COMPUTER FUNDAMENTAL

Module 1

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LESSON 1

BASIC CONCEPTS

1.1 INTRODUCTION

Let us begin with the word 'compute'. It means 'to calculate'. We all are familiar with calculations in our day to day life. We apply mathematical operations like addition, subtraction, multiplication, etc. and many other formulae for calculations. Simpler calculations take less time. But complex calculations take much longer time. Another factor is accuracy in calculations. So man explored with the idea to develop a machine which can perform this type of arithmetic calculation faster and with full accuracy. This gave birth to a device or machine called 'computer'.

The computer we see today is quite different from the one made in the beginning. The number of applications of a computer has increased, the speed and accuracy of calculation has increased. You must appreciate the impact of computers in our day to day life. Reservation of tickets in Air Lines and Railways, payment of telephone and electricity bills, deposits and withdrawals of money from banks, business data processing, medical diagnosis, weather forecasting, etc. are some of the areas where computer has become extremely useful.

However, there is one limitation of the computer. Human beings do calculations on their own. But computer is a dumb machine and it has to be given proper instructions to carry out its calculation. This is why we should know how a computer works.

1.2 OBJECTIVES

After going through this lesson you will be in a position to

- define a computer
- identify characteristics of computer
- know the origin and evolution of computer
- identify capability of computer in terms of speed and accuracy
- distinguish computer from human beings and calculator
- identify the role of computer
- appreciate the evolution of computer through five generations

1.3 WHAT IS A COMPUTER?

Computer is an electronic device. As mentioned in the introduction it can do arithmetic calculations faster. But as you will see later it does much more than that. It can be compared to a magic box, which serves different purpose to different people. For a common man computer is simply a calculator, which works automatic and quite fast. For a person who knows much about it, computer is a machine capable of solving problems and manipulating data. It accepts data, processes the data by doing some mathematical and logical operations and gives us the desired output.

Therefore, we may define *computer as a device that transforms data*. Data can be anything like marks obtained by you in various subjects. It can also be name, age, sex, weight, height, etc. of all the students in your class or income, savings, investments, etc., of a country. Computer can be defined in terms of its functions. It can i) accept data ii) store data, iii) process data as desired, and iv) retrieve the stored data as and when required and v) print the result in desired format. You will know more about these functions as you go through the later lessons.

Fig. 1.1 below depicts a personal computer.

Fig. 1.1: Personal Computer

1.4 CHARACTERISTICS OF COMPUTER

Let us identify the major characteristics of computer. These can be discussed under the headings of speed, accuracy, diligence, versatility and memory.

1.4.1 Speed

As you know computer can work very fast. It takes only few seconds for calculations that we take hours to complete. Suppose you are asked to calculate the average monthly income of one thousand persons in your neighborhood. For this you have to add income from all sources for all persons on a day to day basis and find out the average for each one of them. How long will it take for you to do this? One day, two days or one week? Do you know your small computer can finish this work in few seconds? The weather forecasting that you see every day on TV is the results of compilation and analysis of huge amount of data on temperature, humidity, pressure, etc. of various places on computers. It takes few minutes for the computer to process this huge amount of data and give the result.

You will be surprised to know that computer can perform millions (1,000,000) of instructions and even more per second. Therefore, we determine the speed of computer in terms of microsecond (10^{-6} part of a second) or nano-second (10^{-9} part of a second). From this you can imagine how fast your computer performs work.

1.4.2 Accuracy

Suppose some one calculates faster but commits a lot of errors in computing. Such result is useless. There is another aspect. Suppose you want to divide 15 by 7. You may work out up to 2 decimal places and say the dividend is 2.14. I may calculate up to 4 decimal places and say that the result is 2.1428. Some one else may go up to 9 decimal places and say the result is 2.142857143. Hence, in addition to speed, the computer should have accuracy or correctness in computing.

The degree of accuracy of computer is very high and every calculation is performed with the same accuracy. The accuracy level is determined on the basis of design of computer. The errors in computer are due to human and inaccurate data.

1.4.3 Diligence

A computer is free from tiredness, lack of concentration, fatigue, etc. It can work for hours without creating any error. If millions of calculations are to be performed, a computer will perform every calculation with the same accuracy. Due to this capability it overpowers human being in routine type of work.

1.4.4 Versatility

It means the capacity to perform completely different type of work. You may use your computer to prepare payroll slips. Next moment you may use it for inventory management or to prepare electric bills.

1.4.5 Power of Remembering

Computer has the power of storing any amount of information or data. Any information can be stored and recalled as long as you require it, for any numbers of years. It depends entirely upon you how much data you want to store in a computer and when to lose or retrieve these data.

1.4.6 No IQ

Computer is a dumb machine and it cannot do any work without instruction from the user. It performs the instructions at tremendous speed and with accuracy. It is you to decide what you want to do and in what sequence. So a computer cannot take its own decision as you can.

1.4.7 No Feeling

It does not have feelings or emotion, taste, knowledge and experience. Thus it does not get tired even after long hours of work. It does not distinguish between users.

1.4.8 Storage

The Computer has an in-built memory where it can store a large amount of data. You can also store data in secondary storage devices such as floppies, which can be kept outside your computer and can be carried to other computers.

IN-TEXT QUESTIONS 1.1

1. What is a computer? Why is it known as data processor?
2. What are the important characteristics of computer?

1.5 HISTORY OF COMPUTER

History of computer could be traced back to the effort of man 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, 1, 2, 3, 4, 5, 6, 7, 8, 9). Later you will know how the computer solves all calculations based on decimal system. But you will be surprised to know that the computer does not understand the decimal system and uses binary system of numeration for processing.

We will briefly discuss some of the path-breaking inventions in the field of computing devices.

1.5 .1 Calculating Machines

It took over generations for early man to build mechanical devices for counting large numbers. The first calculating device called ABACUS was developed by the Egyptian and Chinese people.

The word ABACUS means calculating board. It consisted of sticks in horizontal positions on which were inserted sets of pebbles. A modern form of ABACUS is given in Fig. 1.2. It has a number of horizontal bars each having ten beads. Horizontal bars represent units, tens, hundreds, etc.

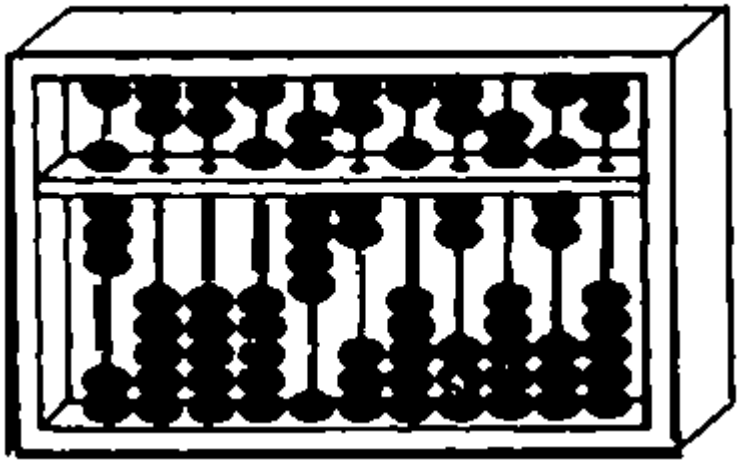


Fig. 1.2: Abacus Computer

1.5.2 Napier's bones

English mathematician John Napier built a mechanical device for the purpose of multiplication in 1617 A D. The device was known as Napier's bones.

1.5.3 Slide Rule

English mathematician Edmund Gunter developed the slide rule. This machine could perform operations like addition, subtraction, multiplication, and division. It was widely used in Europe in 16th century.

1.5.4 Pascal's Adding and Subtractory Machine

You might have heard the name of Blaise Pascal. He developed a machine at the age of 19 that could add and subtract. The machine consisted of wheels, gears and cylinders.

1.5.5 Leibniz's Multiplication and Dividing Machine

The German philosopher and mathematician Gottfried Leibniz built around 1673 a mechanical device that could both multiply and divide.

1.5.6 Babbage's Analytical Engine

It was in the year 1823 that a famous English man Charles Babbage built a mechanical machine to do complex mathematical calculations. It was called *difference engine*. Later he developed a general-purpose calculating machine called *analytical engine*. You should know that Charles Babbage is called the *father of computer*.

1.5.7 Mechanical and Electrical Calculator

In the beginning of 19th 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.

1.5.8 Modern Electronic Calculator

The electronic calculator used in 1960 s was run with electron tubes, which was quite bulky. Later it was replaced with *transistors* and as a result the size of calculators became too 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.

