Unguided Media

Unguided media is used for transmitting the signal without any physical media. It transports electromagnetic waves and is often called wireless communication. Signals are broadcast through air and received by all who have devices to receive them. It can be categorized as follows:

a) Radio waves
b) Micro waves
c) Infrared

a) Radio Waves

Electromagnetic waves ranging in frequencies between 3 Kilo-Hertz and 1 Giga-Hertz are normally called radio waves. Radio waves are easy to generate and can travel long distances and can penetrate buildings easily, therefore widely used for communication. These are omni-directional which implies that these travel in all directions from the source, so the transmitter and receiver do not have to be carefully aligned physically.

Radio signals have been used for a long time to transmit analog information. They are particularly attractive for long distance communication over difficult terrain or across the oceans, where the cost of installing cables can be too prohibitive.

An increasingly-popular form of radio is cellular radio, which is currently being used by carriers for providing mobile telephone networks. These operate in the VHF (Very High Frequency) band and subdivide their coverage area into conceptual cells, where each cell represents a limited area which is served by a low-power transmitter and receiver station. As the mobile user moves from one cell area to another, its communication is handed over from one station to another. Radio waves transmitted by one antenna are susceptible to interference by another antenna due to its Omni-directional property. Radio waves can be received both inside and outside the building.

Radio waves are very useful in multicasting and hence used in AM and FM radios, cordless phones and paging. You may be wondering about the term multicasting. If the communication is between single source and destination then it is called unicast; on the other hand, if one source is transmitting signal and any destination that is in the range may be able to reach it then it is called broadcast. Multicast is when a source transmits a signal for some specific group of destinations which may be more than one.

Bluetooth: Bluetooth is a very popular application of short wave length radio transmission in the frequency band of 2400 to 2480 MHz. It is a proprietary wireless technology standard used for exchanging data over short distances in mobile phones and other related devices. It allows wireless devices to be connected to wireless host which may be a computer over short distances. You may have it for transferring data between a mobile phone and a computer provided both have Bluetooth technology.

b) Microwaves

Electromagnetic waves ranging from 1 to 300 Gigahertz are called microwaves. Microwaves are unidirectional that is the sending and receiving antennas need to be aligned.

Microwave is by far the most widely used form of radio transmission. It operates in the GHz range with data rates in order of hundreds of Mbps per channel. Telecommunication carriers and TV stations are the primary users of microwave transmission.

An important form of microwave system is a satellite system, which is essentially a microwave system plus a large repeater in the sky as shown in Figure 1.5. The signals transmitted by earth stations are received, amplified, and retransmitted to other earth stations by the satellite. Like other microwave systems, the bandwidth is subdivided into channels of 10s of MHz each, providing data rates in order of 100s of mbps. Because of their high bandwidths, satellites are capable of supporting an enormous number and variety of channels, including TV, telephone, and data. The satellite itself, however, is a major investment and typically has a limited lifetime (at most a few decades).

Unidirectional property of microwave helps in avoiding interference by a pair of aligned antenna to another. High frequency micro waves cannot be received inside the building.

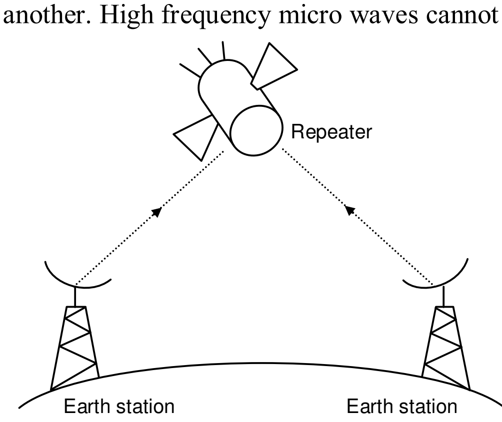


Figure 1.5: Microwaves

c) Infrared

Infrared signals range between 300 Giga-Hertz to 400 Tera-Hertz. These can be used for short range communication. High range infrared rays cannot be used for long range communication as it cannot penetrate walls. This also helps in avoiding interference.

Infrared signals are generated and received using optical transceivers. Infrared systems represent a cheap alternative to most other methods, because there is no cabling involved and the necessary equipment is relatively cheap. Data rates similar to those of twisted pairs are easily possible. However, applications are limited because of distance limitations (of about one kilometer). One recent use of infra-red has been for interfacing hand-held and portable computing devices to Local Area Networks as shown in Figure 1.6.

It cannot be used outside building as rays of sun contain infrared which leads to interference in communication. Infrared having wide bandwidth can be used to transmit digital data with a very high data rate. Infrared signals can be used for communication between keyboards, mouse and printers.

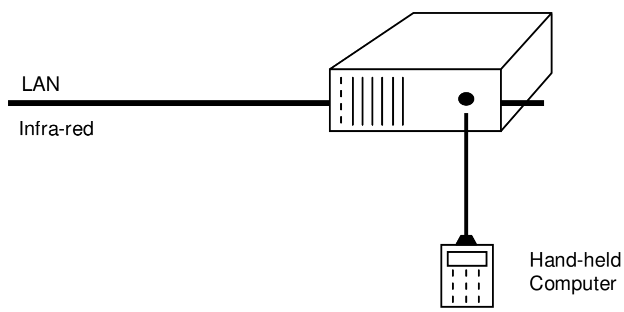


Figure 1.6: Infra Red

Check Your Progress 1

1. What is the need of computer networks?

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2. In the context of communication system, what does a MODEM do?

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3. How can you improve the performance of twisted pair cables?

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4. Describe the principal of optical fiber and its advantages and disadvantages?

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1.4 NETWORK TOPOLOGIES

Network Topology is the study of the arrangement or mapping of the elements (links, nodes, etc.) of a network interconnection between the nodes. It also determines the strategy for physically expanding the network, in future. Topologies can be physical or logical. Physical Topology means the physical design of a network including the devices, location and cable installation. Logical Topology refers to the fact that how data actually transfers in a network as opposed to its design.

There are different types of the topologies like bus, ring, tree, mesh etc. However, we will discuss only the first three to introduce you to the concepts.

1.4.1 Bus Topology

Bus topology is a single common communication to which all the computers are connected. It has a single length of cable with a terminator at each end as shown in the Figure 1.7. It is a passive topology which means only one computer at a time can send a message. Hence, the number of computers attached to a bus network can significantly affect the speed of the network. A computer must wait until the bus is free before it can transmit. Each node is connected to others nodes. The network operating system keeps track of a unique address of each node and manages the flow of data between machines.

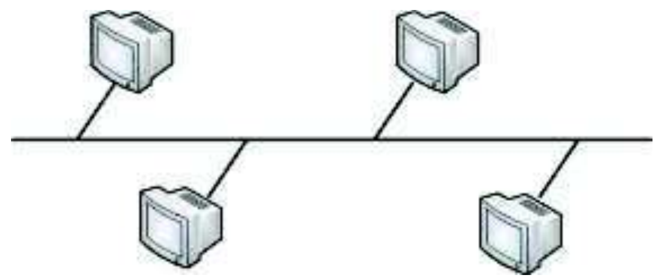

Figure 1.7: Bus topology

The bus topology is the simplest and most widely used with local area network design. The computers on the bus keep on listening. When they hear data that belongs to them, they receive. When one device on the network wants to send a broadcast message to another device on the network, it first makes sure no one else on the bus is transmitting, and then it sends information out on the media. All other devices on the network see it, but only the intended recipient accepts and processes it. This is accomplished by using data frames which contain source and destination addresses.

Advantages

a) It is simple, reliable, and easy to be used in a small sized local area network.

b) It requires least amount of cable to connect computers together and is therefore less expensive than other cabling arrangements.

c) It is easy to implement and extend using connectors.

d) If one computer on the bus fails, it does not affect the rest of the traffic on the bus.

Disadvantages

a) In this topology, no two computers can transmit data at the same time.

b) It does not cope well with heavy load which can slow down a bus considerably.

c) Performance degrades as additional computers are added.

d) Terminators are required at both ends of the cable.

1.4.2 Ring Topology

Ring topology is also known as circular topology. This layout is similar to the linear bus, except that the nodes are connected in a circle as shown in Figure 8. In this topology, each node is connected to two and only two neighboring nodes. The ring does not have an end. It is made of short segments that connect one PC to the next PC and so on Data is accepted from one of the neighboring nodes and is transmitted onwards to another node .Therefore data travels in only direction from node to node around the rings. Since, each computer retransmits what it receives, a ring is an active network and is not subject to the signal loss problems. There is no termination because there is no end to the ring.

This type of topology can be found in peer-to-peer networks, in which each machine manages both information processing and the distribution of data files. Examples of such topology:

1) IBM Token Ring
2) Fiber Distributed Data Interface (FDDI)

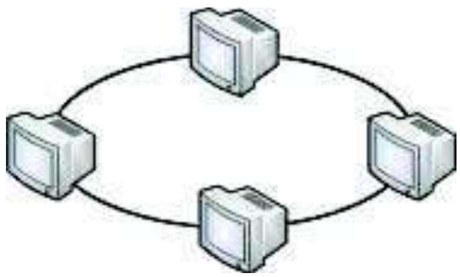

Figure 1.8: Ring topology

Advantages

a) It is an orderly network where every device has access to the token (control signal) and the opportunity to transmit – because every computer is given equal access to the token, no computer can monopolize the network.
b) It performs better than a star topology under heavy network load.
c) It can create much larger network using Token Ring.
d) It does not require network server to manage the connectivity between the computers.

Disadvantages

a) Network adapter cards and Multi Access Units used in this topology are much more expensive than Ethernet cards and hubs used in bus topology.
b) It is much slower than an Ethernet network under normal load.
c) It is difficult to troubleshoot.
d) One malfunctioning node or bad port in the Multi Access Units can create problems for the entire network

1.4.3 Star Topology

In star topology, each computer on a network communicates with a central hub (also called as a concentrator) that re-sends the message either to all the computers or only to the destination computer. A hub expands one network connection into many. For example, a four-port hub connects up to four machines. A single hub is sufficient for a small network; however large networks require multiple hubs. But, it increases hardware and cabling costs.

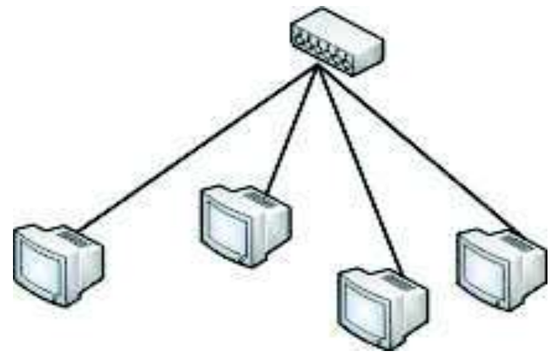

Figure 1.9: Star Topology

Advantages

a) It is more reliable (if one connection fails, it does not affect others) –The centre of a star network is a good place to diagnose network faults and if one computer fails whole network is not disturbed. Hub detects the fault and isolates the faulty computer.

b) It is easy to replace, install or remove hosts or other devices, problem can be easily detected-It is easier to modify or add a new computer without disturbing the rest of the network by simply running a new line from the computer to the central location and plugging it to the hub.

c) Use of multiple cables types in a same network with a hub.

d) It has good performance

Disadvantages

a) It is expensive to install as it requires more cable, it costs more to cable a star network because all network cables must be pulled to one central point, requiring more cable length than other networking topologies.

b) Central node dependency, if central hub fails, the whole network fails to operate.

c) Many star networks require a device at the central point to rebroadcast or switch the network traffic.

1.5 NETWORK CLASSIFICATION

There are mainly three types of networks:

1) LAN (Local Area Network)

2) MAN (Metropolitan Area Network)

3) WAN (Wide Area Network)

1.5.1 Local Area Network (LAN)

LAN (Figure 1.10) is a group of computers located in the same room, on the same floor or in the same building that are connected to form a single network as to share resources such as disk drives, printers, data, CPU, fax/modem, applications etc.

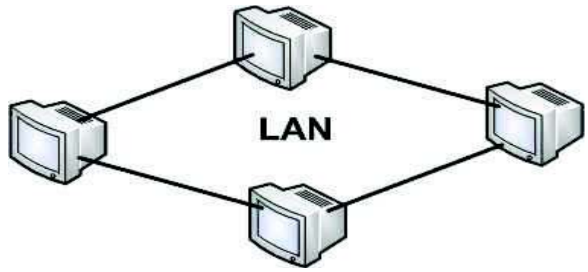

Figure 1.10: LAN

LAN is generally limited to specific geographical area less than 2 Km., supporting high speed networks. A wide variety of LANs have been built and installed, but a few types have more recently become dominant. The most widely used LAN system is the Ethernet system based on the bus topology.

Intermediate nodes (i.e., repeaters, bridges and switches discussed in section 1.7) allow to be connected together to from larger LANs. A LAN may also be connected to another LAN or to WANs and MANs using a “Router” device.

In general, there are five components of a LAN:

1) Network devices such as Workstations, printers, file servers which are normally accessed by all other computers.
2) Network Communication Devices i.e., devices such as hubs, routers, switches etc. that are used for network connectivity.
3) Network Interface Cards (NICs) for each network device required to access the network. It is the interface between the machine and the physical network.
4) Cable as a physical transmission medium. However, present day LAN may not require the physical transmission media. It may be a Wireless LAN. (Please refer to further readings for more details on wireless LANs)
5) Network Operating System –software applications required to control the use of network operation and administration.

Characteristics of LAN

- It connects computers in a single building, block or campus, i.e. they work in a restricted geographical area.
- LANs are private networks, not subject to tariffs or other regulatory controls. For the Wireless LANs there are additional regulations in several countries.
- LANs operate at relatively high speed when compared to the typical WAN (.2 to 100 MB /sec).
- There are different types of Media Access Control methods in a LAN, the prominent ones are Bus based Ethernet, Token ring.

Advantages of LAN

- It allows sharing of expensive resources such as Laser printers, software and mass storage devices among a number of computers.
- LAN allows for high-speed exchange of essential information.
- It contributes to increased productivity. A LAN installation should be studied closely in the context of its proposed contribution to the long range interest of the organization.

Disadvantage of LAN

Some type of security system must be implemented if it is important to protect confidential data. The security may be further low if it is a wireless LAN.

1.5.2 Metropolitan Area Network (MAN)

Metropolitan area networks, or MANs, are large computer network that spans a metropolitan area or campus. Its geographic scope falls between a WAN and LAN. They typically use wireless infrastructure or Optical fiber connections to link their sites.

A MAN is optimized for a larger geographical area than a LAN, ranging from several blocks of buildings to entire cities. MANs can also depend on communications channels of moderate-to-high data rates. A MAN might be owned and operated by a single organization, but it usually will be used by many individuals and organizations. MANs might also be owned and operated as public utilities or privately owned. They will often provide means for internetworking of local networks. Metropolitan area networks can span up to 50km, devices used are modem and wire/cable.

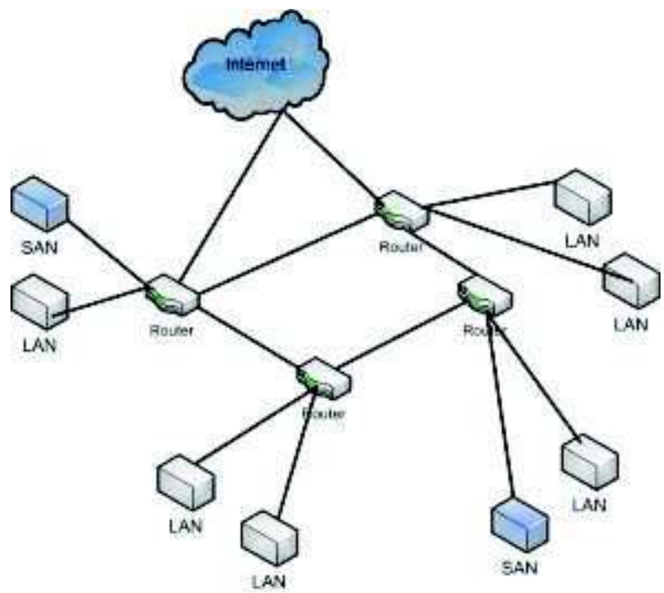

Figure 1.11: MAN

MANs provide Internet connectivity for LANs in a metropolitan region, and connect them to wider area networks like the Internet.

1) The network size falls intermediate between LAN and WAN. A MAN typically covers an area of between 5 and 50 km diameter. Many MANs cover an area the size of a city, although in some cases MANs may be as small as a group of buildings or as large as the North of Scotland.
2) A MAN often acts as a high speed network to allow sharing of regional resources. It is also frequently used to provide a shared connection to other networks using a link to a WAN.

Characteristics of MAN

1) It generally covers towns and cities (50 kms)
2) It is developed in 1980s.

3) Communication medium used for MAN are optical fiber cables, however it may use other media too.

4) Data rates adequate for distributed computing applications.

1.5.3 Wide Area Network (WAN)

Wide Area Network (Figure 1.12) is a network system connecting cities, countries or continents, a network that uses routers and public communications links. The largest and most well-known example of a WAN is the Internet.

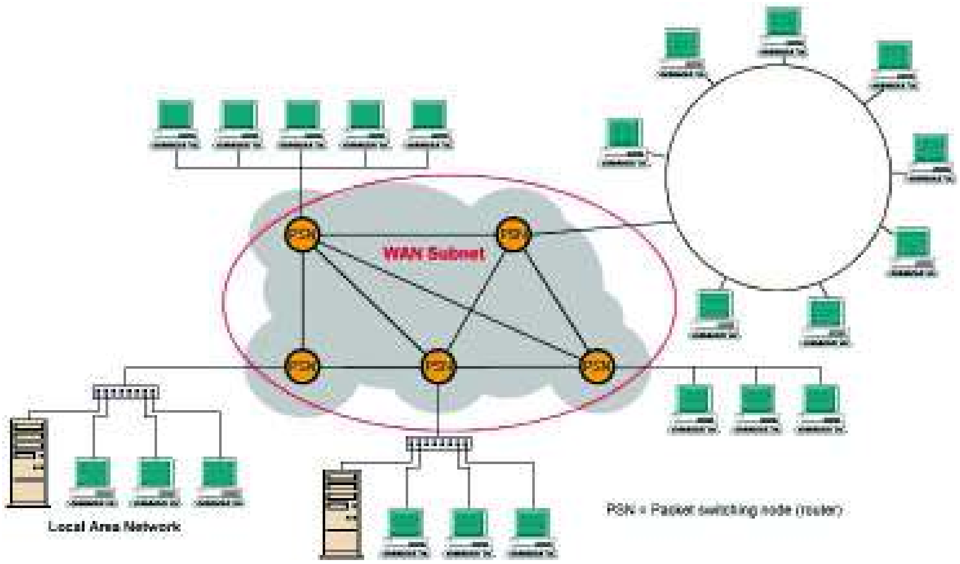

Figure 1.12: WAN

WANs are used to connect LANs and other types of networks together, so that users and computers in one location can communicate with users and computers in other locations. Many WANs are built for one particular organization and are private. Others, built by Internet service providers, provide connections from an organization's LAN to the Internet. WANs are often built using leased lines. At each end of the leased line, a router connects to the LAN on one side and a hub within the WAN on the other. Leased lines can be very expensive. Instead of using leased lines, WANs can also be built around public network or Internet.