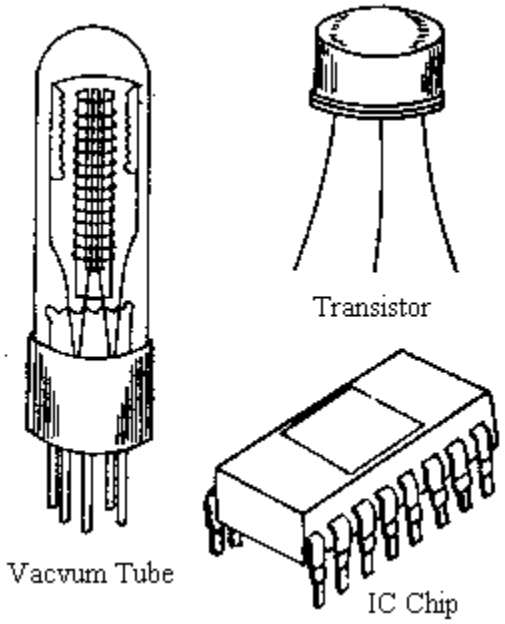


Fig. 1.3: Vacuum tube, transistor, IC

IN-TEXT QUESTIONS 1.2

1. What is the first mathematical device built and when was it built?
2. Who is called the father of Computer Technology.

1.6 COMPUTER GENERATIONS

You know that the evolution of computer started from 16th century and resulted in the form that we see today. The present day computer, however, has also undergone rapid change during the last fifty years. This period, during which the evolution of computer took place, can be divided into five distinct phases known as *Generations of Computers*. Each phase is distinguished from others on the basis of the type of *switching circuits* used.

1.6.1 First Generation Computers

First generation computers used *Thermion valves*. These computers were large in size and writing programs on them was difficult. Some of the computers of this generation were:

ENIAC: It was the first electronic computer built in 1946 at University of Pennsylvania, USA by John Eckert and John Mauchy. It was named Electronic Numerical Integrator and Calculator (ENIAC). 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. Today your favorite computer is many times as powerful as ENIAC, still size is very small.

EDVAC: It stands for Electronic Discrete Variable Automatic Computer and was developed in 1950. The concept of storing data and instructions inside the computer was introduced here. This allowed much faster operation since the computer had rapid access to both data and instructions. The other advantages of storing instruction was that computer could do logical decision internally.

Other Important Computers of First Generation

EDSAC: It stands for Electronic Delay Storage Automatic Computer and was developed by M.V. Wilkes at Cambridge University in 1949.

UNIVAC-1: Ecker and Mauchly produced it in 1951 by Universal Accounting Computer setup.

Limitations of First Generation Computer

Followings are the major drawbacks of First generation computers.

1. The operating speed was quite slow.

2. Power consumption was very high.

3. It required large space for installation.

4. The programming capability was quite low.

1.6.2 Second Generation Computers

Around 1955 a device called *Transistor* replaced the bulky electric tubes in the first generation computer. Transistors are smaller than electric tubes and have higher operating speed. They have no filament and require no heating. Manufacturing cost was also very low. Thus the size of the computer got reduced considerably.

It is in the second generation that the concept of Central Processing Unit (CPU), memory, programming language and input and output units were developed. The programming languages such as COBOL, FORTRAN were developed during this period. Some of the computers of the Second Generation were

1. IBM 1620: Its size was smaller as compared to First Generation computers and mostly used for scientific purpose.
2. IBM 1401: Its size was small to medium and used for business applications.
3. CDC 3600: Its size was large and is used for scientific purposes.

1.6.3 Third Generation Computers

The third generation computers were introduced in 1964. They used *Integrated Circuits* (ICs). These ICs are popularly known as *Chips*. A single IC has many transistors, registers and capacitors built on a single thin slice of silicon. So it is quite obvious that the size of the computer got further reduced. Some of the computers developed during this period were IBM-360, ICL-1900, IBM-370, and VAX-750. Higher level language such as BASIC (Beginners All purpose Symbolic Instruction Code) was developed during this period.

Computers of this generations were small in size, low cost, large memory and processing speed is very high.

1.6.4 Fourth Generation Computers

The present day computers that you see today are the fourth generation computers that started around 1975. It uses *large scale Integrated Circuits* (LSIC) built on a single silicon chip called microprocessors. 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 Circuits* (VLSIC) replaced LSICs.

Thus the computer which was occupying a very large room in earlier days can now be placed on a table. The personal computer (PC) that you see in your school is a Fourth Generation Computer.

1.6.5 Fifth Generation Computer

The computers of 1990s are said to be Fifth Generation computers. The speed is extremely high in fifth generation computer. Apart from this it can perform *parallel processing*. The concept of *Artificial intelligence* has been introduced to allow the computer to take its own decision. It is still in a developmental stage.

1.7 TYPES OF COMPUTERS

Now let us discuss the varieties of computers that we see today. Although they belong to the fifth generation they can be divided into different categories depending upon the size, efficiency, memory and number of users. Broadly they can be divided it to the following categories.

1. Microcomputer: 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 .
2. Mini Computer: This is designed to support more than one user at a time. It possesses large storage capacity and operates at a higher speed. The mini computer is used in multi-user system in which various users can work at the same time. This type of computer is generally used for processing large volume of data in an organisation. They are also used as servers in Local Area Networks (LAN).
3. Mainframes: These types of 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 centralised databases. They are also used as controlling nodes in Wide Area Networks (WAN). Example of mainframes are DEC, ICL and IBM 3000 series.
4. Supercomputer: They are the fastest and most expensive machines. They have high processing speed compared to other computers. They have also multiprocessing technique. One of the ways in which supercomputers are built is by interconnecting hundreds of microprocessors. Supercomputers are mainly being used for whether forecasting, biomedical research, remote sensing, aircraft design and other areas of science and technology. Examples of supercomputers are CRAY YMP, CRAY2, NEC SX-3, CRAY XMP and PARAM from India.

IN-TEXT QUESTIONS 3

1. Into how many generations the evolution of computer is divided?
2. What is VLSIC?
3. The personal computer that you see today is in which generation of computer?

1.8 WHAT YOU HAVE LEARNT

In this lesson we have discussed about the major characteristics of computer. The speed, accuracy, memory and versatility are some of the features associated with a computer. But the computer that we see today has not developed over night. It has taken centuries of human effort to see the computer in its present form today. There are five generations of computer. Over these generations the physical size of computer has decreased, but on the other hand the processing speed of computer has improved tremendously. We also discussed about the varieties of computers available today.

1.9 TERMINAL QUESTIONS

1. Why is computer known as data processor?
2. Explain in brief the various generations in computer technology?
3. Write a short note on Fifth Generation of computer. What makes it different from Fourth generation computer?
4. Why did the size of computer get reduced in third generation computer?
5. Give short notes on the following
    - (a) Versatility (b) Storage (c) Slide Rule (d) Babbage's Analytical Engine
6. Distinguish between Microcomputer and Mainframe computer.

1.10 FEEDBACK TO IN-TEXT QUESTIONS

IN-TEXT QUESTIONS 1

1. A computer is an electronic device, which is used to accept, store, retrieve and process the data. It is called as data processor because it is mainly used for processing data for producing meaningful information.
2. The characteristics of computer are speed, accuracy, diligence, versatility and storage.

IN-TEXT QUESTIONS 2

1. Analytical engine, 1823.
2. Charles Babbage

IN-TEXT QUESTIONS 3

1. Five generations
2. Very Large Scale Integrated Circuits
3. Fourth Generation

1.11 TERMINAL QUESTIONS

1. Explain various types of computers.

2. Explain in brief the various generations in computer technology.

3. Write a short note on Fifth Generation of computer. What makes it different from Fourth Generation computer?

4. Why did the size of computer get reduced in Third Generation computer?

LESSON 2

COMPUTER ORGANISATION

2.1 INTRODUCTION

In the previous lesson we discussed about the evolution of computer. In this lesson we will provide you with an overview of the basic design of a computer. You will know how different parts of a computer are organised and how various operations are performed between different parts to do a specific task. As you know from the previous lesson the internal architecture of computer may differ from system to system, but the basic organisation remains the same for all computer systems.

2.2 OBJECTIVES

At the end of the lesson you will be able to:

- understand basic organisation of computer system
- understand the meaning of Arithmetic Logical Unit, Control Unit and Central Processing Unit
- differentiate between bit , byte and a word
- define computer memory
- differentiate between primary memory and secondary memory
- differentiate between primary storage and secondary storage units
- differentiate between input devices and output devices

2.3 BASIC COMPUTER OPERATIONS

A computer as shown in Fig. 2.1 performs basically five major operations or functions irrespective of their size and make. These are 1) it accepts data or instructions by way of input, 2) it stores data, 3) it can process data as required by the user, 4) it gives results in the form of output, and 5) it controls all operations inside a computer. We discuss below each of these operations.

1. Input: This is the process of entering data and programs in to the computer system. You should know that computer is an electronic machine like any other machine which takes as inputs raw data and performs some processing giving out processed data. Therefore, the input unit takes data from us to the computer in an organized manner for processing.

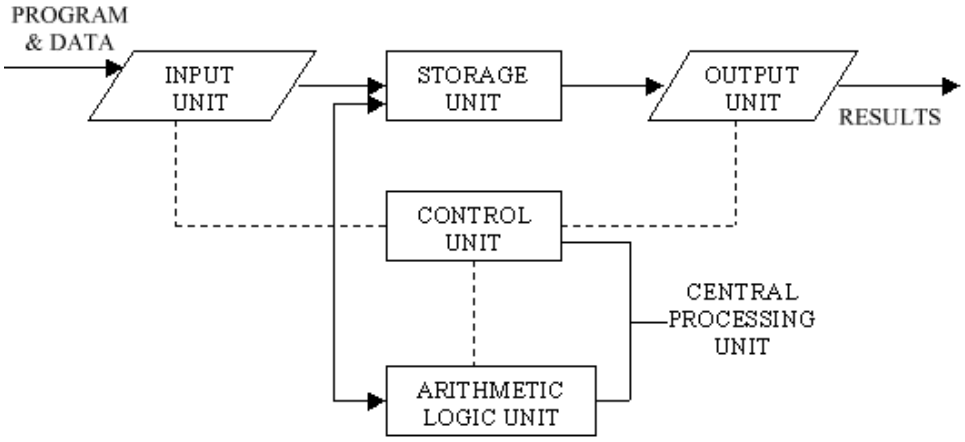


Fig. 2.1 Basic computer Operations

2. 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:

- All data and instructions are stored here before and after processing.
- Intermediate results of processing are also stored here.

3. Processing: The task of performing operations like arithmetic and logical operations is called processing. The Central Processing Unit (CPU) 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.

4. Output: This is the process of producing results from the data for getting useful information. Similarly the output produced by the computer after processing must also be kept somewhere inside the computer before being given to you in human readable form. Again the output is also stored inside the computer for further processing.

5. Control: The manner how instructions are executed and the above operations are performed. Controlling of all operations like input, processing and output are performed by control unit. It takes care of step by step processing of all operations in side the computer.

2.4 FUNCTIONAL UNITS

In order to carry out the operations mentioned in the previous section the computer allocates the task between its various functional units. The computer system is divided into three separate units for its operation. They are 1) arithmetic logical unit, 2) control unit, and 3) central processing unit.

2.4.1 Arithmetic Logical Unit (ALU)

After you enter data through the input device it is stored in the primary storage unit. The actual 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 back to storage unit for further processing or getting stored.

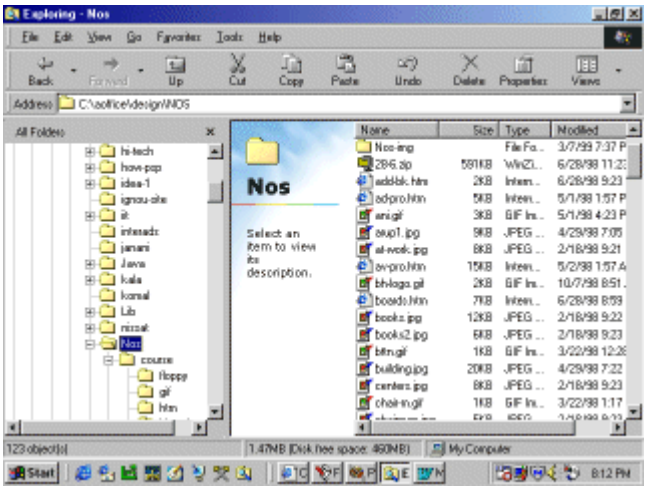
2.4.2 Control Unit (CU)

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.

2.4.3 Central Processing Unit (CPU)

The ALU and the CU of a computer system are jointly known as the central processing unit. You may call CPU 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.

HARDWARE



SOFTWARE

Fig. 2.2: Computer Architecture

Personal Computer Configuration

Now let us identify the physical components that make the computer work. These are

1. Central Processing Unit (CPU)

2. Computer Memory (RAM and ROM)

3. Data bus

4. Ports

5. Motherboard

6. Hard disk

7. Output Devices

8. Input Devices

All these components are inter-connected for the personal computer to work.

IN-TEXT QUESTIONS 1

1. What are the five basic operations performed by the computer?
2. Define ALU, CU and CPU.
3. Choose the correct answer:

(a) The task of performing arithmetic and logical operations is called

(i) ALU (ii) editing (iii) storage (iv) output

(b) The ALU and CU jointly known as

(i) RAM (ii) ROM (iii) CPU (iv) none of the above

(c) The process of producing results from the data for getting useful information

(i) output (ii)input (iii) processing (iv) storage

2.5 MEMORY SYSTEM IN A COMPUTER

There are two kinds of computer memory: *primary* and *secondary*. Primary memory is accessible directly by the processing unit. RAM is an example of primary memory. As soon as the computer is switched off the contents of the primary memory is lost. You can store and retrieve data much faster with primary memory compared to secondary memory. Secondary memory such as floppy disks, magnetic disk, etc., is located outside the computer. Primary memory is more expensive than secondary memory. Because of this the size of primary memory is less than that of secondary memory. We will discuss about secondary memory later on.

Computer memory is used to store two things: i) instructions to execute a program and ii) data. When the computer is doing any job, the data that have to be processed are stored in the primary memory. This data may come from an input device like keyboard or from a secondary storage device like a floppy disk.

As program or the set of instructions is kept in primary memory, the computer is able to follow instantly the set of instructions. For example, when you book ticket from railway reservation counter, the computer has to follow the same steps: take the request, check the availability of seats, calculate fare, wait for money to be paid, store the reservation and get the ticket printed out. The programme containing these steps is kept in memory of the computer and is followed for each request.

But inside the computer, the steps followed are quite different from what we see on the monitor or screen. In computer's memory both programs and data are stored in the binary form. You have already been introduced with decimal number system, that is the numbers 1 to 9 and 0. The binary system has only two values 0 and 1. These are called *bits*. As human beings we all understand decimal system but the computer can only understand binary system. It is because a large number of integrated circuits inside the computer can be considered as switches, which can be made ON, or OFF. If a switch is ON it is considered 1 and if it is OFF it is 0. A number of switches in different states will give you a message like this: 110101....10. So the computer takes input in the form of 0 and 1 and gives output in the form 0 and 1 only. Is it not absurd if the computer gives outputs as 0's & 1's only? But you do not have to worry about. Every number in binary system can be converted to decimal system and vice versa; for example, 1010 meaning decimal 10. Therefore it is the computer that takes information or data in decimal form from you, convert it in to binary form, process it producing output in binary form and again convert the output to decimal form.

The primary memory as you know in the computer is in the form of IC's (Integrated Circuits). These circuits are called Random Access Memory (RAM). Each of RAM's locations stores one *byte* of information. (One *byte* is equal to *8 bits*). A bit is an acronym for *binary digit*, which stands for one binary piece of information. This can be either 0 or 1. You will know more about RAM later. The Primary or internal storage section is made up of several small storage locations (ICs) called cells. Each of these cells can store a fixed number of bits called *word length*.

Each cell has a unique number assigned to it called the address of the cell and it is used to identify the cells. The address starts at 0 and goes up to (N-1). You should know that the memory is like a large cabinet containing as many drawers as there are addresses on memory. Each drawer contains a word and the address is written on outside of the drawer.

Capacity of Primary Memory

You know that each cell of memory contains one character or 1 byte of data. So the capacity is defined in terms of byte or words. Thus 64 kilobyte (KB) memory is capable of storing 64 1024 = 32,768 bytes. (1 kilobyte is 1024 bytes). A memory size ranges from few kilobytes in small systems to several thousand kilobytes in large mainframe and super computer. In your personal computer you will find memory capacity in the range of 64 KB, 4 MB, 8 MB and even 16 MB (MB = Million bytes).