Virtual Private Network (VPN): Consider a situation when you have a secure office LAN which contains some important update of your company products. You are out of the country for a business trip and want to see that information. What your company needs is a VPN. A VPN may be defined as the secure way of connecting to your private LAN (such as your company network) from a remote location using the Internet or any other unsecure network. In such a case, the data that is to be transmitted over the unsecure network is encrypted. In addition, VPNs have a proper mechanism for authenticating the user.

Characteristics of WAN

1) It generally covers large distances (states, countries, continents).

2) Communication medium used are satellite, public telephone networks which are connected by routers.

3) Routers forward packets from one to another on a route from the sender to the receiver.

Table 1.1 compares the three technologies :

Table 1.1: Difference between LAN, WAN and MAN

Characteristics	**LAN**	**MAN**	**WAN**
Full form	It stands for local area network.	It stands for metropolitan area network.	It stands for wide area network.
Cost	Less Costly	More Costly	Costliest
Speed (in general)(the speed is moving beyond the limit)	Upto 10-1 Gbps	5- 10 Mbps and beyond	256 Kbps to 2 Mbps and beyond
Range	1 Km	Upto 50 Kms	Whole earth (20.000 Km in each direction)
Topology	Bus and Ring	Distributed Queue Dual Bus [DQDB]	ATM, Frame Relay, Sonet
Location of computers connected in the system	Computers are located within the same building.	Computers are located in the city and are connected using modems or telephone lines so that they can be easily connected with each other.	Computers are distributed all over the country or the continent. The connection is made via satellite communication link or via internet.
Examples	LAN's example can be an office whose different departments such as personnel, accounting etc. are located in the same building and connected via bus topology using Ethernet cards.	Example of MAN is bank whose different branches in a city like Delhi are connected using public telephone exchange and the system are connected with each other using LAN within each branch and different branches are connected using modem and bridges.	WAN's example is the connection of various branches of MNC such as Proctor & Gamble. These branches are linked using microwave satellite communication system or internet connection. Each branch has its own LAN circuit. But the different LAN's in various branches are communicating with head office using WAN link.

1.6 REFERENCE MODELS

One of the most difficult software to be developed is the networking software. Reference models were designed to standardize the layer of functions and activities. The following section describes one of the most important reference models used in Computer Networks.

OSI (Open System Interconnection) Model

The OSI model is an abstract description for layered communications and computer network protocol design open system means that it can communicate with any other system that follows the specified standards, formats and semantics. **Protocols** give the rules that specify how the different parties may communicate.

In its most basic form, it divides network architecture into seven layers which from top to bottom are the Application, Presentation, Session, Transport, Network, Data-Link, and Physical Layers. It is therefore often referred to as the **OSI Seven Layer Model (Figure 1.13)**.

A layer is a collection of conceptually similar functions that provide services to the layer above it and receives service from the layer below it. On each layer an instance provides services to the instances at the layer above and requests service from the layer below. For example, a layer that provides error-free communications across a network provides the path needed by applications above it, while it calls the next lower layer to send and receive packets that make up the contents of the path. Any two instances at one layer are connected by a horizontal protocol connection on that layer.

The following are the layers of OSI model:

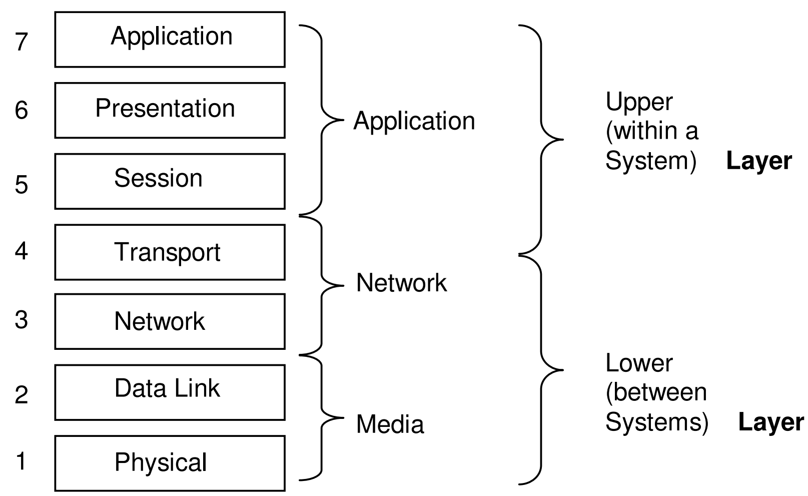

Figure 1.13: OSI Model

In transmission side data flows from layer 7 to layer 1, then to cabling or suitable medium. When data reaches the reception side, it flows from layer 1 to layer 7.

Application Layer: This layer is the layer for user interaction. We must have application software for dealing with the data.

Presentation Layer: It converts the data into suitable format. It does tasks like compression, decompression, encryption and decryption.

Session Layer: This layer manages connections between different application layers.

Transport Layer: This layer converts data into segments and re-assembles the data stream. TCP and UDP are the protocols used in this layer. In this layer, data is converted into so called segments.

Network Layer: This layer translates logical address into physical address. This layer also fixes the route for data path. Router works in this layer. In this layer data is called a packet.

Data-Link Layer: This layer provides physical identification of a device using Media Access Control Address. It adds source and destination address to packets and convert them into frames. This is the layer that provides error free transmission.

Physical Layer: This layer provides the functional requirements for activating a physical link. In this layer, data is carried from one device to another.

Now, we can better understand the OSI layer with an example. Consider that you have to send a word document to a different network or through internet. The following are the process that will take place:

1. In the APPLICATION LAYER, the user can edit the file by using application software like a word processor.

2. In the PRESENTATION LAYER, user can compress the word file by using WINRAR or WINZIP and convert the data into different format for example.zip or .rar. You can also convert the word document into different formats.

3. In the SESSION LAYER, the particular file has to be integrated with browser for attaching it to email or likewise clients.

4. In the TRANSPORT LAYER, data is converted to segments. Source IP and destination IP are added to each packet. Frame checks and parity bits are also added in this layer.

5. In the NETWORK LAYER, the data is handed over to a router. The router calculates the best path for data transmission

6. In the DATA-LINK LAYER, transmission errors are handled and also flow of data is regulated so that receivers are not swamped by fast senders.

7. In the PHYSICAL LAYER, frames are transmitted as bits through media such as Optical fibre.

1.7 NETWORKING DEVICES

For creating a network, you need certain basic devices. This section details some of these basic devices which are used to form a network. Network Interface cards, Hubs, bridges, repeaters, and routers are the devices that let you connect one or more computers to other computers, networked devices, or to other networks. Each has two or more connectors called ports (this term presently is used in the context of hardware) into which you plug in the cables to make the connection. Let us discuss each of these communication devices in detail.

1.7.1 Network Interface Cards

The network interface card (NIC) provides the physical connection between the network and the computer. Most NICs are internal, with the card fitting into an expansion slot inside the computer. Network interface cards are a major factor in determining the speed and performance of a network. It is a good idea to use the fastest network card available for fast transfer of data. The most common network interface connection today is Ethernet cards. **Ethernet cards** Ethernet cards that contain connections for twisted pair cables have a RJ-45 connection. The Ethernet card is sometimes also called as network adapter card. Each for the Ethernet card is identified by a unique number called the Media Access Control (MAC) address. Your mobile phone on which you use internet, generally has a MAC address.

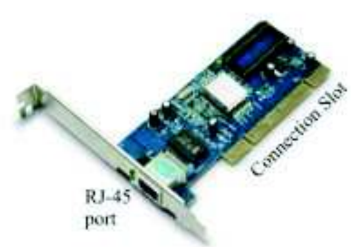

Figure 1.14: Network Interface Card

1.7.2 Modem

Modem is an acronym for modulator demodulator. The meaning of the word modulator is to change and the meaning of the word demodulator is to restore to an original condition. A modem is a communication device that converts (i.e., modulates) binary signal into analog signals for transmission over telephone lines and converts (i.e., demodulates) these analog signals back into binary form at the receiving end.

Figure 1.15 shows the data transmission through modem

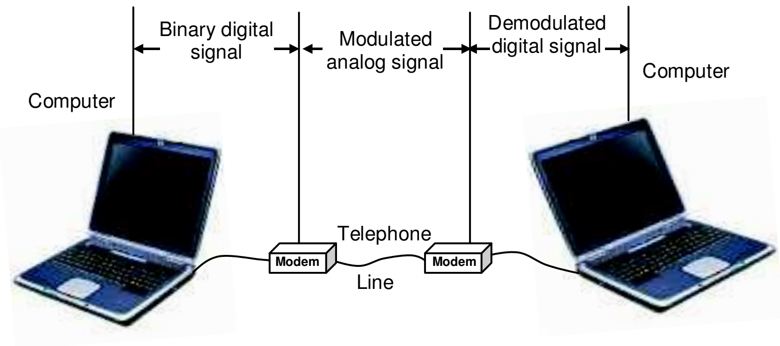

Figure 1.15: Data transmission through a modem

You can use a modem to send data and files to other computer users using standard telephone lines. You can transfer data, exchange electronic files, and even carry on a typed conversation in real time.

Modems are of two types: Internal and External. Internal modems are hardware cards and External modems, are kept outside of your computer, connected either by a USB or Serial Port. Internal modems are good for general usage, as they take up less desk space, and do not require a power supply, and for most purposes, internal modems work fine. External modems tend to be slightly more expensive than internal modems. Many experts consider them superior because they contain lights which indicate how the modem is functioning. In addition, they can easily be moved from one computer to another. However, they do use up one COM port.

External modem

Internal modem

Figure 1.16: Modems

1.7.3 Repeaters

When a signal travels a network cable (or any other medium of transmission), they lose strength, degrade and become distorted in a process that is called attenuation A repeater is a device that electrically amplifies the signal it receives and re-broadcasts it (Figure 1.17). They are used when the total length of your network cable exceeds the standards set for the type of cable being used.

A good example of the use of repeaters would be in a local area network using a star topology with unshielded twisted-pair cabling. If a cable is long enough, the attenuation will finally make a signal unrecognizable by the receiver.

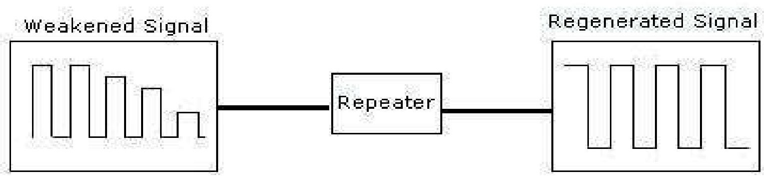

Figure 1.17: Repeater

1.7.4 Bridge

Like a repeater, a bridge can join several LANs. However, a bridge can also divide a network to isolate traffic problems. For example, if the volume of traffic from one or two computers or a single department is flooding the network with data and slowing down entire operation, a bridge can isolate those computers or that department. A bridge (Figure 1.18) is used to connect two segment i.e., segment 1 (LAN 1) and segment 2 (LAN 2). Each segment can have several computer attached to it.

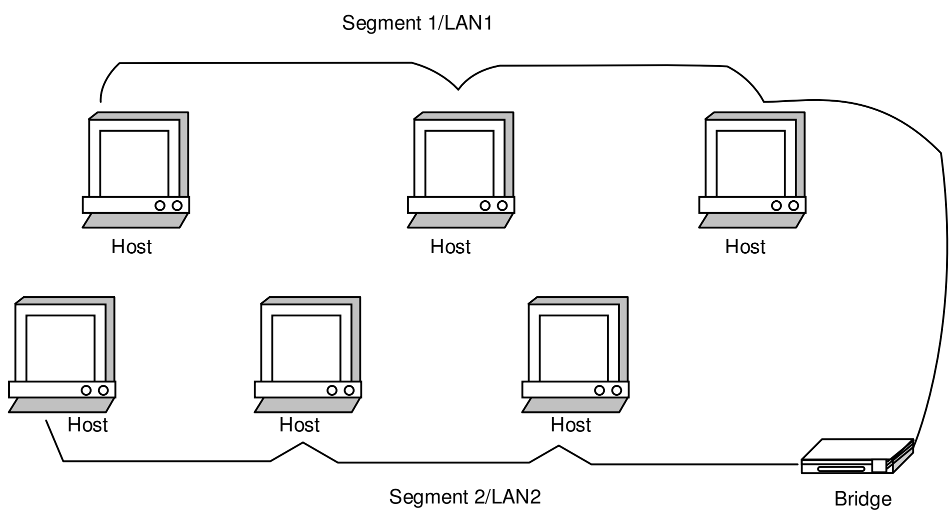

Figure 1.18: Bridge

1.7.5 Hub

A hub sends any data packet coming from one port to all other ports. It is up to the receiving computer to decide if the packet is for it. Typically used to connect segments of a local area network (LAN), a hub contains multiple ports. You can imagine packets going through a hub as messages going into a mailing list. The mail is sent out to everyone and it is up to the receiving party to decide if it is of interest. The biggest problem with hubs is their simplicity. Since every packet is sent out to every computer on the network, there is a lot of wasted transmission. This means that the network can easily become bogged down.

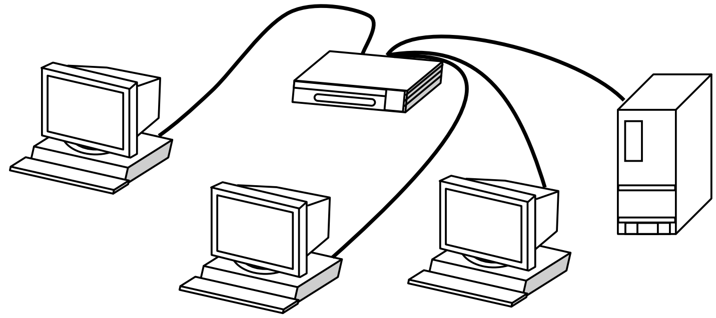

Figure 1.19: Hub

Hubs are typically used on small networks where the amount of data going across the network is never very high. A hub is typically the least expensive, least intelligent, and least complicated of the hub, router and switches. Every computer connected to the hub "sees" everything that every other computer on the hub sees.

1.7.6 Switches

A switch does essentially what a hub does but more efficiently. By paying attention to the traffic that comes across it, it can "learn" where particular addresses are. For example, if it sees traffic from machine A coming in on port 2, it now knows that machine A is connected to that port and that traffic to machine A needs to only be sent to that port and not any of the others. The net result of using a switch over a hub is that most of the network traffic only goes where it needs to rather than to every port. On busy networks this can make the network significantly faster.

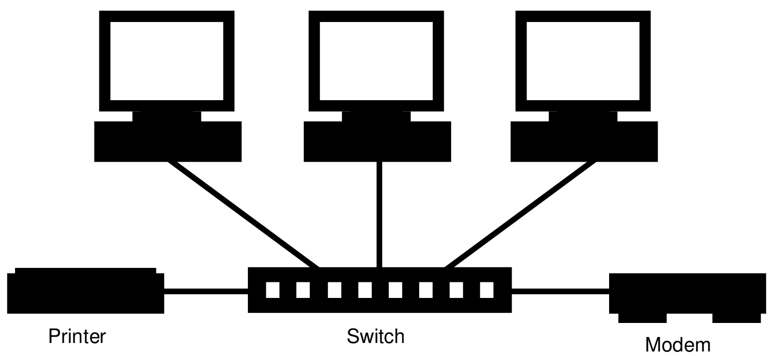

Figure 1.20: Switch

A switch (or Switching Hub) is a device that can segment a larger local area network to reduce the traffic load. One should implement a switch when you have a network with 20 or more users that have bogged down the network by excess traffic. It splits the network into two or more segments with devices that normally talk with each other. Conceptually – switching takes data from one interface and delivers it to another interface.

1.7.7 Router

A router translates information from one network to another; it is similar to an intelligent bridge. Router selects the best path to route a message, based on the destination address and origin. The router can direct traffic to prevent head-on collisions, and is smart enough to know when to direct traffic along shortcuts. Routers can even "listen" to the entire network to determine which sections are busiest—they can then redirect data around those sections until they are removed.

If you have a LAN that you want to connect to the internet, you will need to purchase a router. In this case, the router serves as the translator between the information on your LAN and the internet. It also determines the best route to send the data over the internet. Routers maintain a map of the physical networks on a Internet (network) and forward data received from one physical network to other physical networks.

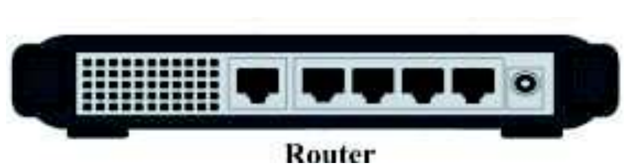

Figure 1.21 : Router

1.7.8 Gateway

If you are connected to the internet, you have to enter through a Gateway. A Gateway connects your smaller network to the internet. A gateway passes information from one network to another network as your information travels across the internet.

Gateway Interconnects networks at higher layers than bridges or routers. A gateway usually supports address mapping from one network to another, and may also provide transformation of data between the environments to support end to end application connectivity. Gateway typically limits the interconnectivity of two networks to a subset of the application protocols supported on either one.

Routers exemplify special cases of gateways. Gateway, also called protocol converters, can operate at any layer of the networking model. The job of a gateway is much more complex than that of a router or a switch. Typically, a gateway must convert one protocol into another.

The main function of a gateway is to convert protocols among communications networks. A router by itself transfers, accepts and relays packets only across networks using similar protocol. A gateway, on the other hand, accepts data formatted for one protocol and convert it to data formatted for another protocol before forwarding it. A gateway can be implemented in hardware, software or both, but they are usually implemented by the software installed within a router. A gateway must understand the protocols used by each network linked into the router. Gateways are slower than bridges, switches and (non- gateway) routers.

The computers of Internet users and the computers that serve pages to users are host nodes, while the nodes that connect the network in between are gateways. For example, the computers that control traffic between company networks or the computers used by internet service providers (ISPs) to connect users to the internet are gateway nodes.

Check Your Progress 2

1) Identify the characteristics of bus, ring and star topologies and write the best characteristic that you think while designing a topology.

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2) Differentiate amongst LAN, MAN and WAN in terms of their coverage area.

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3) Identify the examples of networks around you and classify them in terms of LAN, MAN and WAN.

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4) Differentiate between a bridge and a router.

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5) Explain the function of hub and where should we use this communication device?

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6) What is the function of gateway?

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1.8 INTERNET AND ITS SOFTWARE COMPONENTS

After through some of the basic networking concepts, let us now look into some more concepts relating to one of the major application of networks the Internet. You have been introduced to internet in section 1.2.2. Let us once again sketch some of the basic points on Internet.

- Internet is a global connection of networks. But, how are these computer connected? The Internet is basically built up of multiple smaller networks called the subnets. Each computer systems on a subnet must have a unique address. All these subnets are connected together with network devices called routers, and each subnet may also contain its own subnets.
- Figure 1.22 is a top level view of the structure of the Internet as a cloud of many routers that are connected to each other. You may be able to connect to any of the search engines that allows you to locate information on Internet or any of the web servers like IGNOU web server through many alternative routes. A client may be a part of LAN, WAN or wireless network, it does not matter. Everything is almost in the Internet cloud -why? Because all these networks use one common protocol for reliable data transfer, so they speak common language and communicate irrespective of physical differences. This basic communication protocol on Internet is the Transmission Control Protocol/ Internet Protocol (TCP/IP). This protocol ensures reliable delivery of information from one source identified by a unique IP address to a destination also identified by a unique IP address. Please note that the source and destination computer may either be local or remote computer, depending on the destination location. But what are these IP addresses?