The following terms related to memory of a computer are discussed below:

1. Random Access Memory (RAM): The primary storage is referred to as random access memory (RAM) because it is possible to randomly select and use any location of the memory directly store and retrieve data. It takes same time to any address of the memory as the first address. It is also called read/write memory. The storage of data and instructions inside the primary storage is temporary. It disappears from RAM as soon as the power to the computer is switched off. The memories, which loose their content on failure of power supply, are known as volatile memories .So now we can say that RAM is volatile memory.
2. Read Only Memory (ROM): There is another memory in computer, which is called Read Only Memory (ROM). Again it is the ICs inside the PC that form the ROM. The storage of program and data in the ROM is permanent. The ROM stores some standard processing programs supplied by the manufacturers to operate the personal computer. The ROM can only be read by the CPU but it cannot be changed. The basic input/output program is stored in the ROM that examines and initializes various equipment attached to the PC when the switch is made ON. The memories, which do not loose their content on failure of power supply, are known as non-volatile memories. ROM is non-volatile memory.
3. PROM There is another type of primary memory in computer, which is called Programmable Read Only Memory (PROM). You know that it is not possible to modify or erase programs stored in ROM, but it is possible for you to store your program in PROM chip. Once the programmes are written it cannot be changed and remain intact even if power is switched off. Therefore programs or instructions written in PROM or ROM cannot be erased or changed.
4. EPROM: This stands for Erasable Programmable Read Only Memory, which over come the problem of PROM & ROM. EPROM chip can be programmed time and again by erasing the information stored earlier in it. Information stored in EPROM exposing the chip for some time ultraviolet light and it erases chip is reprogrammed using a special programming facility. When the EPROM is in use information can only be read.
5. Cache Memory: The speed of CPU is extremely high compared to the access time of main memory. Therefore the performance of CPU decreases due to the slow speed of main memory. To decrease the mismatch in operating speed, a small memory chip is attached between CPU and Main memory whose access time is very close to the processing speed of CPU. It is called CACHE memory. CACHE memories are accessed much faster than conventional RAM. It is used to store programs or data currently being executed or temporary data frequently used by the CPU. So each memory makes main memory to be faster and larger than it really is. It is also very expensive to have bigger size of cache memory and its size is normally kept small.
6. Registers: The CPU processes data and instructions with high speed, there is also movement of data between various units of computer. It is necessary to transfer the processed data with high speed. So the computer uses a number of special memory units called *registers.* They are not part of the main memory but they store data or information temporarily and pass it on as directed by the control unit.

IN-TEXT QUESTIONS 2

1. Distinguish between bit and byte.

2. Define volatile and non-volatile memory.

3. Write True or False:

(a) There are two kinds of computer memory primary and secondary.

(b) The computer takes inputs in the form of 0 and 1.

(c) The storage of program and data in the RAM is permanent.

(d) PROM is secondary memory.

(e) The memories which do not loose their content on failure of power supply are known as non-volatile memories.

2.6 SECONDARY STORAGE

You are now clear that the operating speed of primary memory or main memory should be as fast as possible to cope up with the CPU speed. These high-speed storage devices are very expensive and hence the cost per bit of storage is also very high. Again the storage capacity of the main memory is also very limited. Often it is necessary to store hundreds of millions of bytes of data for the CPU to process. Therefore additional memory is required in all the computer systems. This memory is called *auxiliary memory* or *secondary storage*.

In this type of memory the cost per bit of storage is low. However, the operating speed is slower than that of the primary storage. Huge volume of data are stored here on permanent basis and transferred to the primary storage as and when required. Most widely used secondary storage devices are *magnetic tapes* and *magnetic disk*.

1. Magnetic Tape: Magnetic tapes are used for large computers like mainframe computers where large volume of data is stored for a longer time. In PC also you can use tapes in the form of cassettes. The cost of storing data in tapes is inexpensive. Tapes consist of magnetic materials that store data permanently. It can be 12.5 mm to 25 mm wide plastic film-type and 500 meter to 1200 meter long which is coated with magnetic material. The deck is connected to the central processor and information is fed into or read from the tape through the processor. It similar to cassette tape recorder.

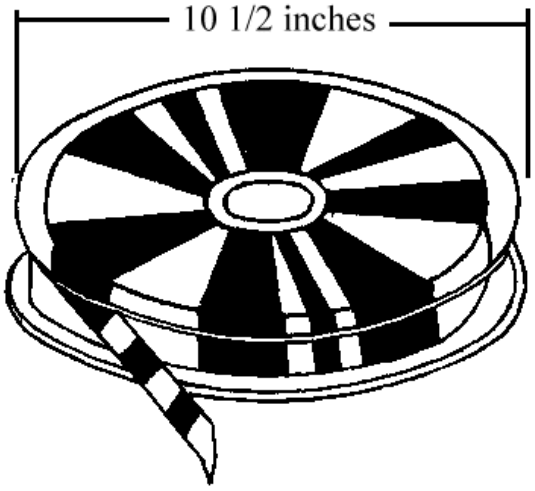


Fig. 2.3 Magnetic Tape

Advantages of Magnetic Tape:

- Compact: A 10-inch diameter reel of tape is 2400 feet long and is able to hold 800, 1600 or 6250 characters in each inch of its length. The maximum capacity of such tape is 180 million characters. Thus data are stored much more compactly on tape.
- Economical: The cost of storing characters is very less as compared to other storage devices.
- Fast: Copying of data is easier and fast.
- Long term Storage and Re-usability: Magnetic tapes can be used for long term storage and a tape can be used repeatedly with out loss of data.

2. Magnetic Disk: You might have seen the gramophone record, which is circular like a disk and coated with magnetic material. Magnetic disks used in computer are made on the same principle. It rotates with very high speed inside the computer drive. Data is stored on both the surface of the disk. Magnetic disks are most popular for *direct access* storage device. Each disk consists of a number of invisible *concentric circles* called *tracks*. Information is recorded on tracks of a disk surface in the form of tiny magnetic spots. The presence of a magnetic spot represents *one bit* and its absence represents zero bit. The information stored in a disk can be read many times without affecting the stored data. So the reading operation is non-destructive. But if you want to write a new data, then the existing data is erased from the disk and new data is recorded.

Floppy Disk: It is similar to magnetic disk discussed above. They are 5.25 inch or 3.5 inch in diameter. They come in single or double density and recorded on one or both surface of the diskette. The capacity of a 5.25-inch floppy is 1.2 mega bytes whereas for 3.5 inch floppy it is 1.44 mega bytes. It is cheaper than any other storage devices and is portable. The floppy is a low cost device particularly suitable for personal computer system.

Fig. 2.5 Floppy Disk

3. Optical Disk:

With every new application and software there is greater demand for memory capacity. It is the necessity to store large volume of data that has led to the development of optical disk storage medium. Optical disks can be divided into the following categories:

1. *Compact Disk/ Read Only Memory (CD-ROM)*: CD-ROM disks are made of reflective metals. CD-ROM is written during the process of manufacturing by high power *laser beam.* Here the storage density is very high, storage cost is very low and access time is relatively fast. Each disk is approximately 4 1/2 inches in diameter and can hold over 600 MB of data. As the CD-ROM can be *read only* we cannot write or make changes into the data contained in it.
2. *Write Once, Read Many (WORM)*: The inconvenience that we can not write any thing in to a CD-ROM is avoided in WORM. A WORM allows the user to write data permanently on to the disk. Once the data is written it can never be erased without physically damaging the disk. Here data can be recorded from keyboard, video scanner, OCR equipment and other devices. The advantage of WORM is that it can store vast amount of data amounting to gigabytes (10^9 bytes). Any document in a WORM can be accessed very fast, say less than 30 seconds.

3. *Erasable Optical Disk*: These are optical disks where data can be written, erased and re-written. This also applies a laser beam to write and re-write the data. These disks may be used as alternatives to traditional disks. Erasable optical disks are based on a technology known as *magnetic optical* (MO). To write a data bit on to the erasable optical disk the MO drive's laser beam heats a tiny, precisely defined point on the disk's surface and magnetises it.

2.7 INPUT OUTPUT DEVICES

A computer is only useful when it is able to communicate with the external environment. When you work with the computer you feed your data and instructions through some devices to the computer. These devices are called Input devices. Similarly computer after processing, gives output through other devices called output devices.

For a particular application one form of device is more desirable compared to others. We will discuss various types of I/O devices that are used for different types of applications. They are also known as peripheral devices because they surround the CPU and make a communication between computer and the outer world.

2.7.1 Input Devices

Input devices are necessary to convert our information or data in to a form which can be understood by the computer. A good input device should provide timely, accurate and useful data to the main memory of the computer for processing followings are the most useful input devices.

1. Keyboard: - This is the standard input device attached to all computers. 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. A typical keyboard used in a computer is shown in Fig. 2.6. You have to press correct combination of keys to input data. The computer can recognise the electrical signals corresponding to the correct key combination and processing is done accordingly.

Fig. 2.6

2. Mouse: - Mouse is an input device shown in Fig. 2.7 that is used with your personal computer. It rolls on a small ball and has two or three buttons on the top. When you roll the mouse across a flat surface the screen censors the mouse in the direction of mouse movement. The cursor moves very fast with mouse giving you more freedom to work in any direction. It is easier and faster to move through a mouse.

3. Scanner: The keyboard can input only text through keys provided in it. If we want to input a picture the keyboard cannot do that. Scanner is an optical device that can input any graphical matter and display it back. The common optical scanner devices are Magnetic Ink Character Recognition (MICR), Optical Mark Reader (OMR) and Optical Character Reader (OCR).

- Magnetic Ink Character Recognition (MICR): - This is widely used by banks to process large volumes of cheques and drafts. Cheques are put inside the MICR. As they enter the reading unit the cheques pass through the magnetic field which causes the read head to recognise the character of the cheques.
- Optical Mark Reader (OMR): This technique is used when students have appeared in objective type tests and they had to mark their answer by darkening a square or circular space by pencil. These answer sheets are directly fed to a computer for grading where OMR is used.