Figure 1.22 : Structure of Internet

- To connect to a physical network, all devices irrespective of being wired or wireless uses an interface card. An interface card may have its own unique physical address. However, you cannot locate a device just by its unique physical address, as these addresses do not provide any indication about the location of the device. Thus, you require a protocol that uniquely identifies a device on the Internet and Internet protocol version 6 (IPV6) which is beyond the scope of this unit.

- TCP and IP (TCP/IP) are the two core protocols of the Internet Protocol suite. The TCP primarily provides the reliable delivery of stream of bytes from a computer or a program to another computer or a program. It breaks the data stream into packets at the source and makes sure that all the packets are assembled orderly at the destination. The IP protocol on the other hand identifies the location of source and the destination. Any computer on Internet is identified by its unique IP address. Currently two standard versions of IP are available viz. Internet Protocol Version 4 (IPv4) which is currently being used on most of the Internet. An IPv4 address is a 32 bit address. IPv6 has not been discussed in this Unit.
- Using the TCP/IP as the basic protocol Internet offers many services and application to it users like work wide web, Email, Chat, Social networking, collaboration etc
- WWW is one of the major applications of Internet and is based on the concept of Hypertext that is hot links to a document that may reside on any website. It is a global infrastructure of connected documents.
- Following are some of the major Software Components required to access Internet:

  - The first **software** for internet access is the Operating system. An operating system must be installed properly on your system (so that it can handle the driver requirements of the hardware components).
  - **Internet Browser:** Browser is software that allows the user to access and read information on the World Wide Web. Internet Explorer, Mozilla, Netscape are the best-known browsers. SpaceTime 3D is new three-dimensional browser. Only browser is sufficient for working with the Internet viz., the browser software that should be loaded on all the clients. In fact, the browser is one of the very intelligent software that contributed to the growth of World Wide Web. A browser converts the standard Hyper Text Markup Language (HTML) web pages to a very sophisticated display with colours and pictures.

Firewall

  - **Firewall:** Internet has many security problems like hacking, Trojan Horse, Virus, etc. There are various tools to provide protection against unwanted access of your computer by anyone else, but the most popular among all security measures is the firewall. Firewall is software that works on some set of rules and instructions given by you. A firewall helps to keep your computer more secure. It restricts information that comes to your computer from other computers, giving you more control over the data on your computer and providing a line of defense against people or programs (including viruses and worms) that try to connect to your computer without invitation.
  - **TCP/IP protocol:** This is the group of protocols that define the Internet and communication method used by it. Let us discuss it in more details :

TCP/IP Stack

TCP/IP was originally designed for the UNIX operating system; however, TCP/IP software is now available for every major operating system. In order to be compatible to the Internet, the computer must have TCP/IP compatible software. The major advantage of Internet is information sharing. Since in computers, bits and bytes are basic building blocks of information. Thus, one of the key aspects in network of many computers is to move bits between two specific computers. For such a communication, we require the address of the destination and a safe mean of moving data in the form of electronic signals. As far as safe movement of data is concerned, there exists a set of rules, which governs the sending, and receiving of data on the Internet.

A stack of protocols called TCP/IP (Transmission Control Protocol/Internet Protocol) implements these rules. Its name reflects names of only two protocols called TCP and IP. For sending large block of text/data to another machine, TCP divides the data into little data packets. It also adds special information e.g., the packet position, error correction code etc. to make sure that packets at the destination can be reassembled correctly and without any damage to data. The role of IP here is to put destination-addressing information on such packets. On Internet, it is not necessary that all the packets will follow the same path from source to destination. A router tries to load balance various paths that exist on networks. Other gateways allow different electronic networks to talk to Internet that uses TCP/IP.

The Internet layer is an important layer in the protocol suite. At this layer, TCP/IP supports Internet Protocol (IP). This layer is responsible for the format of datagram or a packet as defined by IP and routing and forwarding a datagram or packet to the next hop (hop is a term that can be used to represent any computing device on Internet like; router, gateway, computer etc. A hop is the trip from one device to the next.) The primary goal of the Internet is to provide an abstract view of the complexities involved in it. Internet must appear as single network of computers. At the same time network administrators or users must be free to choose hardware or various internetworking technologies like Ethernet, Token ring etc. Different networking technologies have different physical addressing mechanisms. Therefore, identifying a computer on Internet is a challenge. To have uniform addressing for computers over the Internet, IP defines an IP address, which is a logical address. IP address is a 32 bits number, can be represented in decimal e.g., 192.168.32.10. Now, when a computer wants to communicate with another computer on the Internet, it can use logical address and is not bothered with the physical address of the destination and hence the format and size of data packet. IP address is a basic address used by the lower architecture of Internet. It is important for you to know that, any address you type as web address or email address actually gets converted into the equivalent IP address of a machine or computer where the server or resource is available. Web address or email addresses are used for ease and convenience of human beings otherwise; it is just a burden for network.

TCP/IP Model

Just like the OSI model, the TCP/IP model has many layers which are described below:

Host to Host Network: In fact TCP/IP model does not specify this layer. But it basically combines functionally of physical and data link layers. Starting at the bottom, the Physical layer is what deals with hardware (wires, cables, satellite links, NICs, etc.). Utilizing the existing Physical layer, TCP/IP does not define its own, thus letting the layer be compatible with all network suites. This layer also encodes and transmits data over network communications media in the form of bits which are received by the Physical layer of the destination device. Often combined with this layer is the Data link layer which is responsible for moving packets from the network layer onto different hosts. Depending on the connection type, IP packets are transmitted using various methods. Dial-up modems transmit IP packets using PPP while broadband users transmit using PPoE.

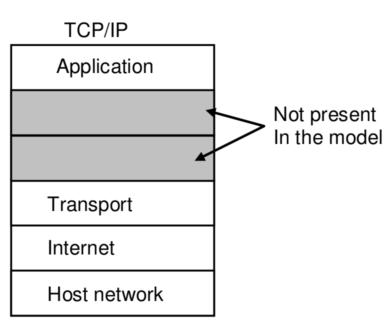


Figure 1.23 : TCP/IP Model

Internet Layer: This layer routes and delivers data across similar networks or completely different networks. The Network layer is responsible for end to end packet delivery while maintaining routing, flow control, and error control functions. An example of this layer is the Internet Protocol (IP) or the Internet Protocol Security (IPSec).

Transport Layer: The Network layer can be thought of the actual vehicle which transports information. This layer categorizes end to end message transmissions or connecting applications as either Transmission Control Protocol (TCP) or User Datagram Protocol (UDP). TCP is a connection-oriented protocol which is considered to provide a reliable byte stream. Some characteristics of TCP are traffic congestion control, data arrives in order, data has minimal error, and duplicate data is discarded.

The top layer of the TCP/IP model is the Application layer which is used for network communication. Ports are used by programs to transfer data through this layer. For example, the File Transfer Protocol uses port 21 by default while the Hypertext Transfer Protocol uses port 80.

TCP/IP has many benefits. TCP/IP enables cross-platform networking which is useful in this day-in-age. This suite also has superior failure recovery and the ability to add networks without interrupting existing services. The reliability of TCP/IP is also a huge benefit to using this protocol. The fact that if one part of the network goes down, other parts are still able to function is what has set TCP/IP above other networking protocols. TCP/IP is also easily expandable which allows for the unprecedented rate of growth which the Internet possesses.

1.9 INTERNET ADDRESSES

We can classify the computers connected with Internet in two categories, servers and clients. A server is a computer with the capacity to provide connectivity and sharing to multiple personal computers or clients (any computing device you use to access the Internet), which is specifically set up to serve its files to client computers. The files that a server makes available to your computer can be web pages, videos, sounds, images, etc. A web server normally has:

- A high end computer with web server software. The three most popular web server software are:
  - Apache HTTP Server, available in public domain
  - Microsoft Internet Information Services (IIS)
  - Sun Java System Web Server
- A very good Internet connection speed, so that it can support multiple simultaneous users.
- Its own URL and IP address. (What is a URL? URL - Uniform Resource Locator. URL is theglobal address of a document or resource on the WWW)

For your home computer to be able to receive files or any data from a server, your computer must request this information. This happens when you enter an URL in your browser or when you receive e-mail. When we work on Internet we come across different types of addresses used for different purposes, like; web address, IP address, email address. Each one has a special syntax, and meaning. It is important for you to know about these addresses, before you start working on Internet.

1.9.1 IP Addresses

Figure 1.23 shows an IPv4 address:

IP address: 192.168.1.97 in various forms:

Decimal	192								168								1								97							
Hexadecimal	C				0				A				8				0				1				6				1			
Binary	1	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1

Figure 1.23: IP Address

IPv4 address is a series of four numbers separated by dots (.). The four numbers ranges between 0 and 255. So IPv4 address takes only 4-bytes (or 32-bits) of computer memory. Not all the IPv4 addresses may be used to identify a computer. Some addresses of IPv4 are not used at all due to certain restrictions. In addition, some addresses are reserved, for example; the IP address 255.255.255.255 is used for broadcasts.

Every device, computer, printer or peripheral connected to a TCP/IP network must have its own IP address. Each 32 bit IP address consists of two components:

- Network Identifier (Net ID) – which identifies one of the Networks that is a part of Internet.
- Device Identifier (Device ID) – which identifies a specific device within the identified Net-ID.

A Net ID may be of 8 to 24 bits long. By using a subnet mask in combination with their own IP address, you can determine the destination address of the devices is remote or local. For example, consider the IP address 192.168.1.35, having 24 bits Net ID. The remaining 8 bits of this address specifies the device ID. The subnet mask for this network should be 255.255.255.0. This subnet mask is used to identify the IP address of the network.

Now, consider a situation in your office, you want to create a small network, but your network service provider has given you only one IP address? Fortunately, there are IP addresses that have been kept for private network. These addresses are not globally allotted to any organisation but are addresses with in your private network. To connect your private network to the Internet, you are required either to use a network address translator gateway, or a proxy server. Please refer to further readings for more details on these networks. The IP range that is allocated for such non-routable addresses are:

IP Address	Subnet Mask	Number of IP addresses (some what equivalent to maximum possible number of Computers/ network devices
10.0.0.0 – 10.255.255.255	255.0.0.0	16,777,216
172.16.0.0 – 172.31.255.255	255.240.0.0	1,048,576
192.168.0.0 – 192.168.255.255	255.255.0.0	65,536

The subnet mask is similar to an IP address - it is also a 4-byte (or 32-bits) field and can be represented using dot notation. In binary, it always comprise a series of ones, followed by sequence of zeros. The total number of bits is 32, but the number of ones and zeros determines the nature of the mask. By comparing any IP address with a given mask, you can split addresses into two parts, a network ID and a device ID. The following example explains this concept in more details.

Suppose your computer has an IP address of 193.168.1.35 and you want to access a location 193.168.1.56, as your subnet mask is 255.255.255.0, it will give you following answers:

Host (you):	193.168.1.35
Subnet Mask	255.255.255.0
Result:	193.168.1.0
Accessed Location	193.168.1.56
Subnet Mask	255.255.255.0
Result:	193.168.1.0

Since, the Result of both the operation points to same Net ID, therefore, you can conclude that the referred destination IP address is local.

Now, suppose your computer has an IP address of 191.168.1.35 and your NetID is 16 bit long. Suppose you want o access a location 190.168.1.35. Since, you have 16 bit NetID, therefore, your network subnet mask will be 255.255.0.0, it will give you following answers:

Sub-netting is based on CIDR (Classless Inter-Domain Routing) concept. It is used in routing between networks both locally and

Host (you):	191.168.1.35
Subnet Mask	255.255.0.0
Result:	191.168.0.0
Accessed Location	190.168.1.35
Subnet Mask	255.255.0.0
Result:	190.168.0.0

Since, the Result of both the operation points to different Net ID, therefore, you can conclude that the referred destination IP address is remote.

By comparing the source network ID with the IP address of the source and the network ID of the destination IP address, you can easily determine if the destination is within the same subnet. A web page request, thus, can be identified as local page or a page from remote server. But, how do you find the location of the remote server? The answer to this question is beyond the scope of this unit. However, you should know that routers may be responsible in finding the final path to the remote server.

As the numbers of users are increasing, the IPv4 addresses will run short. Therefore, a 128 bit Internet Protocol Version 6 (IPv6) was designed which is at present actively being deployed on the Internet. This series can provide up to 3.4 X 10^{38} addresses. For more details on IPv6, please refer to Further Readings.

1.9.2 DNS and Web Addresses

An Internet or Web address is used to view a web page. When you are viewing a Web page, the web address of the page appears in the Address bar in the browser. In the previous section, you have gone through the concept of IP addresses. What do you think about the IP address? Are they not very cumbersome to remember? For example, to visit IGNOU website the address www.ignou.ac.in is far simpler than that of an IP address like 190.10.10.247. Obviously, what we want to use are simpler textual domain addresses instead of complex IP addresses. However, to enable the use of simple textual address, you will require a service that will map these text based names to respective IP addresses automatically. Such a service was designed in 1983 by the University of Wisconsin with the name Domain Name System (DNS).

In the present day, Internet, Domain Name System (DNS) should keep track of address of each computer or any other internet device and email addresses. The name servers translates the web address or email address to respective IP address. For example, the name server translates address like www.ignou.ac.in into a computer understandable IP address. It sounds simple, but remembers on Internet you are dealing with million of addresses and every day this list is increasing. All these computers have a unique address. Therefore, DNS follows a hierarchical naming scheme that is supported by distributed database system to ensure no duplicate names are issued at all. Figure 1.24 shows the hierarchical structure of domains names on Internet. For example, traversing the hierarchy from the top you can track down ignou.ac.in as:

First you can find the **in** (India) in the top level country domains. Within this domain find the **ac** (Academic) sub domain. Please note most of the Indian Universities will be in this sub-domain. Finally, in the **ac** you can find the entry for **ignou.** This entry should point to the IP address for the ignou.ac.in for the WWW as well as for the mail server. This is how the DNS finds the addresses, thus, is a very efficient system.

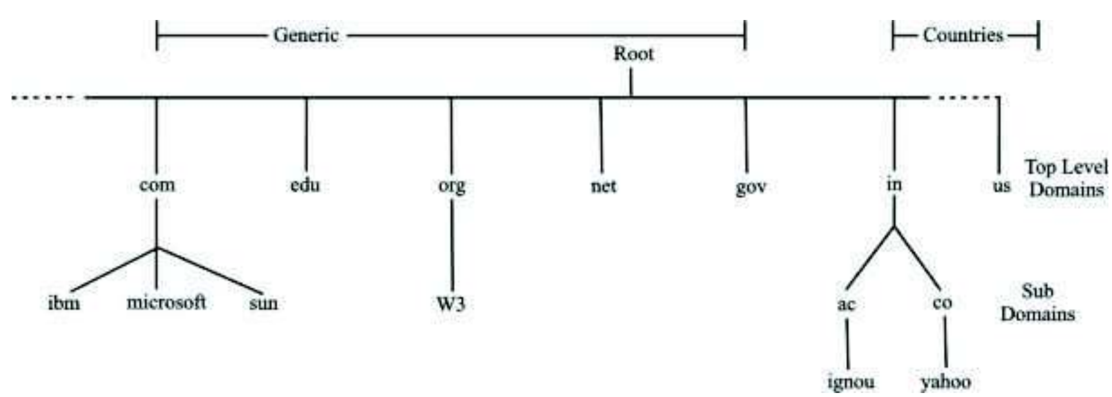


Figure 1.24: A sample portion of domain names on Internet

Thus, using the DNS you will be able to relate a given textual address to IP address. For converting domain name into IP address, it first accepts request from programs and other servers. After accepting the request, the name server can do the following:

- If it knows the IP address of requested domain, it will answer the request with an IP address of the requested domain.
- If it does not know the requested domain name, it will contact another name server and try to find the IP address.
- If the requested domain name is invalid or domain does not exist, it will return an error message.

But how can you name a web page on the Internet? To answer this question you may first identify that a web page actually is part of a website that may reside on a web server having a unique IP address. Thus, to identify a web page you need to identify –

- The protocol used to access that page.
- The server on which the website is located.
- The name of the page within that web site. Please note that simple web pages are stored as files.

Please note that a web page may be stored as a single or multiple files.

Thus, to identify a web page you will have an address like:

http://www.ignou.ac.in/students/result.html

- the address as above recognises the protocol http (Hyper Text Transfer Protocol) to access the page,
- the www.ignou.ac.in identifies the DNS name of IGNOUs WWW server, and
- the name of the page accessed by you is result.html which resides in the students folder within the website.

This address is called the URL. URL stands for Uniform Resource Locater.

You can now clearly see that a URL consists of three parts – the first part is used to tell the browser what kind of server it will connect to. In the example above, the browser will connect to a web server using Hypertext Transfer Protocol (HTTP). Other protocols that we can use in this field of an URL are FTP, smtp etc. the protocol is always followed by "**://**".

The range of Well Known Ports is in between 0–65535

The second part of an URL is a fully Qualified Domain Name (www.ignou.ac.in). In an URL, the fully qualified domain name identifies the site running the server. Web servers use port 80 by default, but some servers has been set up to use other ports. For this, a URL can contain a port number following the domain name and separated from it by a colon (www.ignou.ac.in:80), it is optional to write a port number with domain name. If the URL contains no port number, the default port is used.

The first two parts of an URL are used to identify the web server of the website. Each web server has a home page and a directory to store the entire document related to the web page like images, audio, video files.

The third component of URL is an optional pathname for a particular document itself. For example, the address http://www.ignou.ac.in/students/result.html specifies the file result.html i.e., in the directory students (/students/result.html) in the specified web server.

But how does this information exchange between the web client and web server is achieved? This whole communication is managed by a protocol called the Hyper Text Transfer Protocol (HTTP). However, the only protocol that works on Internet as told to you in the previous section was TCP/IP. So what is this HTTP? Please note HTTP can work only over a connection that is managed by TCP. Thus, it is a higher level protocol that uses the services of TCP.

URL - Uniform Resource Locator – identifies the GLOBAL address of a document or

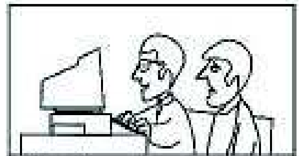
HTTP specifies the list of actions that lead to transfer of a requested information exchange between a web client and web server. Whenever you wish to visit a web page on the internet, you request that page from a web server. When you type a URL into your browser (for example, "http://www.abc.com/"), your web browser requests the page (or file) named index.html from the web server and the web server sends the page back to the web browser. Let us identify these steps in more details:

1) As a first step you may put a URL like http://www.abc.com/index.html or equivalent Domain name www.abc.com as the address of the website that you want to access through your web browser.

2) The Web browser tries to resolve the IP address of the website www.abc.com by the information available in its own cache memory. If web server does not have the information about IP address stored in its cache, it requests the IP address from Domain Name System (DNS) servers. The DNS server tells the browser about the IP address of the website.
3) Once the web browser knows the IP address of the website, it then requests the web page (index.html page which is the home page in the present example) from the web server.
4) The web server responds by sending back the requested web page. If the requested page does not exist then it will send back the appropriate error message.
5) Your web browser receives the page from the web server and displays it as per the display requirements of the web page.

1.5.3 E-mail Addresses

As you have studied earlier that e-mail is one of the popular services increasingly being used by people in their daily life. The following can be a typical email address format on Internet for any e-mail service provider like, Gmail, Rediff, Yahoo, MSN, or any network (domain) name etc.



"My wife passed away months ago,
but we are still in touch.
Her e-mail is rupa@heaven.com"

username@subdomain.domain

The username in general is the name assigned or chosen during creation of an email account. Sub-domain are domain we have already discussed in above section, in case of private service provider it is generally its own name like abc@yahoo.com, abc@yahoo.co.in, abc@gmail.com, etc. On the Internet you can see both kind of domains non-Geographic and geographic domains. Lets take an example to better understand an e-mail address: In an e-mail address *"naveen@ignou.ac.in"*, naveen indicates the username, the sub-domain named IGNOU (Indira Gandhi National Open University) which is an academic organisation (.ac) and is situated in country India (.in).

Check Your Progress 3

1. What are the services on Internet?

   ………………………………………………………………………………………

   ………………………………………………………………………………………
2. What is firewall? Where can it be used?

   ………………………………………………………………………………………

   ………………………………………………………………………………………
3. What it TCP/IP? Why is it used?

   ………………………………………………………………………………………

   ………………………………………………………………………………………
4. What is a URL?

   ………………………………………………………………………………………

   ………………………………………………………………………………………
5. Define the terms DSN, IPv4 address, Subnet mask

   ………………………………………………………………………………………

   ………………………………………………………………………………………

1.10 SUMMARY

This unit is an effort to answer some of the very basic questions about the data communications, networking and the Internet. The Unit first defines the term networks, while discussing its advantages and disadvantages. It also defines the term Internet. Some of the basic terminology of data communications like modes of transmission, speed of transmission, packet etc has also been defined. To communicate data, you require some channel. This unit provides details on the Guided and unguided data transmission channels. Network topologies define the basic structure of the network. Three basic network topologies – bus, ring and star have been defined in this Unit. The networks can also be classified on the basis of their characteristics. LANs are the networks that cover a range of few Kilometers whereas MANs cover a range of about 50 Kilometers. The WANs have the largest range. On the other hand, the speed of transmission of data decreases from LAN to WAN as you can employ better, faster but costlier technology at short distances. The unit also covers the reference models that may define the networking software. In addition, the unit discusses about some of the basic devices used in Computer Network. These devices are - Network Interface Card, Modem, Repeaters, Bridge, Hub, Switches, Router and Gateway. The Unit also explains the IP addresses, DNS and email based addresses. One of the most important addresses for Internet user is Uniform Resource Locator that uniquely identifies a document or resource on the Internet. Networking and Internet is a very dynamic area and newer technologies emerge very fast in this area. Therefore, you must update yourself on various newer concepts on these topics from the further readings.

1.11 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. Computer networks are manly used for the purpose of resource sharing which helps in reducing organizational costs. Networks are highly reliable, scalable and very powerful communication system.
2. MODEM is an encoder as well as decoder it converter digital signal to analog at the source and analog signal back to digital at the destination.
3. The performance of the twisted pair can be improved by adding a metallic shield around the wires. Shielded wires are much more resistant to thermal noise and crosstalk effects.
4. An optical fiber consists of two concentric cylinders: an inner core surrounded by a cladding. Both the core and the cladding are made of transparent plastic or glass material. Optical fiber use reflections to guide light through a channel. The density of core and cladding must differ sufficiently to reflect the beam of light instead of refracting. The core is used for guiding a light beam, whereas the cladding (which has a different refractive index) acts as a reflector to prevent the light from escaping from the core. Optical Fiber has high bandwidth and does not suffer from noise. However, it is costly and requires experts to do the connections.

Check Your Progress 2

1. The basic characteristic of topology is its organization. This leads to properties that may be used to differentiate them. Some of these characteristics are: Network Scalability, Cost, Length of Cable etc.
2. LAN – about 2 Kms it is high speed network; MAN up to 50 Kms - may use devices like Modem; WAN – covers large distances like states countries.

3. LAN – Network in a University, Small office, Internet Cafes

   MAN – Cable TV network

   WAN – Internet, VPN etc.

4. A bridge connects several LANs. A bridge can also divide a network to isolate traffic or problems. Bridge Interconnects LAN segments at the network interface layer level and forwards frames between them.

   A router translates information from one network to anther; it is more intelligent than a bridge. Routers select the best path to route a message, based on the destination address and origin. In contrast to bridges few of the large routers may include programs for their operations.

5. A hub is the simplest of connection devices. Any data packet coming from one port is sent to all other ports. It is then up to the receiving computer to decide if the packet is for it. A hub is typically the least expensive, least intelligent, and least amount of date going across the network is network is never very high.

6. Gateway Interconnects networks at higher layers than bridges or routers. A gateway usually supports address mapping from one network to another, and may also provide transformation of the data between the environments to support end-to-end application connectivity. The main functionality of a gateway is to convert protocols among communications networks. A gateway on the other hand can accept a packet formatted for one protocol and convert it to packet formatted for another protocol before forwarding it. Gateways work on all seven OSI layers.

Check Your Progress 3

1) Today you can avail the facilities of e-mail; messenger services, Chatting etc., to share your ideas, knowledge, and feeling. You can join different groups, discussion forums or create your own blogs. You can use websites to broadcast huge amount of information on Internet.

2) Firewall is software that works on some set of rules and instructions given by you. A firewall helps to keep your computer more secure and protect from many security problems like; hacking, Trojan Horse, Virus, etc. It restricts information that comes to your computer from other computers, giving you more control over the data on your computer and providing a line of defense against people or programs (including viruses and worms) that try to connect to your computer without invitation.

3) A stack of protocols called TCP/IP (Transmission Control Protocol/Internet Protocol) implements different rules to handle the data communication from source machine to destination machine. For sending a message from source machine to destination machine, TCP divides the message data into little data packets. It also adds special information e.g., the packet position, error correction code etc., to make sure that packets at the destination can be reassembled correctly and without any damage to data. The role of IP here is to put destination-addressing information on such packets. On Internet it is not necessary that all the packets will follow the same path from source to destination A special machine called routers tries to, load balance various paths that exist on networks. Other special machine called gateways allows different electronic networks to talk to Internet that uses TCP/IP.

4) A URL is a unique identifier for a resource on Internet.

5) DNS is responsible for Web addresses to IP address; IPv4 address is a 32 bit address of a host on Internet. Subnet mast separates Network ID and Machine ID.

1.12 FURTHER READINGS

- CIT-001-Fundamentals of Computer System, Block 3 : Networking and Communication, Block Preparation team : Sh. Shashi Bhushan (Content editor) and Shri Saurabh Shukla
- CIT-001 : Web based Technologies and Multimedia Applications, Block-1 : Internet Concepts, Block Preparation Team – Prof. M.N. Dooja (Content Editor), Dr. Pramod Kumar (Language Editor), Dr. R. Khandwal, Mr. Hemant Rana, Dr. Naveen Kumar, Mr. Akshay Kumar.
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UNIT 2 WEB APPLICATIONS I

Structure

2.0 INTRODUCTION

In the previous unit, you have gone through the concepts relating to networking and Internet. The Internet is the network of networks and is used for many applications. Internet allows you to share resources and applications with ease. The Internet uses TCP/IP as its basic protocol on which many more application level protocols have been developed. The Internet can carry any digital signals such as text, graphics, sound, video and animation. Today, Internet has thousands of networks and millions of users, using many services.

Uses of Internet technologies have become common place in recent times. Since, the advent of Mosaic Browser in 1993, the popularity of web and its users grew very fast. The web application during this era primarily wanted to provide information about various organizations and some basic interaction with the clientele. Even in this time some of major usages of Internet were to browse and search the information and communication through emails. Since, 2003 there is a shift in focus in use of Web technologies. The Web has now become a platform for collaborative, community driven applications. This form of Web at present is called Web 2.0. There are other more structured forms of web organization that is at present popular named Web 3.0 and beyond. However, that is beyond the scope of this Block.

This unit introduces you to some of the basic applications of the Internet that have become part of daily routine application of any Internet users, whereas, the next unit will focus on some of the applications relating to Web 2.0. We will discuss about browsing, emailing, searching and chatting in this unit. If you are using World Wide Web on Internet then you are essentially doing the browsing. You may need to search the net for relevant information. Sometimes, you may like to send messages to your friends either offline or online and hence you will need email or chat.

2.1 OBJECTIVES

After going through this unit, you should be able to:

- explain the term browsing and perform browsing on the Internet;
- explain the role of search engines;
- identify and use the basic features of email services;
- identify and use basic models of chat; and
- appreciate the various security issues on the Internet.

2.2 BROWSING

Browsing also called Surfing the process of looking into the information available in the web. One of the preconditions for browsing is that you should be connected to the Internet. For connecting to Internet you should have an Internet account with a service provider (like MTNL, BSNL) and you have done the connection settings on your computer relating to that account.

Activity: Set up a connection to Internet on your Computer. Ask for the relevant settings.

2.2.1 What is Browser?

A Web browser is software application that enables you to find, retrieve, and display information available on the World Wide Web (WWW). Browser also allows you to traverse information resources on the WWW. As you know that the information on the Web is organized and formatted using tags of a Markup language called Hypertext Markup Language or **HTML**. A web browser is converts the HTML tags and their content into a formatted display of information. Thus, a web browser allows you to see the rich web contents from a website. Some of the popular web browsers are - **Internet Explorer, Mozilla Firefox, Apple Safari, Google Chrome, and Opera.**

Types of servers are **Web server,** Application server, FTP server, Mail server, File server, Print server, Terminal server

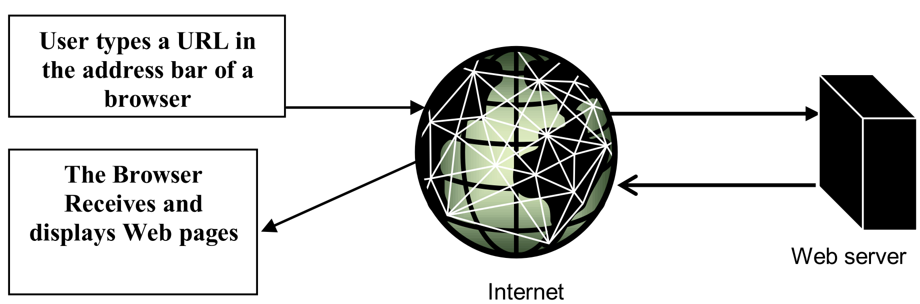


Figure 2.1 : The Browsing

2.2.2 How does Browser work?

Internet is characterized by the Client Server Computing that consists of three basic **components:**

- The **Web client** which may be the **web browser;**
- The **web server** that services the request of the web client; and
- The **network** that connects the client and the servers through a network such as LAN, WAN or the Internet.

For exchanging information between the client and the server, an application level protocol *H*yper*t*ext *T*ransfer *P*rotocol (HTTP) is used. This protocol uses the services of TCP/IP for communication of reliable information over the Internet. However, HTTP is not suitable for all kinds of applications especially that requires large amount of data transfer in real time, for example, Voice over IP (VoIP) application which requires real time transfer of voice data. For such applications, different application level protocols have been designed, for example, for VoIP a protocol named Real-time Transport protocol (RTP) has been designed. Such protocols instead of reliable TCP may run over unreliable User Datagram Protocol (UDP)

The HTTP protocol allows us to access a **web page** by a web client running a browser. A Web page is a document or resource of information that may be available on a Web Server.

2.2.3 How communication takes place between web server and Web browser?

As stated earlier, a web browser is an application that allows you to interact with various web sites on the Internet. You can run a browser from your Windows Desktop. Figure 2.2 and Figure 2.3 shows some of the important interactions/displays that are available on a browser window:

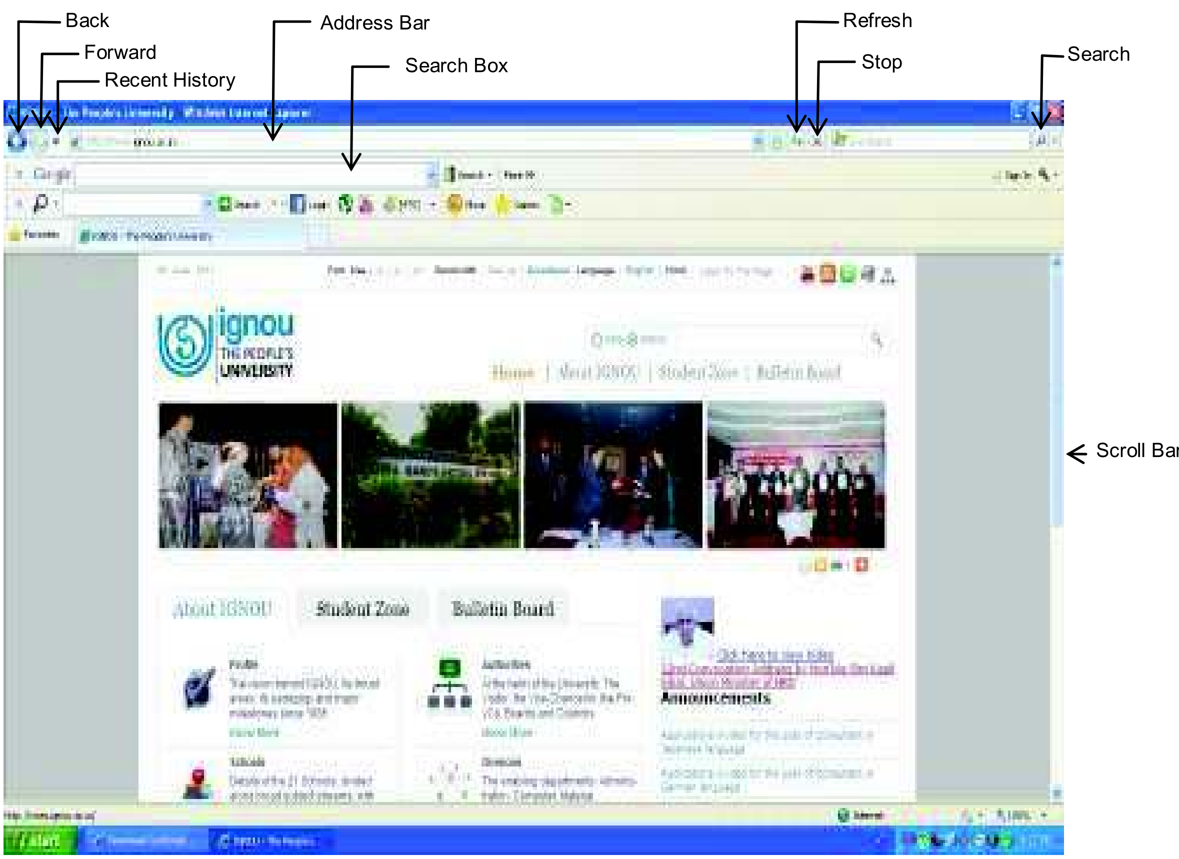


Figure 2.2 : IGNOU's website in Internet Explorer

Figure 2.3 : IGNOU's web site in Mozilla Firefox

A brief description about some of these interactions/buttons is as follows:

- **Back/Forward Buttons**: Back button can be used by you for going back to the previously visited web page whereas the Forward button is used to visit the next page (if you are not on the most recent page visited by you, this may happen when you have pressed the back button at least once).
- **Tab**: It allows you to view multiple web pages in the same browser without opening a new browser session.
- **Address bar**: Also known as URL Bar is a place where you can type the web page address that you want to retrieve from the web address. It also displays the address of the web pge currently being visited by you.
- **Recent History**: This shows the links to the web pages previously visited by you.
- **Refresh**: This is also called as reload button. It reloads the current web page.
- **Stop**: It cancels loading of the current web page. This button is used when the page is in the loading state.
- **Home**: This button will bring you back to the home page of your website. Home page is the first page of any web site.
- **Search:** Search box allows any term to be searched by the search engine from the web. It can also used for searching contents from the website visiting.

When you type in the address of a web site, for example, *http://www.ignou.ac.in* in the address bar of your web browser, the web browser performs the following actions:

- Your web browser knows that you want to access a web site (http:// indicates that). But, where is this website? The web browser requests the nearest **Domain name system (DNS) server** to resolve the IP address of the intended web site *www.ignou.ac.in*
- The name server may take the help of other name servers in case it is not able to resolve the IP address, otherwise it will generate an error message.
- Assuming that there is an entry for the web site, the name server will return the resolved IP address of the Web server of the website *http://www.ignou.ac.in*
- The browser then requests TCP/IP protocol to establish a connection with the web server whose IP address has been resolved in the previous step and get the home page of the web site (generally named as index.html). In addition, to the HTML text file, the browser may also request download of the related image files, audio files, video files, XML files, Flash files, Java applets etc. with Hypertext Markup Language (HTML).
- A web browser then receives webpage and related files from the server then displays the webpage as desired.

When the desired webpage loads into your browser you will see the text comes in, the pictures arrives, the animation gets loaded and so on. You will notice that some text is underlined and in different colour — it is **hypertex**t, if you link multimedia elements like graphics, sound, and video then it is called **Hypermedia.** The contents of these links are hosted on some web server. These links are called **hyperlinks**. Usually, by clicking hyperlink you will move from one location to another location within the same document or in another document or some other website. This process of clicking hypertext links, loading one page after another, is called "**browsing**" or "**surfing the web**".

In the current times, Web Browsers are most user-friendly and essential technology tool for surfing the internet. Web browsers help you to view contents of different file formats, interact with other websites, and incorporate appropriate technology to view or download or upload multi-media content and streaming multi-media. Web browsers also provide functions like blocking of unwanted pop-up advertisements; spywares and phishing (please refer to references for more details on these terms). They provide the convenience of tabbed browsing and come with advanced features like auto-fill and password and download managers. Web browsers of today are full-fledged programs capable of using fuzzy logic to select most appropriate content and help you to browse safely.

2.2.4 A Brief History of Web browser

In the **late 1980s,** a variety of technologies laid the foundation for World Wide Web by Sir Tim Berners-Lee. You may trace the history of the WWW and Web Browser from the website *http://www.wikipedia.org*. Some key points of the history are highlighted below:

- The first graphical web browsers which led to explosion of web usage was developed in 1993 by under the leadership of Marc Andreessen. The browser was named NCSA Mosaic.
- Netscape Navigator was the first very popular browser in 1994. It accounted for 90% of all web use at its peak.

- Microsoft Internet Explorer was launched in 1995. The usage of this software peaked in 2002 at 95%. Internet Explorer is one of the popular browsers.
- Opera was started in 1996. It is presently one of the popular browsers on a mobile phone.
- Firefox has evolved from Netscape. It was released in 2004. It is one of the popular browsers.
- Apple Safari was developed in 2003. It is the main browser used in Apple machines.
- Google Chrome was released in September, 2008. It is also becoming popular.