- Optical Character Recognition (OCR): - This technique unites the direct reading of any printed character. Suppose you have a set of hand written characters on a piece of paper. You put it inside the scanner of the computer. This pattern is compared with a site of patterns stored inside the computer. Whichever pattern is matched is called a character read. Patterns that cannot be identified are rejected. OCRs are expensive though better the MICR.

2.7.2 Output Devices

1. Visual Display Unit: The most popular input/output device is the Visual Display Unit (VDU). It is also called the monitor. A Keyboard is used to input data and Monitor is used to display the input data and to receive massages from the computer. A monitor has its own box which is separated from the main computer system and is connected to the computer by cable. In some systems it is compact with the system unit. It can be *color* or *monochrome*.
2. Terminals: It is a very popular interactive input-output unit. It can be divided into two types: hard copy terminals and *soft copy* terminals. A *hard copy* terminal provides a printout on paper whereas soft copy terminals provide visual copy on monitor. A terminal when connected to a CPU sends instructions directly to the computer. Terminals are also classified as dumb terminals or intelligent terminals depending upon the work situation.
3. Printer: It is an important output device which can be used to get a printed copy of the processed text or result on paper. There are different types of printers that are designed for different types of applications. Depending on their speed and approach of printing, printers are classified as *impact* and *non-impact* printers. Impact printers use the familiar typewriter approach of hammering a typeface against the paper and inked ribbon. *Dot-matrix printers* are of this type. Non-impact printers do not hit or impact a ribbon to print. They use electro-static chemicals and ink-jet technologies. *Laser printers* and *Ink-jet printers* are of this type. This type of printers can produce color printing and elaborate graphics.

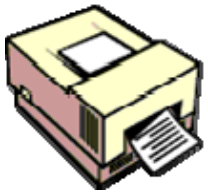


Fig. 2.8 Laser Printer

IN-TEXT QUESTIONS 3

1. Distinguish between impact and non-impact printers.

2. Define soft copy and hard copy terminals.

3. Write True or False:

(a) Secondary memory is called Auxiliary memory.

(b) The magnetic tapes and magnetic disk are primary memories.

(c) A CD-ROM is read only memory.

(d) Mouse is an output device.

(e) Printer is an important output device.

2.8 WHAT YOU HAVE LEARNT

In this lesson we discussed five basic operations that a computer performs. These are input, storage, processing, output and control. A computer accepts data as input, stores it, processes it as the user requires and provides the output in a desired format. The storage unit of a computer is divided into two parts: primary storage and secondary storage. We have discussed the devices used for these two types of storage and their usefulness.

2.9 TERMINAL QUESTIONS

1. What are the five basic operations performed by any computer system?
2. Draw a block diagram to illustrate the basic organization of computer system and explain the function of various units.
3. What is input device? How does it differ from output device?
4. Differentiate between RAM and ROM. Also distinguish between PROM and EPROM.
5. What is cache memory? How is it different from primary memory?
6. Write short notes on (a) Control Unit (b) Random Access Memory (RAM)

2.10 FEEDBACK TO IN-TEXT QUESTIONS

IN-TEXT QUESTIONS 1

1. The five basic operations that a computer performs are input, storage, processing, output and control.
2. ALU: Arithmetic Logic Unit

CU: Control Unit

CPU: Central Processing Unit

3. (a) i (b) iii (c) i

IN-TEXT QUESTIONS 2

1. A bit is an acronym for binary digit, which stands for one binary piece of information. This can be either 0 or 1. A byte is equal to 8 bits.

2. The memories which are erased if there is a power failure are known as volatile memories. RAM is an example of volatile memory. The memories, which do not loose their content on failure of power supply, are known as non-volatile memories. ROM is non-volatile memory.
3. (a) T(b) T(c) F(d) F(e) T

IN-TEXT QUESTIONS 3

1. Impact printers use the familiar typewriter approach of hammering a typeface against the paper and inked ribbon. Non-impact printers do not hit or impact a ribbon to print. They use electro-static chemicals and ink-jet technologies.
2. A *hard copy* terminal provides a printout on paper whereas soft copy terminals provide visual copy on monitor.
3. (a) T(b) F(c) T (d) F (e) T

LESSON 3

LANGUAGE/SOFTWARE

3.1 INTRODUCTION

In the previous lesson we discussed about the different parts and configurations of computer. It has been mentioned that programs or instructions have to be fed to the computer to do specific task. So it is necessary to provide sequence of instructions so that your work can be done. We can divide the computer components into two major areas, namely, *hardware* and *software*. Hardware is the machine itself and its various individual equipment. It includes all mechanical, electronic and magnetic devices such as monitor, printer, electronic circuit, floppy and hard disk. In this lesson we will discuss about the other part, namely, software.

3.2 OBJECTIVES

After going through this lesson you will be able to

- explain the concept of software
- distinguish between different types of software
- differentiate application software from system software
- define a language
- differentiate between different types of language
- distinguish between compiler and interpreter

3.3 WHAT IS SOFTWARE?

As you know computer cannot do anything without instructions from the user. In order to do any specific job you have to give a sequence of instructions to the computer. This set of instructions is called a computer *program*. Software refers to the set of computer programs, procedures that describe the programs, how they are to be used. We can say that it is the collection of programs, which increase the capabilities of the hardware. Software guides the computer at every step where to start and stop during a particular job. The process of software development is called *programmin*g.

You should keep in mind that software and hardware are complementary to each other. Both have to work together to produce meaningful result. Another important point you should know that producing software is difficult and expensive.

3.4 SOFTWARE TYPES

Computer software is normally classified into two broad categories.

- Application Software
- System software

Application Software: Application Software is a set of programs to carry out operations for a specific application. For example, payroll is an application software for an organization to produce pay slips as an output. Application software is useful for word processing, billing system, accounting, producing statistical report, analysis of numerous data in research, weather forecasting, etc. In later modules you will learn about MS WORD, Lotus 1-2-3 and dBASE III Plus. All these are application softwares.

Another example of application software is programming language. Among the programming languages COBOL (Common Business Oriented Language) is more suitable for business application whereas FORTRAN (Formula Translation) is useful for scientific application. We will discuss about languages in next section.

System Software: You know that an instruction is a set of programs that has to be fed to the computer for operation of computer system as a whole. When you switch on the computer the programs written in ROM is executed which activates different units of your computer and makes it ready for you to work on it. This set of program can be called system software. Therefore system software may be defined as a set of one or more programs designed to control the operation of computer system.

System software are general programs designed for performing tasks such as controlling all operations required to move data into and out of the computer. It communicates with printers, card reader, disk, tapes etc. monitor the use of various hardware like memory, CPU etc. Also system software are essential for the development of applications software. System Software allows application packages to be run on the computer with less time and effort. *Remember that it is not possible to run application software without system software*.

Development of system software is a complex task and it requires extensive knowledge of computer technology. Due to its complexity it is not developed in house. Computer manufactures build and supply this system software with the computer system. DOS, UNIX and WINDOWS are some of the widely used system software. Out of these UNIX is a multi-user operating system whereas DOS and WINDOWS are PC-based. We will discuss in detail about DOS and WINDOWS in the next module.

So without system software it is impossible to operate your computer. The following picture is shown in Fig. 3.1 relation between hardware, software and you as a user of computer system.

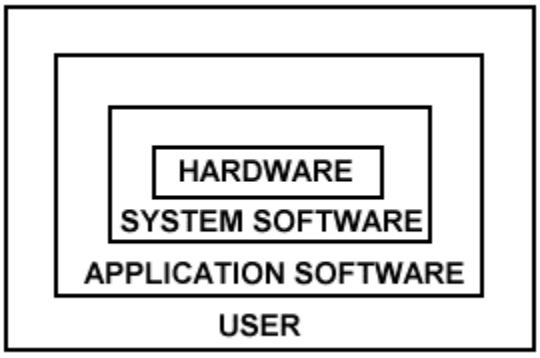


Fig. 3.1 Relation between hardware, software.

IN-TEXT QUESTIONS 1

1. What are program, programming and software?
2. Differentiate between system software and application software.
3. Write True or False.
    a. The set of instructions given to the computer is called programming.
    b. Application Software is a set of programs to carry out operations for a specific application.
    c. UNIX is a multi-user operating system.

3.5 WHAT IS LANGUAGE?

You are aware with the term language. It is a system of communication between you and me. Some of the basic natural languages that we are familiar with are English, Hindi, Oriya etc. These are the languages used to communicate among various categories of persons. But how you will communicate with your computer. Your computer will not understand any of these natural languages for transfer of data and instruction. So there are programming languages specially developed so that you could pass your data and instructions to the computer to do specific job. You must have heard names like FORTRAN, BASIC, COBOL etc. These are programming languages. So instructions or programs are written in a particular language based on the type of job. As an example, for scientific application FORTRAN and C languages are used. On the other hand COBOL is used for business applications.