Types of Browsers

Line Mode Browsers: The initial browsers were line mode text browsers. These browsers were simple and used to display text line by line. They used to provide command line interface to the user on a less sophisticated computers and terminals. These browsers provided fast access to websites as they displayed only the text part. Lynx is a line mode browser.

Graphical User Interface based Browsers: These browsers run under graphic user interface systems such as Windows, Macintosh etc. A graphical browser, in addition to text can handle images, audio, video and animation. These browsers are very easy to use – You just need a point and click device like mouse. They have good display features.

Java enabled web browsers: These browsers include a Java Runtime Environment that support Java programming language. These browsers can dynamically load java applet from web server to web client. These browsers are portable, extensible and secure. The example of java enabled browser is "LOBO". It is open source software written completely in java.

2.2.5 Browser Security

WWW is used for many applications today including Banking, reservation, trading, e-commence and many such applications which require security and confidentiality of data. However, HTTP was not a secure protocol. Thus, a secure HTTP protocol was developed for applications that required secure communication channel over an unsecured network. This is called HTTP Secure and most of the contemporary browsers support this HTTPS protocol. Thus, if you are browsing a secure website then you will find https:// at the beginning. In case, you are browsing from a public computer then you must delete the contents of web cache, cookies and browsing history. All browsers provide simple way of doing this task.

Please make sure while logging in to your Bank account that web browser shows https:// or else there may be a chance of leak of your login information.

Activity 2: List the steps to clear browser cache, cookies and history on the browser used by you.

Browser Cookies

A cookie is a small message sent by the Web server to a your web client. This message is stored by the browser as a text file. The basic purpose of cookie is to store information needed by a server at the user end only. The cookie is used to send information back to the Web Server each time the browser requests a page from the server. For example, a website may ask you to fill up a form with the information about your name and interests. This information is packaged by the server into a cookie and sent to your Web browser which stores it for later use. The next time, you go to the same Website, your browser will send the stored cookie to the Web server along with the request for a web page. This way, server will be able to remember you and send you only that information that you had desired earlier.

Are cookies bad?: Cookies are merely text files that can be deleted at any time - they are not malicious nor are they programs. Cookies cannot be used to spread viruses and they cannot take control of your hard drive. However, they contain important information about you, so they may be threat to your privacy and anonymity on the Internet. The cookie contains information that you provide to a Website. So be careful about what information you provide on the web.

Some Security Tips While Browsing:

Web although on one side is huge resource of information, but on the other there is an increasing threat from software attacks that take advantage of vulnerable web browsers. Therefore, you are advised to take following precautions while browsing a web site:

- Do not click all the links without considering the risks of your actions. Some web page addresses may be disguised and may be very close to address of a site you want to visit but they may take you to an unexpected site.
- You must use the latest versions of browsers and please do not configure them to have decreased security.
- Do not login to a critical application if it does not have https://.
- Please do not download or install plug-in from the unknown party such tendencies may put your computer to additional risk.
- Third-party software may not have a mechanism for receiving security updates.
- Do not visit unsolicited websites, those add to your computer vulnerabilities.
- You may use a separate user account for accessing internet on your computer. You may restrict the rights of this user account.

This list may include many more tenet as you become more prolific internet user.

Activity 3: Develop a comprehensive Dos and Don'ts Card on Internet use.

Check Your Progress 1

1. What is a browser? Discuss various types of browsers.

   …………………………………………………………………………………

   …………………………………………………………………………………

2. How does Web Server communicate with Web browser?

   …………………………………………………………………………………

   …………………………………………………………………………………

3. What is cookie? Is it really bad? Discuss.

   …………………………………………………………………………………

   …………………………………………………………………………………

Activity 4: Use at least 3 browsers? Give at least 5 criteria on which you compare them?

2.3 SEARCHING

The Internet consists of millions of private/public/academic/business and government networks having local to global scope. It has billions of web pages on varied topics that may be accessed by you. Thus, if you are asked to surf the net for specific information relating to a topic, it may take years before you could find all the pages related topic you are looking for. How can you make this process faster? Well perhaps you require the service of a search engine on the Internet. Some of the popular search engines on the Internet are: Yahoo!, Google, Bing, Ask.com and many more. These are the tools to help you locate the content that you are looking for.

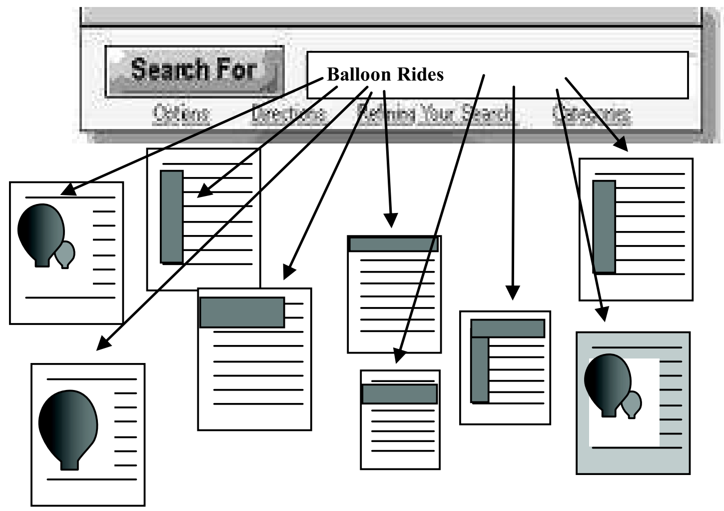


Figure 2.4 : A Search Engine

A search engine can be defined as a tool to search diverse and disorganized sources of information available on the Internet. You can clearly visualize from this definition that a search engine has to use some automated programs that needs to continuously keep visiting the web pages about the content they have and organize the information about web pages in some format. Programs that continuously keep searching for information from web pages are called -spiders, robots, crawlers, wanderers and worms. Search engines finds, classifies and stores information about the contents of various websites on the Internet.

Types of Search Engine

Some of the basic categories of Search engines are :

a. **Primary Search Engines:** Such search engines use web crawlers or spiders to traverse the web and scan websites for key words, phrases, to generate database of web pages having some indexing or classification. Google and Alta Vista are examples of primary search engines.

b. **Web directory:** Web directories organize information into categories and subcategories or directories. You can search a web directory for all those entries that contain a particular set of keywords. Directories differ from search engines in the way they organize information. Yahoo is an example of web directory.

c. **Meta search engines:** Such search engines pass your queries to many search engines and web directories and present summarized results to the users. Some of the examples of meta search engines are — Dogpile, Infind, Metacrawler, Metafind and Metasearch.

You can refer to further readings for more details on various types of search engines.

But how does search engine get able to do searching?

A search engine performs, the following three actions:

1. Spidering or Web crawling
2. Indexing
3. Searching

Spidering or Web crawling: Spider or Web crawler is a computer program that browses the web pages of WWW in a systematic, automated manner. Search Engines use spider for getting up-to-date data on web sites. They are used to create a copy of the pages visited by them for later processing to create Index. These programs are also useful in validating HTML code to a particular standard like XHTML or checking or validating the hyperlinks.

Indexing: Once, the spiders have completed the task of finding information about Web pages, the search engine must store the information in such way that you are able to use it. The search engine may provide some information relating to relevance of information may be in the form of Ranking. Thus, a search engine may store the keywords of a web page, number of times that word appeared on the page, the URL of the page. A weighting factor that gives more weightage in case a word is found at the top of the document. Each commercial search engine uses a different formula for assigning weight to the keywords in its index. This is one of the reasons that a search for the same word on different search engines will produce different results.

Since, the data that is to be stored for indexing is large, therefore, search engine may encode it. The Index is created with the sole purpose, that is, it allows you to find the information on the Internet quickly. In general, Index uses hashing (you will study this concept in the Data Structure course).

Remember
You leave "electronic footprints" wherever you go on the web for searching. So delete cookies

Searching: When a user enters a query into a search engine, the engine examines its index and provides a listing of best-matching web pages according to its ranking criteria. This short list, usually, have a short summary containing the title of the document and small part of the text. Most search engines support **Boolean search.** Some simple example of a search is given below:

To find website which contains "java tutorial", you may type **Java tutorial** in the search box of the browser. The search will look for keywords "Java" AND "Tutorial"; the search expression will retrieve all those records where both the terms occur (Figure 2.5).

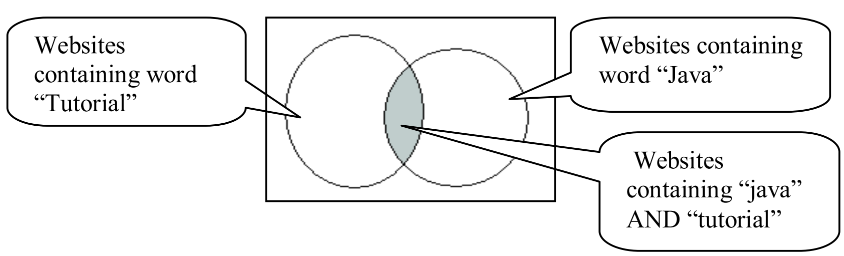
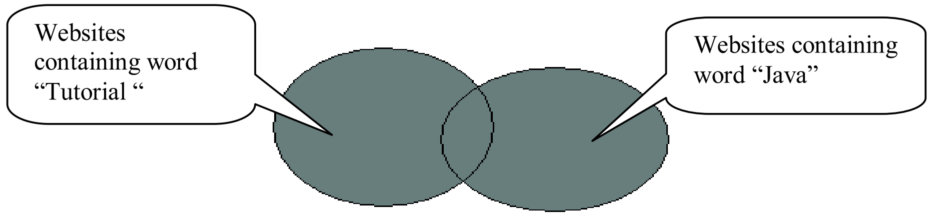


Figure 2.5: A Searching Example using AND

You may use other Boolean operators like OR and NOT in the searches. For example, if you are interested either in web pages having keyword "Java" or they are tutorials then you may use search expression as: **"Tutorials" OR "Java" (**please refer to Figure 2.6).



Shaded portion depicts websites either on java or tutorials
or java tutorials

Figure 2.6: A Searching Example using OR

If you are looking for Tutorials that are not related to Java then you may use the search expression as “Tutorials” AND (NOT “Java”) (refer to Figure 2.7).

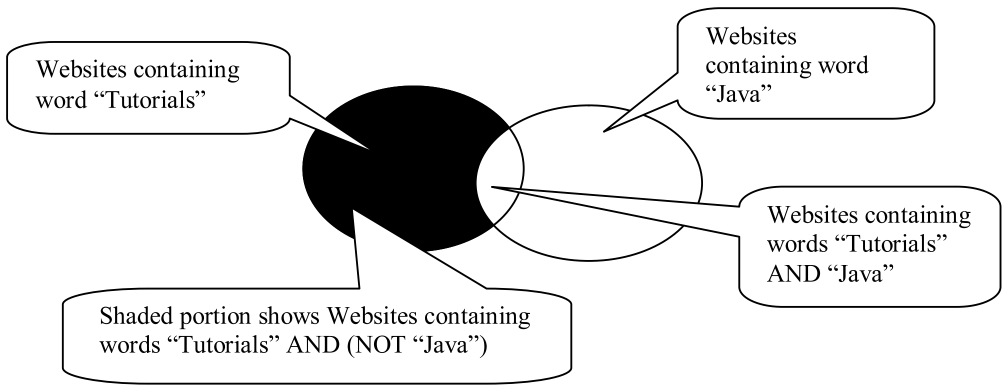


Figure 2.7: A Simple example of use of NOT

Some other Boolean expressions are:

FOLLOWED BY: One of the terms must be directly followed by the other.

NEAR : One of the terms must be within a specified number of words of the other.

Quotation Marks : The words between the quotation marks are treated as a phrase, and that phrase must be found within the document or file.

Field search: Using ‘title’, ‘in title:’ or ‘all in title’ etc.

Limiting search: Limiting by time, date or file type language or occurrences.

Google was launched in January 1996, as a research project by Larry Page and Sergey Brin as PhD students at Stanford University

Please note that different search engine provides these search forms using different syntax. You should refer to further studies for more details on this topic.

Let us now show you how you may be able to use search engines. For the purpose of this unit, we have selected Google and Yahoo, however, you must do the similar exercise using Bing, Ask.com, and many other search engines.

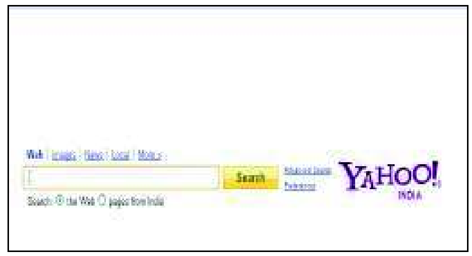
Yahoo was launched in January 1996, by Jerry Yang and David Filo, Electrical Engineering graduate students from Stanford University

The Table 1.1 shows in detail some of the basic features of Google and Yahoo.

Table 1.1 : Basic Features of Google and Yahoo

<table>
<tr><td>Searches</td><td>Website:
www.google.co.in</td><td>Website
www.yahoo.co.in</td></tr>
<tr><td>Web Search

You just type any word for e.g. New Delhi and click search</td><td>Google has a very large number of indexed pages.

</td><td>Yahoo also has faster ways to find the information.

</td></tr>
<tr><td>The Result Screens</td><td>
</td><td></td></tr>
<tr><td>On Home Page near search button there is option Advance Search. If you Click that button you get this screen</td><td>Advance search can help you to create more specific search.

</td><td>Yahoo advance search is primarily category based

</td></tr>
<tr><td>Image Search</td><td>Google has a very good Image Search facility on the Web. It has more than one billion indexed images for viewing.</td><td>Image Search of Yahoo! allows you to search millions of images from across the Web.</td></tr>
<tr><td>Other Searches</td><td>You may be able to do many other types of searches including scholar for scholarly articles, books, maps, news and many more categories</td><td>You may able to perform searches using yahoo such as news, products etc.</td></tr>
</table>

There are many other search features provided by search engines. You must use various search engines and explore the facilities they provide.

Activity 5: Compare the features of at least four search engines.

Some Searching Tips

Any Search engine allows you to perform either a broad search of everything on the Web or a narrow search limited specifically to images, video, news, or other specific search type. If you are interested in further narrowing your search results, try adding more words to your query Or search again using different terms. Following are some of the tips that may help you to formulate better search strings:

Choose words carefully: Use specific words to describe exactly what you are looking for.

Make sure to watch for words with more than one meaning. In case word has more than one meaning then also include the context in which you are searching the information

Try to use phrases instead of single word for pointed search.

You should perform multiple searches simultaneously

Now let us discuss about some of the products provided by the search engine. Figure 2.8 lists the products provided by Google and Yahoo:

Figure 2.8: Products in Google

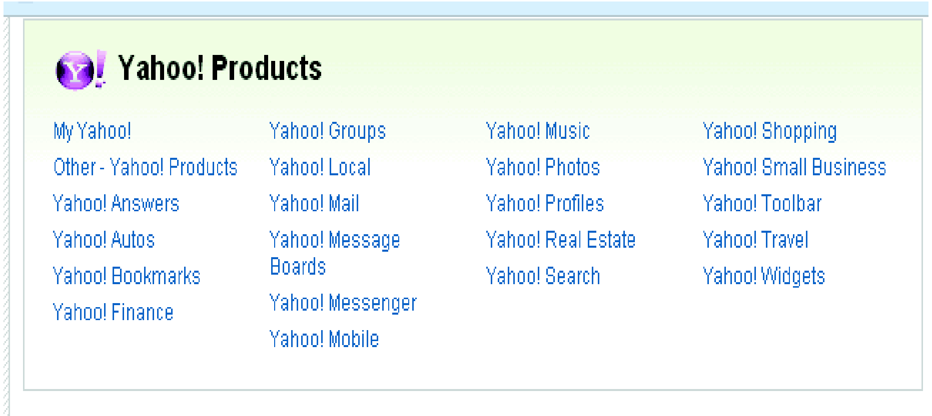


Figure 2.9: Products in Yahoo

Following is a list of some of these products.

Product	Google	Yahoo
Language Tool: Can be used to translate. But please check these translations before use.		
Alerts	Alerts sends you an email about the latest relevant updates on information of your choice.	
Answers	Answers may help you to get answers to your questions from researchers.	
Directory	Directories are pool of information that is integrated with the search option to provide more structured information on the web.	
Finance	You may get stock updates and related information.	It provides you access to financial resources.
Groups	It is an online discussion group or mailing list that helps you communicate with your families, friends or a group of people.	
Mail	These are client/server based email services that provide free email account with huge storage space. Section 2.4 provides more information on one of the mail service.	
Maps	Maps are very well developed mapping services with many features like driving directions, location addresses etc.	
Other Services	Other services provided by Google and Yahoo include – Mobile – that allows browsing and searching of contents through mobile phones News – that collects news from different news sources and present to the user as per his/her preferences. Personalised home pages – you can create your own home pages very quickly. Weather – you can see weather conditions and predictions. Some other services include social networking and chat.	

Please note that many search engines provides the similar products. You must try several search engines from time to time as they keep updating their features.

Activity 6: Find all the products available with any four different search engines.

Check Your Progress 2

1. What is a Search Engine? How does it work?

   …………………………………………………………………………………

   …………………………………………………………………………………

2. What is searching? How efficiently you can search:

   …………………………………………………………………………………

   …………………………………………………………………………………

   a. Tutorials of XML

      ……………………………………………………………………………

      ……………………………………………………………………………

   b. Universities in India and USA

      ……………………………………………………………………………

      ……………………………………………………………………………

   c. Universities is not in USA or Britain

      ……………………………………………………………………………

      ……………………………………………………………………………

   d. Cleaning process of gold, it should not give process related to cleaning of jewelry

      ……………………………………………………………………………

      ……………………………………………………………………………

Activity 7: Find out 10 search engines from the web. Also list the importance in the context of type of searches they are good at. You may select the some of the search engines from the following list:

Bing, Yahoo, Google, MSNSearch, Lycos, Webcrawler, Hotbot, Alta Vista, AOLSearch, Alltheweb.com, Allacademic.

2.4 E-MAIL

Internet has changed the art of writing letters to email. Email is one of the ways on Internet to send messages to another person across the network. E-mail and postal mail coexist in the present India. In our country, the reach of postal mail is far more penetrative through technically you may claim that e-mail has the potential to reach every village may be through mobile devices. The e-mail system has been designed on the postal system that is why in email you have to write the email address of the sender and the recipient. In case the address of the receiver is incorrect the mail is undelivered and returns back to the sender. The advantages of e-mail over postal mail may be:

- E-mail is faster than postal mail.
- E-mail cannot be lost like letters and can be stored for life long.

- It can be edited and forwarded to other users.
- Emails are not affected by distances. It can be sent anywhere in world in seconds unlike postal mails.
- You can add video and audio with the e-mail.

The disadvantages of email over postal mail are:

- There must be computer or alternatively suitable mobile devices and network connection should be available at sender and recipient side unlike postal mails.
- There is a need of knowledge of opening email account and how email can be sent. There is no such knowledge is required for postal mail.

2.4.1 History of E-mail

Internet based E-mail system was designed by a Computer engineer - Ray Tomlinson in late 1971 while working with ARPANET. Tomlinson used a file transfer protocol to send electronic messages to any computer on the ARPANET network. The first email was sent between two computers that were actually sitting beside each other but connected through ARPANET.