3.5.1 Programming Languages

There are two major types of programming languages. These are Low Level Languages and High Level Languages. Low Level languages are further divided in to *Machine language* and *Assembly language*.

3.5.2 Low Level Languages

The term low level means closeness to the way in which the machine has been built. Low level languages are machine oriented and require extensive knowledge of computer hardware and its configuration.

(a) Machine Language

Machine Language is the only language that is directly understood by the computer. It does not needs any translator program. We also call it machine code and it is written as strings of 1's (one) and 0's (zero). When this sequence of codes is fed to the computer, it recognizes the codes and converts it in to electrical signals needed to run it. For example, a program instruction may look like this:

1011000111101

It is not an easy language for you to learn because of its difficult to understand. It is efficient for the computer but very inefficient for programmers. It is considered to the first generation language. It is also difficult to debug the program written in this language.

Advantage

The only advantage is that program of machine language run very fast because no translation program is required for the CPU.

Disadvantages

1. It is very difficult to program in machine language. The programmer has to know details of hardware to write program.
2. The programmer has to remember a lot of codes to write a program which results in program errors.
3. It is difficult to debug the program.

(b) Assembly Language

It is the first step to improve the programming structure. You should know that computer can handle numbers and letter. Therefore some combination of letters can be used to substitute for number of machine codes.

The set of symbols and letters forms the Assembly Language and a translator program is required to translate the Assembly Language to machine language. This translator program is called `*Assembler*'. It is considered to be a second-generation language.

Advantages:

1. The symbolic programming of Assembly Language is easier to understand and saves a lot of time and effort of the programmer.
2. It is easier to correct errors and modify program instructions.
3. Assembly Language has the same efficiency of execution as the machine level language. Because this is one-to-one translator between assembly language program and its corresponding machine language program.

Disadvantages:

1. One of the major disadvantages is that assembly language is machine dependent. A program written for one computer might not run in other computers with different hardware configuration.

IN-TEXT QUESTIONS 2

1. What is the difference between FORTRAN and COBOL?
2. Differentiate between machine language and Assembly language.
3. Write True or False
    a. Low level language and High level language are two major types of programming languages.
    b. Machine language is the only language that is indirectly understood by the computer.
    c. Assembly language is second generation language.

3.6 HIGH LEVEL LANGUAGES

You know that assembly language and machine level language require deep knowledge of computer hardware where as in higher language you have to know only the instructions in English words and logic of the problem irrespective of the type of computer you are using.

Higher level languages are simple languages that use English and mathematical symbols like +, -, %, / etc. for its program construction.

You should know that any higher level language has to be converted to machine language for the computer to understand.

Higher level languages are problem-oriented languages because the instructions are suitable for solving a particular problem. For example COBOL (Common Business Oriented Language) is mostly suitable for business oriented language where there is very little processing and huge output. There are mathematical oriented languages like FORTRAN (Formula Translation) and BASIC (Beginners All-purpose Symbolic Instruction Code) where very large processing is required.

Thus a problem oriented language designed in such a way that its instruction may be written more like the language of the problem. For example, businessmen use business term and scientists use scientific terms in their respective languages.

Advantages of High Level Languages

Higher level languages have a major advantage over machine and assembly languages that higher level languages are easy to learn and use. It is because that they are similar to the languages used by us in our day to day life.

3.6.1 Compiler

It is a program translator that translates the instruction of a higher level language to machine language. It is called compiler because it compiles machine language instructions for every program instructions of higher level language. Thus compiler is a program translator like assembler but more sophisticated. It scans the entire program first and then translates it into machine code.

The programs written by the programmer in higher level language is called *source program*. After this program is converted to machine languages by the compiler it is called *object program.*

Higher Level Language --> (Compile) ---> Program --> Machine Language Program

Fig. 3.2 Compile

A compiler can translate only those source programs, which have been written, in that language for which the compiler is meant for. For example FORTRAN compiler will not compile source code written in COBOL language.

Object program generated by compiler is machine dependent. It means programs compiled for one type of machine will not run in another type. Therefore every type of machine must have its personal compiler for a particular language. Machine independence is achieved by using one higher level language in different machines.

3.6.2 Interpreter

An interpreter is another type of program translator used for translating higher level language into machine language. It takes one statement of higher level languages, translate it into machine language and immediately execute it. Translation and execution are carried out for each statement. It differs from compiler, which translate the entire source program into machine code and does involve in its execution.

The advantage of interpreter compared to compiler is its fast response to changes in source program. It eliminates the need for a separate compilation after changes to each program. Interpreters are easy to write and do not require large memory in computer. The disadvantage of interpreter is that it is time consuming method because each time a statement in a program is executed then it is first translated. Thus compiled machine language program runs much faster than an interpreted program.

IN-TEXT QUESTIONS 3

1. What is the difference between interpreter and compiler?
2. Give some examples of high level language.
3. Write True or False

(a) High level languages are problem-oriented language.

(b) Object program generated by compiler is machine independent.

(c) The disadvantage of interpreter is that it is time consuming.

3.7 WHAT YOU HAVE LEARNT

In this lesson we discussed about two types of software, namely, system software and application software. System software controls the hardware part of the computer. It is designed for performing tasks such as controlling all operations required to move data into and out of the computer. It communicates with printer, card reader, disk, tapes, etc. and monitors the use of various components like memory, CPU, etc. DOS, UNIX and WINDOWS are three important system softwares. Application software is a set of programs written for specific purpose. Examples of application softwares are MS WORD, Lotus 1-2-3, COBOL, BASIC and FORTRAN. We have discussed about levels of computer language.

3.8 TERMINAL QUESTIONS

1. What is software and hardware?

2. What is computer Language?

3. Name the three different categories of computer languages.

4. What is machine language? Why is it required?

5. What are advantages and disadvantages of machine language .

6. What is assembly language? What are its advantages over machine languages?

7. What is the difference between source program and object program?

8. What is higher level languages? Why are higher level languages are easier to use.

9. What is compiler? Why is it required?

10. What is interpreter? How does it differ from compiler?

3.9 FEEDBACK TO IN-TEXT QUESTIONS

IN-TEXT QUESTIONS 1

1. Program is a set of instructions given to the computer by the user. Software is a set of computer programs and procedures that describe the programs. Programming is the process of software development.
2. Application Software is a set of programs to carry out operations for a specific application. System software is a set of programs written for performing tasks such as controlling all operations required to move data into and out of the computer.

3. (a) False b) T rue (c) True

IN-TEXT QUESTIONS 2

1. FORTRAN is used for scientific applications whereas COBOL is used for business applications.
2. Machine Languages are the only language that is directly understood by the computer. It is written in binary form that is 0 and 1. The set of symbols and letters forms the Assembly Language.
3. (a) True (b) False (c) True

IN-TEXT QUESTIONS 3

1. Both compiler and interpreter are program translators used for translating higher level language into machine language. While compiler scans the entire program first and then translates it into machine code, an Interpreter translates the program line by line.
2. FORTRAN (Formula Translation) and BASIC (Beginners All-purpose Symbolic Instruction Code) are some of the high level languages.
3. (a) True (b) False (c) True

LESSON 4

COMMUNICATION AND COMPUTER NETWORK

4.1 INTRODUCTION

Today computer is available in many offices and homes and therefore there is a need to share data and programs among various computers with the advancement of data communication facilities. The communication between computers has increased and it thus it has extended the power of computer beyond the computer room. Now a user sitting at one place can communicate computers of any remote sites through communication channel. The aim of this chapter is to introduce you the various aspects of computer network.

4.2 OBJECTIVES

After going through this lesson you will be in a position to:

- explain the concept of data communication
- understand the use of computer network
- identify different components of computer network
- identify different types of network
- explain communication protocols
- understand what is internet and email and its uses in modern communication
- appreciate the use of satellite communication.

4.3 DATA COMMUNICATION

We all are acquainted with some sorts of communication in our day to day life. For communication of information and messages we use telephone and postal communication systems. Similarly data and information from one computer system can be transmitted to other systems across geographical areas. Thus data transmission is the movement of information using some standard methods. These methods include electrical signals carried along a conductor, optical signals along an optical fibers and electromagnetic areas.

Suppose a manager has to write several letters to various clients. First he has to use his PC and Word Processing package to prepare his letter. If the PC is connected to all the client's PCs through networking, he can send the letters to all the clients within minutes. Thus irrespective of geographical areas, if PCs are connected through communication channel, the data and information, computer files and any other program can be transmitted to other computer systems within seconds. The modern form of communication like *e-mail* and *Internet* is possible only because of computer networking.

Basic Elements of a Communication System

The following are the basic requirements for working of a communication system.