The first important email standard was called **SMTP**, or simple message transfer protocol. SMTP was very simple and is still in use - however, SMTP has a problem – it makes no attempt to find out whether the person claiming to have sent a message is actually the same person. This basic flaw in the protocol was later to be exploited by viruses and worms, and by security frauds and spammers forging identities. Some of these problems are still being addressed.

In 2004, when Internet standards for email began to mature the **POP (or Post Office Protocol**) servers began to appear as a standard - before that each server was a little different. POP was an important standard to allow users to develop mail systems that would work with each other.

Now Internet mail is defined by a large number of standards and recommendations by the Internet Engineering Task Force (IETF). However, only a few of the protocols used in Internet mail are full IETF standards. Most of these standards are being used by for people writing Internet mail software.

2.4.2 How to create Email Account?

For sending or receiving email, you need to have to an email account. The email account may be provided by the organization for which you are working or else you can create an account with web based email providers. If you are working on mail services provided by your organization's mail server, you have to install and use email client software such as Microsoft Outlook Express, Pegasus Mail, Apple Mail client, Mozilla Thunderbird etc. On the other hand if you are using web based mail services then you may use the mail services offered by any of the web based mail service providers. Some of these web based mail providers are – Windows Live mail, Yahoo mail, Gmail, Rediffmail, and many more. In this section we discuss about the process of creating an email account with the web mail service. Although for example we have selected Gmail, you must try creating account with at least 3-4 such services and choose the one that suites you the most. It is also worth mentioning here is that most of these web e-mail programs work in a similar way.

Start the browser and Open the Gmail Homepage *www.gmail.com*. The screen similar to Figure 2.10 may appear on your system. Select the "Create an Account" button on the right.

Figure 2.10: The Screen for creating an account

Then following page will open

Terms of Service:	Please check the Google Account information you've entered above (feel free to change anything you like), and review the Terms of Service below. With Gmail, you won't see blinking banner ads. Instead, we display ads you might find useful that are relevant to the content of your messages. Learn more

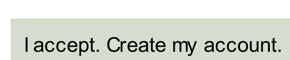


Figure 2.11: The Screen for entering information and creating an account

Fill all the fields and click "I accept. Create my account"

If you have not made any mistake then your account will be created, otherwise the error will be displayed. Correct the errors and try again. Now you have created your account.

Activity 8: Open your account with at least 3-4 web mail services.

Next time you visit the Gmail website, you can now you access your account as: Enter the *username* and *password* (as shown in Figure 2.12) and click "Sign in" button.

Figure 2.12: Log in to your account

Now you can access your account. An email account, in general has the following folders:

Inbox: Inbox is the main folder in your email account. It contains all the e-mails that have arrived in your e-mail account. You can click on inbox to see the mails that you have not read (shown in bold) as well as the mails that you have already read (in normal font)

Sent Mail: It shows all the e-mails sent by you from your e-mail account.

Drafts: This folder stores those messages that you have created but have not been sent by you so far. These messages are saved by you for more work.

Spam: Spam is unsolicited e-mails or junk mails. It is generally e-mail advertising sent to group of people. We can also term spam as unwanted e-mails. Spam mails are also a big cause of computer viruses. Spam mails are identified by the mail services and placed in this folder. These spam mails are automatically deleted after few days.

Trash: Any deleted mail is put in the Trash folder. Trash folder allows you to get back an e-mail which have already been deleted. But it is important to know that you can get back the mails only within few days from trash after its deletion. After few days, mails are permanently deleted from trash folder.

An email account, in general has the following options:

Compose Mail: Composing is addressing, writing, and sending an e-mail message. By clicking on the Compose Mail button a window appears where we can write our message in the message box and the email addresses of the person we want to send the mail.

Contacts: The Contacts helps you to find email address of a person whom you have saved in your Contact list. We can also quickly find email conversations associated with a contact, and store additional information about our other persons whose email id is stored in our contacts (such as a mailing address, title, phone number, etc).

Now, if you want to read your mails then click " **Inbox**"(Figure 2.13)

Figure 2.13: Inbox

If you want to send email then click "composes mail" and screen as shown in Figure 2.14 will appear.

In the **To** field you have to put the address of the receiver. In case you want to send email to more than one receiver then put commas between their email addresses or you can use "add cc" or "add bcc".

Cc stands for *Carbon copy* the persons whose address is listed in this field will receive carbon copy of the message and Bcc means *blind carbon copy* similar to Cc but only difference is that the recipient who had got Bcc is invisible to other recipients.

Subject : The main heading of your mail i.e., it will explain that the mail is regarding which issue. Please note that the subject should be descriptive of the mail to help the receiver understand what mail is about without having to open the mail.

Text Area : The message is written in this area.

When all the required fields are filled as shown in Figure 2.14, you can send the mail by clicking the *Send* button.

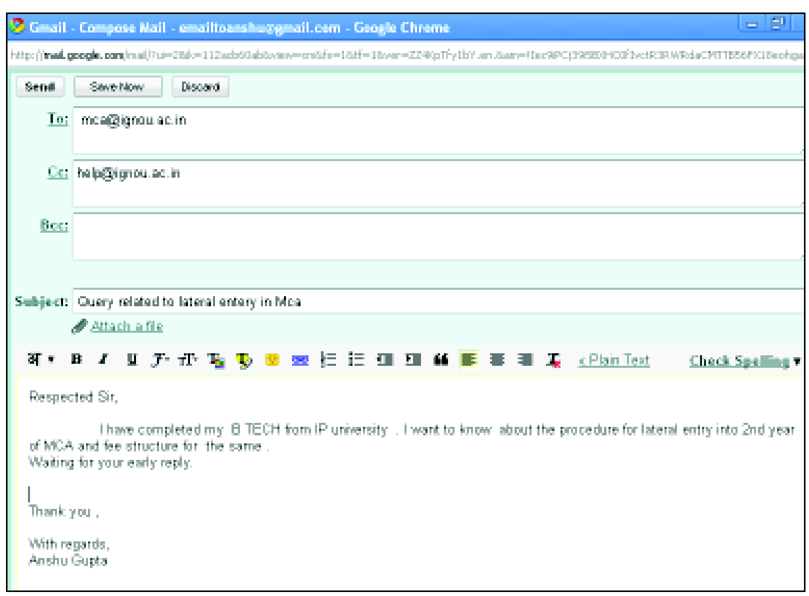


Figure 2.14: Compose mail window

Besides sending or receiving mails. Email services have other features. Contacts is one such list as explain earlier. Contacts can be organized in different groups like office, school, relatives etc.

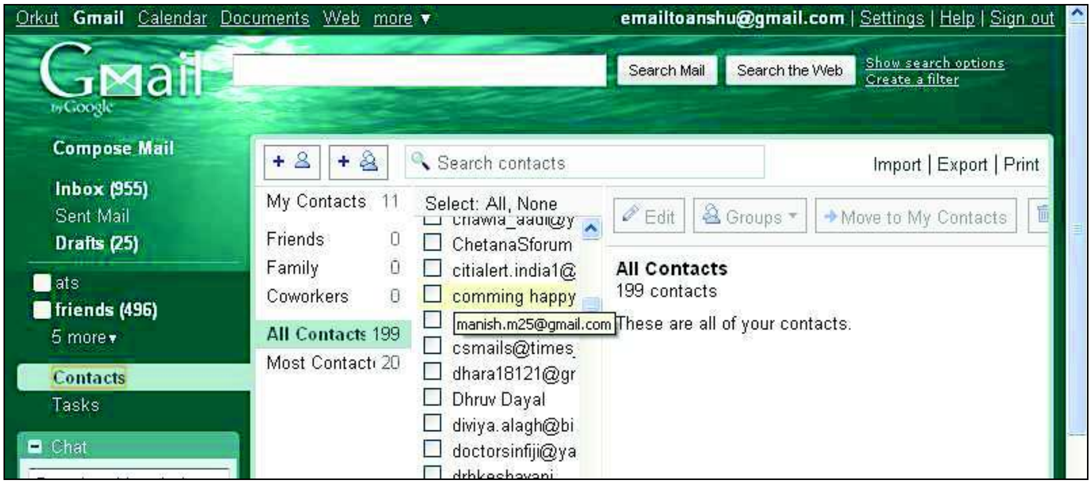


Figure 2.15: Contacts

Gmail also provides many other facilities in addition to the mail. These include Chat , Orkut, Calendar, Documents, photos, web and many more. We will discuss Chat in this unit, whereas Orkut is a social networking facility. Social networking is discussed in the next unit. You should try the other facilities yourself.

2.5 CHAT

The word chat in English language means - casual conversation. On Internet it means the same, except that you need to use text and your keyboard skills are tested. Earlier chatting was possible only between two people, now you can enjoy chatting with a number of people at a time. Now, you can use Voice Chat – it requires microphone and speaker; and Video Chat – it requires microphone, speakers and web camera. You can chat even using your mobile if it had that facility.

Chat is normally done in a chat room. Some of the common chat services are yahoo messenger (yahoo), Gtalk (Google), RediffBol. We will just show you an example using gtalk. However, you may use any other chat software. Remember you need to download and install chat software of your choice. After installing the chat software, you may run it to open the chat window so that you can start chatting. Figure 2.16 shows a typical chat window. To chat, you just type in the text and press the Enter key.

Figure 2.16: Chat Window

Most chat services also provide different forums, communities, discussion groups. These forums may be useful, for example, if you have any query, you just post it in forum. You may get the answer or you may get some related news or related information posted by a community. There are many such technical communities where you can learn latest in your field. Tutorials, interview, walk-in alerts, and online discussion with experts are available through these services. You may register with some such community.

What can you do with Chat Software?

- Most of the chat software support textual, voice and video chatting.
- You can create your electronic avatars using these software.
- While you may be chatting with group, yet may be able to send private messages to individuals.
- You can add graphics while chatting, even file transfer is possible.

There are several types of chat room variations online today. They include Java, Flash, MIRC and many other.

Java Chat rooms: The most common and popular chat scripts are based on java which is object oriented language. Java is freely available and comes with virtually every computer sold today. To use a Java chat room you must have Java enabled in your browser.

Java chat rooms load quickly and are reasonably fast to use. However, they require you to keep the new release of Java. You can get them from *www.java.com*

Flash Chat rooms

Flash chat is an upgraded version of chat rooms that is becoming more and more popular. Flash chat rooms use Adobe/Macromedia Flash Player client that are integrated into a website. Flash Chat rooms require that the Macromedia Flash Player from Adobe be installed on your computer. You can get the flash player for free from *www.adobe.com* .

Internet Relay Chat (IRC)

IRC is multi-user chat network where people around the world can chat and talk in channels or in private. To use IRC you must install IRC client on your computer. Using this client, you can connect to an IRC server, which is connected to other IRC networks. An IRC may have thousands of people you can chat with. IRC is being used for a long time.

MIRC

MIRC is a small computer program for chat. It has many chat channels. You can download the mirc chat from the mirc homepage *http://www.mirc.com.*

Some basic mannerisms while chatting: The term chatiquette describes basic rules of online communication. To avoid misunderstandings and to simplify the communication between users in a chat, these conventions or guidelines have been created. For example, one such convention is that it is considered rude to write only in UPPER CASE as it is considered analogous to shouting. You should not try to chat with unknown people. You should never use abusive or obsessive words.

2.6 SECURITY THREATS ON INTERNET

The Internet has many advantages; however, it also opens up security threat. In this section we just want to highlight some of the threats that you may face because of being an Internet users. When you use internet you are faced with three basic threat situations:

- **Confidentiality**: No unauthorized person should be able to read or copy information that s/he is not supposed to read.
- **Integrity:** No unauthorized person should be able to modify information.
- **Availability:** No unauthorized person should be able to erase information or make it inaccessible.

The other threats posed on the Internet are due to Computer Viruses and identity information thefts.

To make sure the above security situations the following methods may be followed by you:

Authentication and **authorization** mostly using username and password are used by most Internet security systems. Therefore, your username and password are very important and should be such that they cannot be broken easily. In addition, you must give the username and password only on a HTTP Secure website.

You can protect your computer against Computer Viruses and Malware (identity theft programs) through use of antivirus software, which quarantines or removes malicious software programs. So use good antivirus software on your machine that scans email and IM attachments. Maintain a backup of your critical data and programs. Keep deleting cookies from your computer from time to time.

You can use firewalls to block websites having unwanted contents.

The recent threat includes, a rise in threats to confidential information, exploitation of emerging Web browser vulnerabilities, and predictions for future attacks associated with blogs and social networking sites. So keep your browser up-to-date and do not give your personal information on blogs and social networking sites.

Other recent threats relate to wireless networking. Limit your wireless router range to the smallest convenient distance. Also try to maximize the security of wireless network by keeping a series of passwords.

Suggestion

The basic security MUST use a good firewall, strong antivirus software, and download files from safe sites only.

Check Your Progress 3

1. What facility of email makes it appealing than postal mail?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

2. How chat is different than email?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

3. What are security threats? How can you prevent it?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

Activity

1. Create and use email account in yahoo.
2. List the most important security threats on Internet

2.7 SUMMARY

This unit provides you a good account of basic internet applications. One of the major softwares required to do browsing is the Browser. Browsing is mainly looking into the content of Internet using the hyperlinks. You must have a good browser and keep updating the browser, otherwise it may become a security threat. Searching is a very important activity on the Internet as it contains huge amount of information. Therefore, search engines are to be used essentially to search good information. Search engines uses spiders that search the web for information about the words. The information then is indexed. These indexes provide the word and URL of the document where it is used. This information along with other information about the documents helps in the process of searching. Email and chat are two main applications of Internet. Email allows you to send messages while the other person may not be present to receive it while chatting requires a person receiving and replying. You must use internet in a safe manner otherwise you may be exposed to many security threats.

2.8 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. A browser is software that allows you to access and display a HTML document or web page from a web server. The document first gets downloaded along with all the related file and then is displayed in a browser window. There are different kinds of Web browsers - Text based, Graphical user interface based browsers, Java enabled browsers. Present day browsers are equipped with many features including security.

2. Communication is started by you when either you click a hyperlink or type a web address (URL) in the browser address bar.

   - The browser first takes the help of DNS to resolve the IP address of the website.
   - Then it requests a TCP connection with the Server and sends the request for the web page once the connection is established.
   - The server in response sends back the required web page and any additional request for pages. This whole communication is governed by HTTP protocol.

3. A cookie is a small text message sent by a web server to your web client. This message contains the information that you have submitted to that Web Server. Every time you connect to the server that has set the cookie, the information contained in the cookie is send by the browser to the server.

   Cookies are just text files that can be deleted at any time. They cannot spread viruses or harm your hard drive. However, they may be risk to your privacy. You should not give your information on unprotected sites; also never forget to delete cookies, if somebody else is sharing your computer either in your study center, office or cyber café.

Check Your Progress 2

1. Search engines are special sites on the Web that helps you to find information stored on other sites. There are differences in the ways various search engines work. But there are three basic steps which most search engine perform:

   a. Web Crawling
   b. Indexing
   c. Searching

a) **Web Crawling** : To find information on the hundreds of millions of Web pages that exist, a search engine employs special software robots, called spiders, to build lists of the words found on Web sites. Process of building list by spiders is called crawling.

b) **Indexing :** Once the list of information on Web pages is made, the search engine stores the information in a way that it can be searched on words and list related URLs.

c) **Searching :** Searching through the index involves a user building a query and submitting it through the search engine.

2. Searching implies typing the required search term into the search field and pressing the Search button

a. First you simply type Tutorials of XML

And then next time you type "Tutorials of XML"

The second search will be more accurate as it contained the exact phrase.

b. Universities and (India or USA).

c. Universities and (not(USA or Britain)

OR

\+ Universities - USA -Britain

d) Cleaning process of gold – cleaning process of Jewellery
This will give list of web pages which has cleaning process of gold and not of Jewellery.

Check Your Progress 3

1. Email provides feature of contacts, sending same mail to many person, forwarding mails in addition to being very fast.

2. Email does not require receiver of the mail to be present at the time of sending the Email. The receiver may open the email whenever s/he logs in. Chat, however, is a synchronous communication.

3. The information should be seen, written and made available at the required time to the authorized person only. Other threat includes viruses and privacy of information. The best solution in such cases is to use internet judiciously. Use good antivirus software and firewall, do not give your information on non secure websites, do not download content from unsafe websites etc.

2.9 FURTHER READINGS

- www.wikipedia.com
- http://www.eiu.edu
- http://www.neiu.edu

UNIT 3 WEB APPLICATIONS II

Structure

3.0 INTRODUCTION

As discussed in the previous unit, Internet has many applications for its user. In the recent times, one of the major applications of Internet has been the Web 2.0 technologies that are identified by more interactive Internet based applications. Some of the popular technologies used in Web 2.0 include XHTML, Cascading Style Sheets (CSS), eXtensible Markup Language (XML), Asynchronous JavaScript on XML (Ajax), Ruby on Rails, Adobe Flex, Java and its frameworks, PHP, ASP.net and many more. The aim of this unit is not to introduce you to these technologies but familiarize you with some of the important applications that have been developed using these technologies under the Web 2.0. These newer applications are allowing you to do a number of activities that were unthinkable in the last decade. Today, you can go to social networking sites through which you can find and remain in touch with your friends. You can share your pictures, videos, ideas with them. You can go on to make many new friends. You can also register and study through online means. You can get access to online study material, tutorials, feedback system and so on. Thus, internet has the ability to transform your life. However, you must use Internet intelligently otherwise it can be very distracting also. You must use the online activities for benefit and advancement of your career.

This unit is an attempt to provide you information on some of the popular applications of the Internet in recent times.

3.1 OBJECTIVES

After going through this unit, you should be able to:

- define the purpose of e-learning;
- describe the processes in e-learning;
- explain the use of Wiki;
- participate in Collaboration on the net;
- take steps to do Social networking; and
- create a simple Blog.

3.2 E-LEARNING

E-learning is one of the most used terms on the Internet that describes any form of learning that is facilitated academically by the electronic means. Such means may be in the form of multimedia rich contents, web based lectures and web based tutorials or training programmes. In general, E-learning is strongly supported electronically by the administrative, academic and assessment processes.

Some of the activities that may be done using such electronic form using web sites include providing multimedia based contents, providing assignments, conducting on line tests, lectures or discussions through web conferencing, feedback on students work, student progress report to faculty etc.

Some of the major advantages of E-learning are:

- It allows creation and fast update of online contents.
- You may use the contents at your own pace and convenience.
- E-learning also provides a possibility of standardization of contents that can be changed much faster.
- It has the potential of providing new learning opportunities.
- It has the possibility of student's interaction.
- Flexibility of programme/course management such as student may choose courses of their choices.
- Allows creative development of new courses in specific areas.
- E-learning brings people together and allows sharing their experience and thoughts.
- You can do an e-learning programme from anywhere in a much easier way.
- It allows expanding boundaries and gain knowledge without having to leave home.
- Overall, in general e-learning allows saving of resources.

Some of the key requirements for a good e-learning system are:

- A successful e-learning system depends on good student interaction, self-motivation of individuals.
- A student has to study in an effective manner. This is essential as there is no teacher to motivate or drive the student.

3.2.1 E- Learning Processes

Since, any e-learning project checks your achievements against a learning outcome, therefore, it starts with identification and verification process. The common process used for this purpose is the use of Username and Password. You are asked to login to the e-learning system before you start using it.

Once you are successfully logged in to the system. The e-leaning topics or contents are presented to you topic by topic. This content may include text, graphics, video, audio, animation, link to other references. In general, such content may be followed by some quiz or questions that try to access your understanding about the topic that you have studies. The e-learning systems may be a Learning Management System (LMS) or Content Management System (CMS) running as the base system. These systems help in recording information about you - such as time spent by you on a topic, marks scored by you in a feedback quiz etc. All such information may be sent to the content designer as a feedback, who in turn may modify the content of the basis of the feedback so obtained. Thus, an e-learning system supported by LMS or CMS will have different types of users who will have different access rights. For example, a student may be allowed to see the contents of the courses s/he has registered for, his/her scores in various quizzes and assignments, whereas an instructor may login to correct the specific content, load an assignment for the student or a new video for the student, provide a link to a new important material, look into consolidated student response and identify weaknesses in the contents, identify the students who are defaulting and find ways to contact those students may be using SMS. Thus, the technology provides a number of ways a teacher and a student can communicate with each other through the e-learning system. Please note that e-learning technologies are available in the present time, only that they need to be properly harnessed for the proper teaching learning process. Some of the activities that may be undertaken by students in the e-learning process:

- Login.
- Content access and assimilation.
- undertake formative assessment online.
- formative assessment using assignments and discussions.
- Getting the feedback on formative assessment and working towards achieving learning outcomes.
- Communication with the students through various means like; email, chat, SMS, and other means.
- Go through a summative assessment.
- Measuring the effectiveness of e-learning and performance assessment.
- Recoding student achievements and certification.

Please note that it is not necessary that all the e-learning system have all such activities. However, a good e-learning system should have most of these activities.

3.2.2 E-Learning Content Development Process

Developing E Learning contents is a specialised activity. The quality of e-learning relates to achievements of the objectives of the content by the learners. Better quality e-learner content can be created if you follow a proper process of e-content generation. A simple e-learning content process is given in the Figure 3.1.

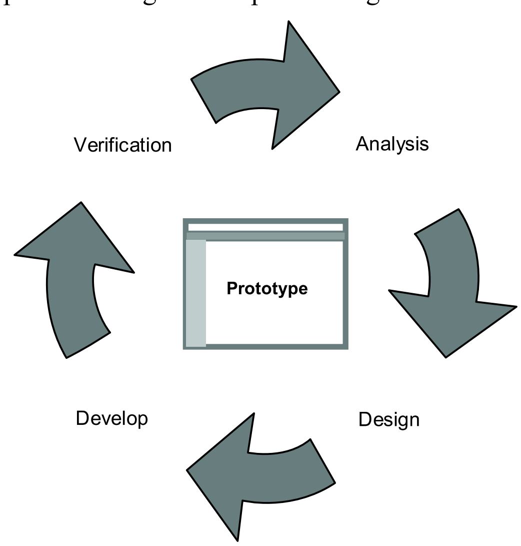


Figure 3.1: A simple development process for development of e-learning contents

Analysis Phase: Analysis requires identifying the learning objectives for the development of content for the target audience. This phase also lists the financial, technological and time constraints for the e-learning project. It also enables identification of the gap between the expected knowledge of the target audience and what they should know after going through the course. This facilitates the design phase.

Design Phase: In most organizations the design phase involves development of a storyboard that may include a concept flow, text, graphics, video, audio, animation if needed. In this phase you may also design the basic questions that must be answered by the learner after going through the learning content. You may also design the interface and interactivity during this step.

Implementation Phase: Implementation phase brings the design to live course material. You may take the help of various experts for this phase including content expert, graphic expert, interaction designer, web designer etc.

Verification Phase: during the Verification phase the contents so produced can be tested to determine if it is conveying what it is expected to convey. It may also be used to check the usability features of the product. You may perform verifications by e-learning experts or sample of target audience.

3.2.3 An Example of E-Content and Support - IGNOU

IGNOU uses two different e-platforms form providing learning and support. The first platform provides several programmes from the website *http://www.ignouonline.ac.in*. This web site support many features starting form online admission to delivery of contents and online discussion sessions. Some of the screens demonstrating these activities are shown in the Figure 3.2.

.

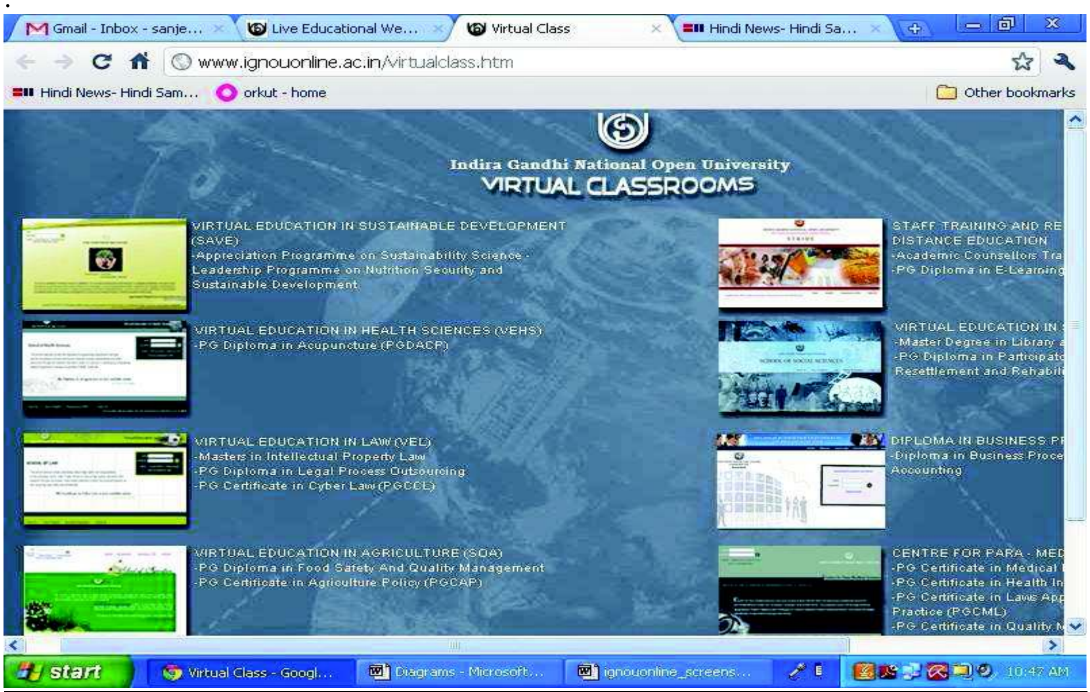


Figure 3.2: IGNOU online programmes

Figure 3.3 : An online programmes of IGNOU

The second platform that is under development at IGNOU is based on IGNOU wiki which is supported by the MOODLE like learning and content management system. The model of e-learning as conceived at IGNOU is given in Figure 3.4

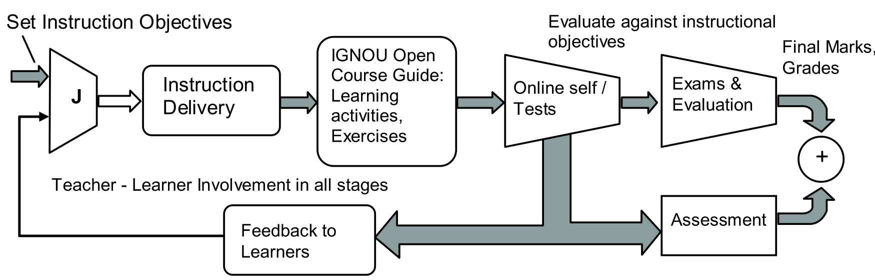


Figure 3.4: One of the Proposed e-learning Model of IGNOU
(Source: Presentation of Prof K. Srivathsan, ProVice Chancellor, IGNOU)

Detailed description of each block is outlined below:

Input Block 'J': J' here stands for judging the gap between set instructional objectives in a learning module such as a Unit or a Block TO the understanding achieved as measured by the Self Test or in the interactions in discussions.

Instruction Delivery: Instruction Delivery may use different modes.

- It may be the conventional class teaching. (please note that this model even envisages the classroom as well as e-learning)
- It may be recorded Video Lectures being used by a counselor for a group of students.
- It may be the Self instructional material (such as this block itself) designed and developed for a course by IGNOU
- It may be the programme portal like ignouonline or any other e-Content Website of IGNOU.
- Any hybrid of these modes may also be employed.

IGNOU Open Course Guide (IOCG): The open course guide is an extended version of your Programme Guide. The objective of introducing the IOCG is to help student with information about a course and also to provide information on good supplementary content. IOCG may be maintained by the Course Management Group.

Online/Self Tests and Feedback to the Learners: A good education system is one that provides feedback to its learners at several stages of study in a course. This feedback may be provided using self tests that try to determine how much they have understood against the instructional objectives stated in the Block/Unit of study. At present these tests are in the form of Check Your Progress exercises in your study material. These tests may be conducted in the future typically using online platforms like Module LMS or even on a Wiki.

Assessment: You as a student has to undertake formative assessment with feedback that finds out the extent of fulfillment of objectives of the learning. At present assignment are the tools to do such assessment. However, in a e-learning system a number of possibilities exists that may be used in the future. Some of these activities may be student participation and engagements in specified learning activities like practice sessions, group discussions, laboratory experiments, term papers, critical writing, etc.

Examinations and Evaluation: This is a part of Summative assessment of the student achievement. The overall course may have a term-end examination. At present, such examination is through a formal examination system. However, with developing technology may be in future, it may take a different form. For example, some part of the summative assessment may happen through on-line examinations as is already being done for various professional certification and entrance examinations.

The details on Vedydhara are given in the section 3.3.

3.2.4 Modular Object-Oriented Dynamic Learning Environment (MOODLE)

MOODLE is a free and open-source e-learning software platform. It provides feature for Learners and content management. In the past decade, it has become very popular for the delivery of e-learning content and student management. You can get access to information related to Moodle for the website *http://www.moodle.org* (Please refer to Figure 3.5). Alternatively, you may download the Moodle software and create your own server having Moodle

Figure 3.5: Home Page of MOODLE

To access the MOODLE and learn about it from the Moodle website, you may need to create an account. The process of creation of an account with Moodle is somewhat similar to what you do for creating any Internet based account like email account.

The popularity of MOODLE may be attributed primarily to the fact that it is free and it allows dynamic content creation facilities. It has a number of tools available for managing a number of students online. In addition to content management, MOODLE provides a number of tools for building interaction among the learning community. Thus, allowing collaboration and peer to peer learning in the learning communities.

The best way to learn MOODLE is read tutorial on MOODLE from the MOODLE website. The main content page for this website is shown in Figure 3.6.

Figure 3.6 : MOODLE Course page

Finally, please note that these days there are several standards which have been developed for standardization of learning contents. MOODLE supports most of these standards. A detailed discussion on these standards is beyond the scope of this Unit.

3.2.5 Advantages and Disadvantages of E-Learning

Before we discuss about advantages and disadvantages of e-learning, you should know that e-learning is just another model for learning. It is not that it can replace all other forms of learning models. However, it provides several opportunities that may be of benefit for creating certain learning instances. Some of these opportunities are:

- It allows possibilities of course material but that require constant support of a course team.
- The level of participation of student in learning may improve as it provides anytime, anywhere learning, but in any case the student has to be motivated by the course team from time to time.
- E-learning does improve the IT skills of individuals and may improve their time management skills.
- The content like recorded lectures may be viewed by a student at any time, however, the interactive support that requires teacher at the other end may still be available in slotted time only.

- It allows you to measure student activities very easily, but beware too much of interference in student style of learning is not advisable.
- E-learning gives flexibility in curriculum design and reuse of contents, however, the expert team has to work constantly to make that happen.
- The general understanding of e-learning as cost effective mechanism is often misleading. Please note that first e-learning is about teaching-learning process. Any good teaching-learning process is rigorous and requires substantial costs.

3.3 ELECTRONIC EDUCATIONAL RESOURCES

In the present era, you can get access to a large number of electronic educational resources through the web. These resources may be on different specialized areas. These resources include the electronic journals, encyclopedias, dictionaries, digital libraries, educational resource databases, indexing and abstracting databases and electronic books. However, please note that some of these resources require paid subscription. These resources allow you to browse through the abstracts, search on various topics, and access the complete information for research in specific areas. Some of these electronic resources are listed below:

E-Journals and Databases

- ACM Digital Library
- EBSCO database
- IEL Online
- JSTOR
- Lawyers Collective Magazine
- Lecture note in Mathematics
- Maths Sci_net
- Project Muse
- ProQuest
- Springer Link
- Taylor and Francis

WTO E-library

Indexing and Abstracting Databases:

- LISA
- J-Gate

E-Books

- Credo References
- Idea-Reference Resources
- NetLibrary

WIKI

Wiki's are a powerful tool for creating collaborative knowledge resources created by the community. A wiki is a page or collection of Web pages designed to create and edit contents. Wiki supports hyperlinks and has simple text syntax for creating new pages. Wiki's are also used to create websites, to enhance the features of community websites and for knowledge management. The collaborative encyclopedia, Wikipedia (*www.wikipedia.com*) is one of the best-known wiki's. It contains very large number of articles – all created and moderated by the community. Ward Cunningham developed the first wiki software - WikiWikiWeb in 1995.

Wiki stands for "What I Know Is".

Characteristics of Wiki

- A wiki invites all registered users to edit any page or to create new pages within the wiki Website.
- Wiki promotes meaningful topic associations between different pages by making page link creation very easy.
- Wiki promotes discussion and also keeps the history of changes of a document.

Figure 3.7: WIKI in Wikipedia

You can write documents in a wiki using a markup language. You can see a wiki page using web browser. Wiki pages are connected through hyperlinks. So in general, a wiki is database for creating, editing, browsing, and searching through information.

Another example of wiki (as stated in section 3.2) is Vedyadhara, also called the IGNOU Open Course Guide (iocg) wiki. The figure 3.8 shows the home page of Vedyadhara of IGNOU *http://vedyadhara.ignou.ac.in/wiki/*

Figure 3.8: Vedyadhara wiki

Vedyadhara is a website that uses specific wiki software for user creation and editing of web pages. In the case of IGNOU, the wiki software used in Media Wiki – the same software used by the famous Wikipedia. It is a simple system that enables creation of web pages without knowing the Hypertext Markup Language (HTML). It requires only common word-processing skills, and knowledge of some Media Wiki tags to work. Vedyadhara may be used in the future for administrative and academic activities such as:

- Curriculum Design documents
- Compilation of documents
- Keeping daily records as well as personal information
- Developing Learning Materials in a collaborative manner

Vedyadhara will provide following information about various courses:

- Course Objective
- Course concept map which links to learning module
- Sequence of learning modules
- Course support and counseling details.
- Course calendar
- Assignments are uploaded
- Course evaluation approach
- References, web references
- Video lectures by IGNOU and other lecturers.
- Instruction team and contact details.

It further plans to have prerequisite quiz for students to check that they have a basic knowledge for taking up that course and feedback system given by students to the course team.

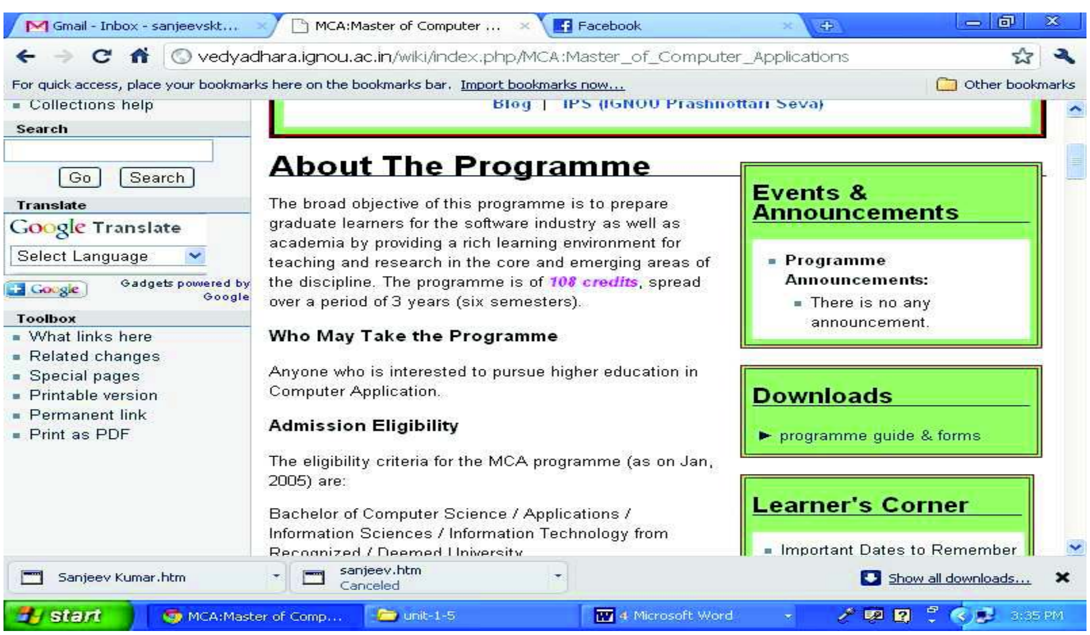


Figure 3.9: A Programme Page on Vedyadhara wiki

Check Your Progress 1

1. What is eLearning? Compare e-Learning courses with traditional, on-campus courses?

   …………………………………………………………………………………………
   …………………………………………………………………………………………
2. How do e-Learning classes work?

   …………………………………………………………………………………………
   …………………………………………………………………………………………
3. How is e-learning useful for Universities?

   …………………………………………………………………………………………
   …………………………………………………………………………………………
4. What is wiki? How is it useful?

   …………………………………………………………………………………………
   …………………………………………………………………………………………
5. What is MOODLE?

   …………………………………………………………………………………………
   …………………………………………………………………………………………

3.4 COLLABORATIONS

Collaboration is defined as an act or process of working together on a project or some intellectual activity.

But what is the importance of collaboration? The world is increasingly becoming globalised on issues like environment protection, control of terrorism, international business, learning etc. In such changing circumstances, even the scientific explorations have become collaborative. Thus, in this global world, role of the Internet tools is to enable collaboration among people. From this perspective chat, news groups, wikis all are some basic tools for collaboration. Collaboration involves both communication and sharing of ideas. Modern day science, to certain extent, has become collaborative. Today, you may find a number of research papers coauthored by many people staying at geographically diverse places.

Each collaborative project has several social, political, ethical and technical issues that are to be addresses at the start of the project itself.

Some of the key questions a distributed collaborative project needs to address are:

Will cumulative wisdom emerge from the collaborative efforts? After all a collaborative project also requires good investment. Several research papsers have been written about the broad set of success measures and factors that are responsible for successful collaboration. You may refer to further readings given at the end of this Unit for more details.