1. A *sender* (source) which creates the message to be transmitted.
2. A *medium* that carries the message.
3. A *receiver* (sink) which receives the message.

In data communication four basic terms are frequently used. They are

- Data: A collection of facts in raw forms that become information after processing.

- Signals: Electric or electromagnetic encoding of data.

- Signaling: Propagation of signals across a communication medium.
- Transmission: Communication of data achieved by the processing of signals.

4.3.1 Communication Protocols

You may be wondering how do the computers send and receive data across communication links. The answer is *data communication software*. It is this software that enables us to communicate with other systems. The data communication software instructs computer systems and devices as to how exactly data is to be transferred from one place to another. The procedure of data transformation in the form of software is commonly called *protocol*.

The data transmission software or protocols perform the following functions for the efficient and error free transmission of data.

1. Data sequencing: A long message to be transmitted is broken into smaller packets of fixed size for error free data transmission.
2. Data Routing: It is the process of finding the most efficient route between source and destination before sending the data.
3. Flow control: All machines are not equally efficient in terms of speed. Hence the flow control regulates the process of sending data between fast sender and slow receiver.
4. Error Control: Error detecting and recovering is the one of the main function of communication software. It ensures that data are transmitted without any error.

4.3.2 Data Transmission Modes

There are three ways for transmitting data from one point to another

1. Simplex: In simplex mode the communication can take place in one direction. The *receiver* receives the signal from the transmitting device. In this mode the flow of information is Uni.-directional. Hence it is rarely used for data communication.
2. Half-duplex: In half-duplex mode the communication channel is used in both directions, but only in one direction at a time. Thus a half-duplex line can alternately send and receive data.
3. Full-duplex: In full duplex the communication channel is used in both directions at the same time. Use of full-duplex line improves the efficiency as the line turn-around time required in half-duplex arrangement is eliminated. Example of this mode of transmission is the telephone line.

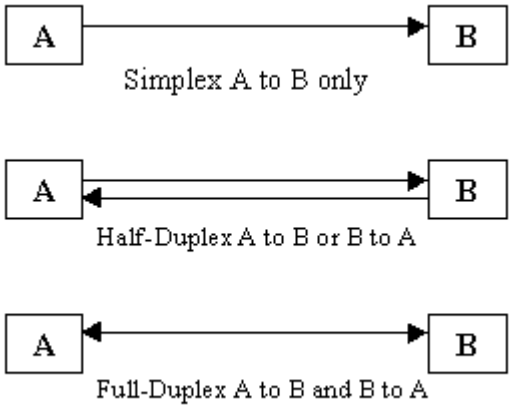


Fig. 4.1

4.3.3 Digital and Analog Transmission

Data is transmitted from one point to another point by means of electrical signals that may be in digital and analog form. So one should know the fundamental difference between analog and digital signals. In analog signal the transmission power varies over a continuous range with respect to sound, light and radio waves. On the other hand a digital signal may assume only discrete set of values within a given range. Examples are computer and computer related equipment. Analog signal is measured in *Volts* and its frequency in *Hertz* (Hz). A digital signal is a sequence of voltage represented in *binary form*. When digital data are to be sent over an analog form the digital signal must be converted to analog form. So the technique by which a digital signal is converted to analog form is known as *modulation*. And the reverse process, that is the conversion of analog signal to its digital form, is known as demodulation. The device, which converts digital signal into analog, and the reverse, is known as *modem*.

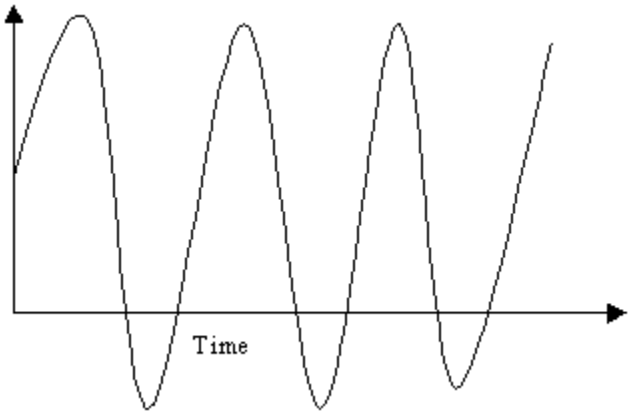


Fig 4.2:Analog Signal

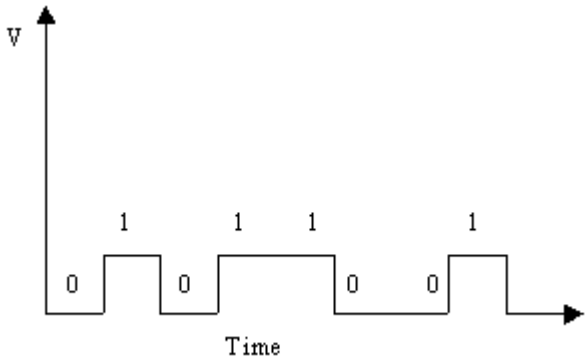


Fig 4.3 :Digital Signal

4.3.4 Asynchronous and Synchronous Transmission

Data transmission through a medium can be either asynchronous or synchronous. In asynchronous transmission data is transmitted character by character as you go on typing on a keyboard. Hence there is irregular gaps between characters. However, it is cheaper to implement, as you do not have to save the data before sending. On the other hand, in the synchronous mode, the saved data is transmitted block by block. Each block can contain many characters. Synchronous transmission is well suited for remote communication between a computer and related devices like card reader and printers.

Following are the major communication devices used to day.

1. Wire Pairs: Wire pairs are commonly used in local telephone communication and for short distance digital data communication. They are usually made up of copper and the pair of wires is twisted together. Data transmission speed is normally 9600 bits per second in a distance of 100 meter.
2. Coaxial Cables: Coaxial cable is groups of specially wrapped and insulted wires that are able to transfer data at higher rate. They consist of a central copper wire surrounded by an insulation over which copper mesh is placed. They are used for long distance telephone lines and local area network for their noise immunity and faster data transfer.
3. Microwave: Microwave system uses very high frequency radio signals to transmit data through space. The transmitter and receiver of a microwave system should be in line-of-sight because the radio signal cannot bend. With microwave very long distance transmission is not possible. In order to overcome the problem of line of sight and power amplification of weak signal, repeaters are used at intervals of 25 to 30 kilometers between the transmitting and receiving end.
4. Communication Satellite: The problem of line-sight and repeaters are overcome by using satellites which are the most widely used data transmission media in modern days. A communication satellite is a microwave relay station placed in outer space. INSAT-1B is such a satellite that can be accessible from anywhere in India. In satellite communication, microwave signal is transmitted from a transmitter on earth to the satellite at space. The satellite amplifies the weak signal and transmits it back to the receiver. The main advantage of satellite communication is that it is a single microwave relay station visible from any point of a very large area. In microwave the data transmission rate is 16 giga bits per second. They are mostly used to link big metropolitan cities.

IN-TEXT QUESTIONS 1

1. What is communication protocol?

2. What is the difference between asynchronous and synchronous transmission?

3. State whether True or False

(a) The basic requirements for working of a communication system are sender medium and receiver.

(b) Electric or Electromagnetic encoding of data is called Transmission.

(c) In full duplex the communication channel is used in both directions at the same time.

(d) Analog signal is measured in Volts and its frequency in Hertz

(e) The technique by which a digital signal is converted to analog form is known as modulation.

4.4 COMPUTER NETWORK

A computer network is an interconnection of various computer systems located at different places. In computer network two or more computers are linked together with a medium and data communication devices for the purpose of communicating data and sharing resources. The computer that provides resources to other computers on a network is known as *server*. In the network the individual computers, which access shared network resources, are known as *workstations* or *nodes.*

Computer Networks may be classified on the basis of geographical area in two broad categories.

1. Local Area Network (LAN)

2. Wide Area Network (WAN)

4.4.1 Local Area Network

Networks used to interconnect computers in a single room, rooms within a building or buildings on one site are called Local Area Network (LAN). LAN transmits data with a speed of several megabits per second (10^6 bits per second). The transmission medium is normally *coaxial cables*.

LAN links computers, i.e., software and hardware, in the same area for the purpose of sharing information. Usually LAN links computers within a limited geographical area because they must be connected by a cable, which is quite expensive. People working in LAN get more capabilities in data processing, work processing and other information exchange compared to *stand-alone computers*. Because of this information exchange most of the business and government organisations are using LAN.

Major Characteristics of LAN

- every computer has the potential to communicate with any other computers of the network
- high degree of interconnection between computers
- easy physical connection of computers in a network
- inexpensive medium of data transmission
- high data transmission rate

Advantages

- The reliability of network is high because the failure of one computer in the network does not effect the functioning for other computers.
- Addition of new computer to network is easy.
- High rate of data transmission is possible.
- Peripheral devices like magnetic disk and printer can be shared by other computers.