Some of the areas where collaboration has been found to be successful is the area of physical science that requires huge investment in expensive devices. However, if the already existing labs can do a distributed collaborative attempt then the overall cost of a project may be reduced. One such area may be the high-energy physics. Another important area in this direction may be Health Sciences. Some of the complex data intensive problems including genetics, neurology, biomedicine etc. may require international participation. The third important area for collaboration is the Environmental Studies, this also require wide spread data collection and involvement of large communities. Some of the topics of concern may be the ecology. The latest discovery of new species of plants and animals are result of collaborative efforts. The earthquake data and global tsunami warning system may be based on worldwide collaboration.

As stated earlier, most of the tools used on the Internet can be used for some form of collaboration. However, we would like to show an example of collaborative tool for student. Google Docs is one such tool that may enable you to create a collaborative project report online. You may create a document using it and share it with your colleagues who in turn may be able to add content to it from anywhere, edit it and discuss about it using a discussion group. For example, you want are writing a research paper with few other writers. You may create a draft report that may be edited by other writers online. Please note that in such a case all of you are working on the same document. Please note that this document may be a spreadsheet or presentation or just text document.

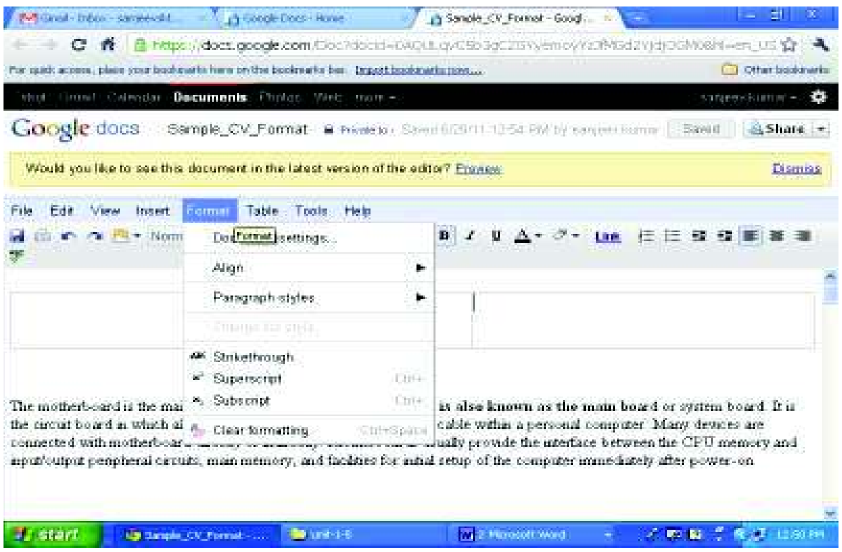


Figure 3.10: Google Docs

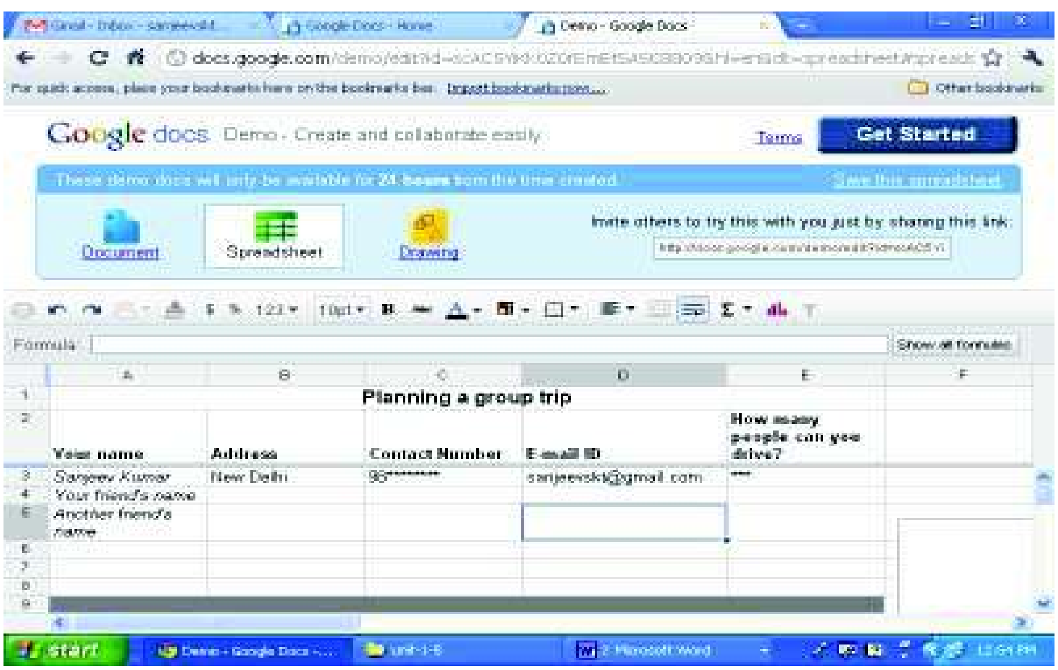


Figure 3.11: Google online Spreadsheet

Similarly, such kind of collaborative activity exists in the Microsoft Office 2010 and Adobe Acrobat. In addition, there are many tools available on Windows and UNIX for collaboration.

Another software that can be used for collaboration is Google Wave. It allows you a shared web space for discussion or working together in a group. You may use text, photographs, maps etc for this purpose. This software also combines collaboration with email, chat, messaging etc. The following figure shows a sample screen of Google wave:

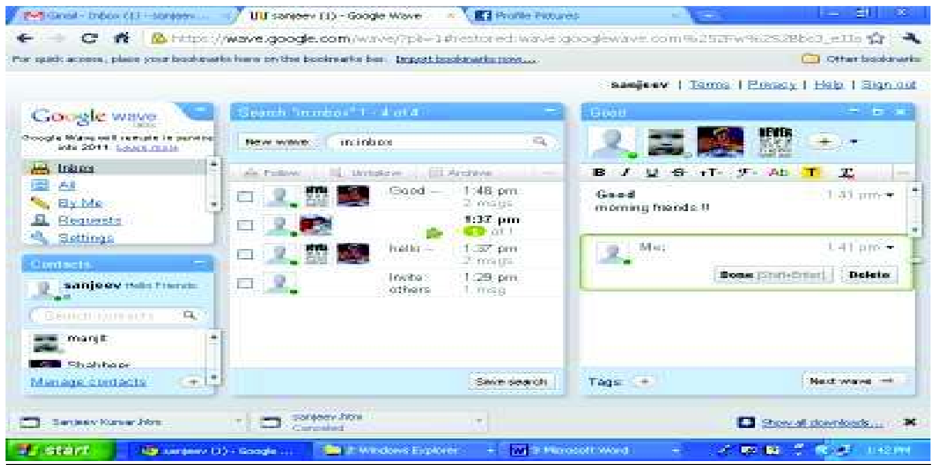


Figure 3.12: Sample Google Wave Screen

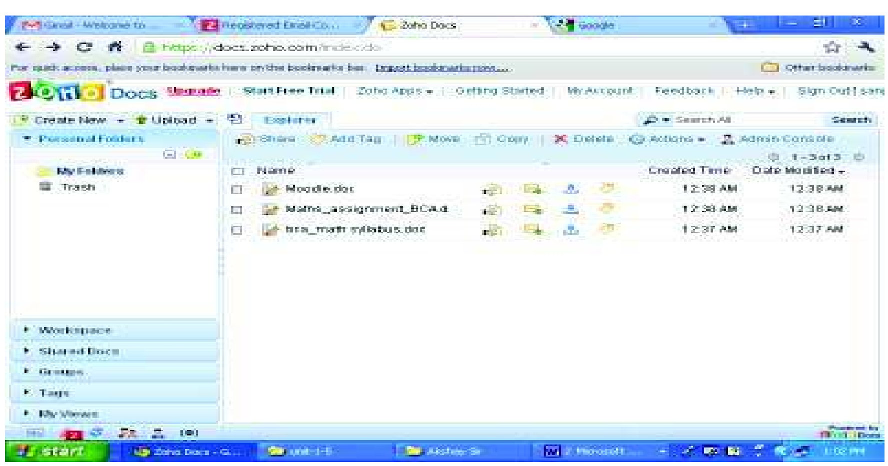
There are plenty of other web-based collaboration tools. Here are a few of them:

MediaWiki

As discussed earlier, Media Wiki is the software in which Wikipedia and IOCG wiki of IGNOU have been developed. It is a very simple tool that allows multiple people to make and commit changes in a document. It keeps the version of each change. Many Universities have used this software to develop a collaboration space.

Zoho

Zoho is a division of ZOHO Corporation, a US-based Software Company. Zoho is a very good site for collaboration. It not only allows simple mundane tasks like group editing, document sharing, group chat, etc but also provides some management tasks like milestone tracking, invoice creation, and other team tasks. The figure 3.13 shows the screen on Zoho. For more details on Zoho, you may visit the website:



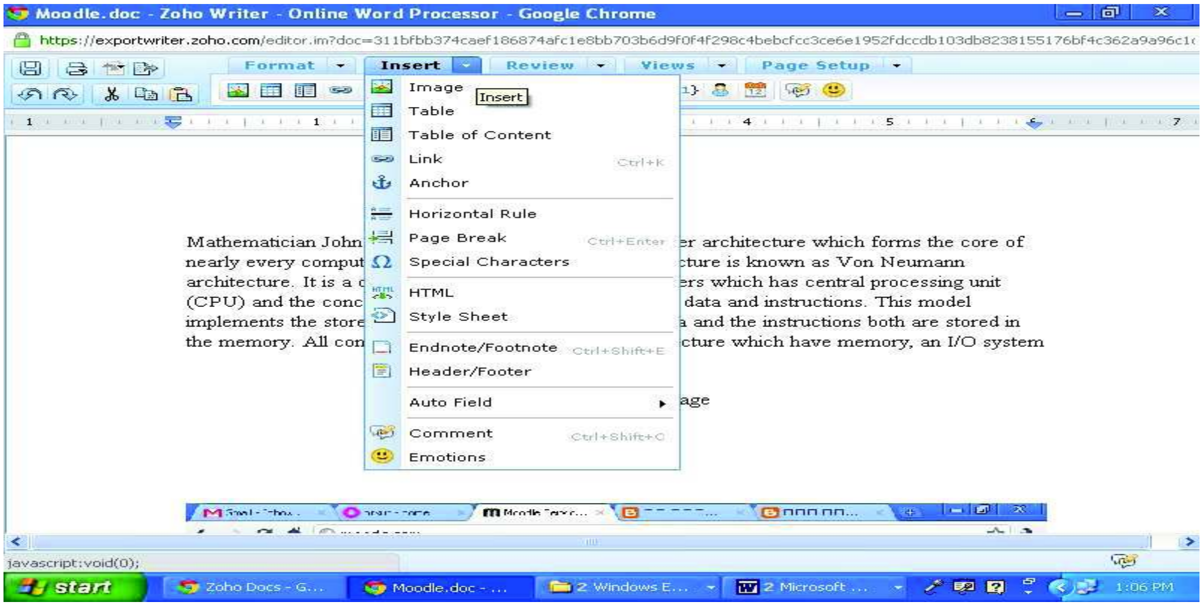


Figure 3.13 : ZOHO docs and word processor

Volunteer Computing:

A somewhat similar concept to collaboration is the concept of volunteer computing where you allow your hardware resources to be used for the purpose of some online project. One such project that is hosted by Space Science Laboratory at the University of California, Berkley is for Search of Extra-Terrestrial Intelligence called SETI@Home. This project employs a software platform called BOINC that you need to download in case you wish to part of the project. Once, you become part of the project then your computer executes some of the data that is constantly being received from sensors. This project has paved the way for volunteer computing but has not located any Extra Terrestrial so far. You can obtain more details on this project from the website *http://setiathome.berkeley.edu/*. Researches in Taiwan are making an attempt to use volunteer computing to visualize earthquakes.

3.5 SOCIAL NETWORKING

A social network is a network of individuals which have some sort of interdependence on each other. This interdependence may be in the form of friendship, kinship, common causes and so on. A Social networking service may be offered through a web site on the Internet. Some of the popular social networking services are – Orkut, Facebook, Twitter, Linkedln, MySpace, Friend Finder, Yahoo! 360, Classmates and many more.

You need to register to a social networking service in order to use it. Some of the features provided by these services are:

- Creation of a profile page of your own informing others about the information that you would like to share about you.
- Viewing of profile pages of others.
- Creating your own network of friends.
- Searching online friends.

- Putting your albums online for your friends.
- Sharing your thoughts and experiences.
- Sharing of audio and video may be through youTube – a popular website where you can put your videos for general public viewership.

The Social networking technologies have opened up a new way for information and knowledge sharing. Social networking allows instantaneous communication of information to large audience. It helps in generating large scale public response to emergency situations that may occur during disaster. One such use of social networking and mobile technology is cited in the further readings, where these tools were helpful for emergency rescues, and gathering and disseminating real-time information by government agencies, in the case of typhoon disaster in Taiwan.

The figure 3.14 shows a screen of common social networking services :

Figure 3.14: A Sample Social Networking Service

Social networking sometimes can be potentially unsafe. **You are advised not to put any confidential information about you on such sites.** You must use such services for good reasons and not misuse them. Some basic security policies for such sites are:

- Please do not share your account related information such as username and password.
- Always scan your computer for viruses and spyware.
- Do not add strangers as your friends about whom you are not sure about this/her identity.
- Always make sure to sign out once you have done your intended activities
- Restrict the individuals who may see your profile.
- Do not use bad or aggressive vocabulary on such web sites.
- Do not allow people to use such sites for unlawful purposes.

3.6 BLOG

Blog is a website where entries are written as information or news on a particular subject. You may choose any subject for writing a blog like food, health, or information about IGNOU dates etc. A blog may combine text, images, or other media components; however, most blogs are textual. They may also provide links to other web pages or blogs. In addition, blog allows you to leave comments in an interactive format. Blogging is becoming increasingly popular among students as it allows you publish and keep record of your ideas over time. In addition, you may get some useful comments on your ideas may be from your teacher or your peer group or other people. A blog need not be restricted to a single author; it can merge different kinds of ideas, including fellow students, teachers, and subject specialists. An example: *http://edu.blogs.com/*.

Blogging is emerging as wonderful way to share and publish your views. Most famous person these days have their own Blog.

Figure 3.15: Few Blogs

Many famous personalities these days are hosting their own blog. The following is one of the many websites through which you can create your own blog.

Figure 3.16 : One of the website that allows you to create blog

Following are the list of some of the types of blogs that are currently in use on Internet. We have not given graphical examples of these blogs. You must explore blogs on internet itself.

- Corporate and organizational blogs – may be used for projecting organizational culture and market branding.
- Category based blogs – blogs on particular subject like travel, health, environment, music, education and many other.
- Blogs having different media and device types – a blog having only videos may be called *vlog*, having only links may be called *linklog*, there are many such categories, a log for mobile devices may be called *moblog*. The collective community of blogs is known as the *blogoshere*.

How to Start Your Own Blog

- a good blogging service provider. You may select blogging service providers like LiveJournal, Blogger, WordPress.com, Xanga, Tumblr and Webs. Most of these services provide templates for creating and publishing blogs. You may be able to choose colours and layout for your blog.
- You can make a blog public or private based on your requirements. A private blog may be password protected.
- Make few sample postings and test your blog for the look and feel. After completing the blog publish the URL of your blog on your website.
- Visit and leave comments on other blogs leaving your blog address so that they can also make a visit to your blog.
- Update your blog frequently so that when people return they have something new to read.

Some Issues while blogging

Blogging may result into some unforeseen consequences including legal liabilities, therefore, you should be very careful while blogging. You should never release any confidential information about you or any other person or organization. Please do not use any defamatory language against anybody in a blog. Please do not discuss office matters through blogs. Please be very careful of the language you are using on the blog, it should not be offending, aggressive or abusive.

Check Your Progress 2

1) Why is collaboration used on Internet?

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2) What are the different ways of sharing information through Internet?

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3) Explain the advantages of Blogging.

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3.7 SUMMARY

This Unit highlights some of the popular applications of the Internet with the advent of Web 2.0. This Unit is not about the technologies but about what are the different applications and how can you use those applications. The Unit first have introduced you to e-learning applications. It highlights the IGNOU e-learning model and the way you can access IGNOU e-learning. The unit also introduces you to the process of creation of e-contents. The Unit also provides information on educational resources that can be found on the Internet. In addition it provides information about the usage of wiki. IGNOU may be using Vedyadhara wiki for its courses. A Wiki is a collaborative community website where you can compile and publish the information posted by different registered users. We have also discussed topics such as collaborations, social networking and blogging. Collaboration allows us to participate in different projects from our own places, social networking allows us to share information with friends and blogging allows us to publish information online. A word of caution – "Please use all these applications judiciously, beware we do not know how someone may misuse information about us.

3.8 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. E-learning is electronic based learning that uses latest technologies to support the delivery of training or education. E-learning as far as reach and access is concerned provides better opportunities for the learner. In addition, if e-learning uses Content and Learner Management System then can provide useful tips for teachers about the learners and usefulness of content. E-learning can also support interactivity.

2. First of e-learning need not necessary be conducted as a classroom lecture on the Internet. It may be a recorded lecture or a session in which student undertakes the study of learning content created for the purpose of e-learning. Thus, you can learn through online study material, you can interact with the teacher using email or synchronous chat, do online quizzes or assignments, participate in discussions.

3. E-learning can be used in many ways by the Universities – may be for delivering online distance learning programmes using leaning contents, or blending e-learning with other face to face courses. In both the cases, there is an opportunity to enhance the quality of learning.
4. Media wiki is software that enables collaborative, dynamic creation of websites called wikis that can be used to provide information about an organization. Wiki is useful as it allows editing of the content without any problem in a collaborative manner.
5. MOODLE is a open source software that is very popular these days as a content development and learner management system. It is very popular among teaching communities for development and delivery of educational programmes.

Check Your Progress 2

1) The collaboration helps in sharing of resources. These resources may be your intellectual efforts, hardware computing power or any other form of activity. Collaboration helps in solving complex problem domains by distributing the problems.
2) You can use e-mail; messenger services, Chatting to share your ideas, knowledge, and feeling. You can join social networking sites and create friends group to share your information. You can use websites to publish huge amount of information on Internet.
3) Blogs if used properly can help your expression. It has the potential of preservaing your ideas, getting comments on your ideas and developing your ideas.

3.9 FURTHER READINGS

1. Book titled “Scientific Collaboration on the Internet” Edited by Gary M. Olson, Ann Zimmerman and Nathan Bos. (Year of Publication)
2. www.wikipedia.com
3. www.facebook.com
4. edu.blogs.com
5. www.mynewblog.com
6. www.ignou.ac.in
7. http://setiathome.berkeley.edu/
8. www.google.com
9. www.zoho.com
10. http://www.moodle.org
11. Web 2.0 and internet social networking: a new tool for disaster management?--lessons from Taiwan, Huang CM, Chan E, Hyder AA, Public Med.gov at *http://www.ncbi.nlm.nih.gov/pubmed/20925944*; Source-International Injury Research Unit, Department of International Health, Johns Hopkins Bloomberg School of Public Health, 615 North Wolfe Street, Suite E-8132, Baltimore, Maryland 21205, USA. *chuang@jhsph.edu*
12. http://www.wikihow.com/Start-a-Blog