Disadvantages

If the communication line fails, the entire network system breaks down.

Use of LAN

Followings are the major areas where LAN is normally used

- File transfers and Access
- Word and text processing

- Electronic message handling
- Remote database access
- Personal computing
- Digital voice transmission and storage

4.4.2 Wide Area Network

The term Wide Area Network (WAN) is used to describe a computer network spanning a regional, national or global area. For example, for a large company the head quarters might be at Delhi and regional branches at Bombay, Madras, Bangalore and Calcutta. Here regional centers are connected to head quarters through WAN. The distance between computers connected to WAN is larger. Therefore the transmission medium used are normally telephone lines, microwaves and satellite links.

4.4.3 Characteristics of WAN

Followings are the major characteristics of WAN.

1. Communication Facility: For a big company spanning over different parts of the country the employees can save long distance phone calls and it overcomes the time lag in overseas communications. Computer conferencing is another use of WAN where users communicate with each other through their computer system.
2. Remote Data Entry: Remote data entry is possible in WAN. It means sitting at any location you can enter data, update data and query other information of any computer attached to the WAN but located in other cities. For example, suppose you are sitting at Madras and want to see some data of a computer located at Delhi, you can do it through WAN.
3. Centralised Information: In modern computerised environment you will find that big organisations go for centralised data storage. This means if the organisation is spread over many cities, they keep their important business data in a single place. As the data are generated at different sites, WAN permits collection of this data from different sites and save at a single site.

4.4.4 Examples of WAN

1. Ethernet: Ethernet developed by Xerox Corporation is a famous example of WAN. This network uses coaxial cables for data transmission. Special integrated circuit chips called *controllers* are used to connect equipment to the cable.
2. Aparnet: The Aparnet is another example of WAN. It was developed at Advanced Research Projects Agency of U. S. Department. This Network connects more than 40 universities and institutions throughout USA and Europe.

Difference between LAN and WAN

- LAN is restricted to limited geographical area of few kilometers. But WAN covers great distance and operate nationwide or even worldwide.

- In LAN, the computer terminals and peripheral devices are connected with wires and coaxial cables. In WAN there is no physical connection. Communication is done through telephone lines and satellite links.

- Cost of data transmission in LAN is less because the transmission medium is owned by a single organisation. In case of WAN the cost of data transmission is very high because the transmission medium used are hired, either telephone lines or satellite links.

- The speed of data transmission is much higher in LAN than in WAN. The transmission speed in LAN varies from 0.1 to 100 megabits per second. In case of WAN the speed ranges from 1800 to 9600 bits per second (bps).

- Few data transmission errors occur in LAN compared to WAN. It is because in LAN the distance covered is negligible.

4.5 NETWORK TOPOLOGY

The term topology in the context of communication network refers to the way the computers or workstations in the network are linked together. According to the physical arrangements of workstations and nature of work, there are three major types of network topology. They are star topology, bus topology and ring topology.

4.5.1 Star topology

In star topology a number of workstations (or nodes) are directly linked to a central node (see, Fig. 4.3). Any communication between stations on a star LAN must pass through the central node. There is *bi-directional* communication between various nodes. The central node controls all the activities of the nodes. The advantages of the star topology are:

- It offers flexibility of adding or deleting of workstations from the network.
- Breakdown of one station does not affect any other device on the network.

The major disadvantage of star topology is that failure of the central node disables communication throughout the whole network.

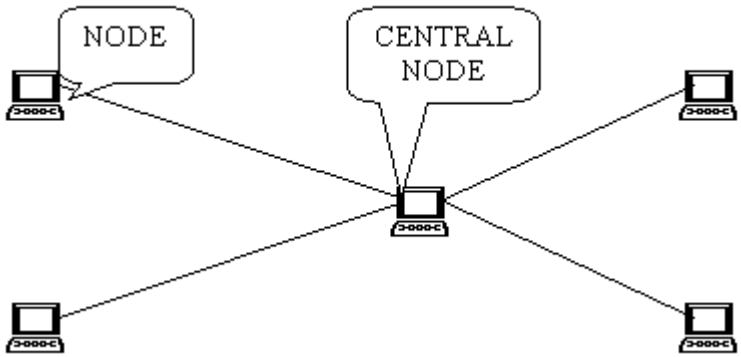


Fig. 4.3: Star Topology

4.5.2 Bus Topology

In bus topology all workstations are connected to a single communication line called *bus*. In this type of network topology there is no central node as in star topology. Transmission from any station travels the length of the bus in both directions and can be received by all workstations. The advantage of the bus topology is that

- It is quite easy to set up.
- If one station of the topology fails it does not affect the entire system.

The disadvantage of bus topology is that any break in the bus is difficult to identify.

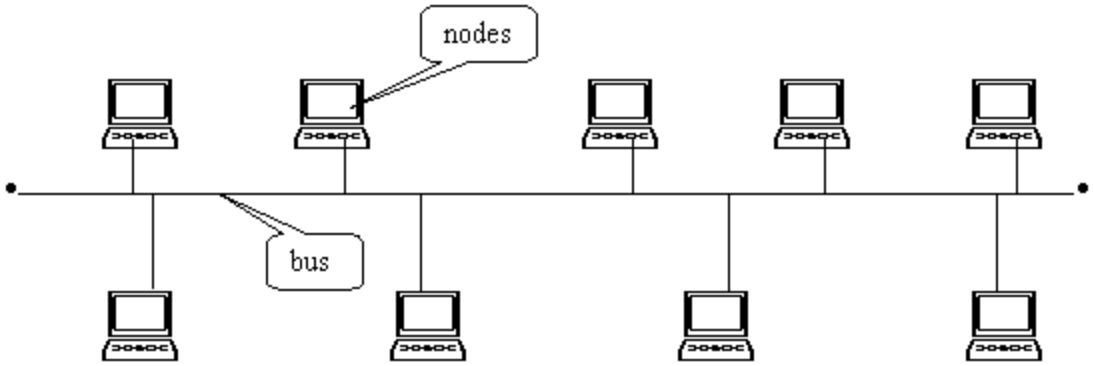


Fig. 4.4: Bus Topology

4.5.3 Ring Topology

In ring topology each station is attached nearby stations on a point to point basis so that the entire system is in the form of a ring. In this topology data is transmitted in one direction only. Thus the data packets circulate along the ring in either clockwise or anti-clockwise direction. The advantage of this topology is that any signal transmitted on the network passes through all the LAN stations. The disadvantage of ring network is that the breakdown of any one station on the ring can disable the entire system.

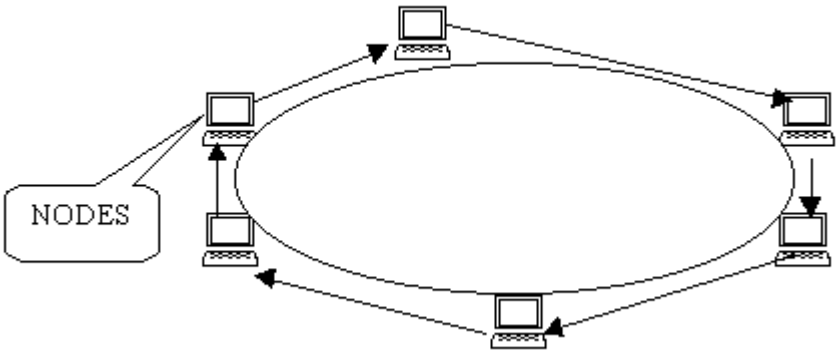


Fig. 4.5: Ring Topology

IN-TEXT QUESTIONS 2

1. Differentiate between LAN and WAN.
2. What are the different types of network topology?
3. State True or False

(a) Networks used to interconnect computers in a single room, rooms within a building or buildings on one site are called Wide Area Network (WAN).

(b) The term Wide Area Network (WAN) is used to describe a computer network spanning a regional, national or global area.

(c) The speed of data transmission is much higher in WAN than in LAN.

(d) In star topology a number of workstations (or nodes) are directly linked to a central node.

(e) The advantage of the bus topology is that, If one station of the topology fails it does not affect the entire system.

4.6 INTERNET

The Internet is a network of networks. Millions of computers all over the world are connected through the Internet. Computer users on the Internet can contact one another anywhere in the world. If your computer is connected to the Internet, you can connect to millions of computers. You can gather information and distribute your data. It is very much similar to the telephone connection where you can talk with any person anywhere in the world.

In Internet a huge resource of information is accessible to people across the world. Information in every field starting from education, science, health, medicine, history, and geography to business, news, etc. can be retrieved through Internet. You can also download programs and software packages from anywhere in the world. Due to the tremendous information resources the Internet can provide, it is now indispensable to every organisation.

Origin of Internet

In 1969 Department of Defence (DOD) of USA started a network called ARPANET (Advanced Research Projects Administration Network) with one computer at California and three at Utah. Later on other universities and R & D institutions were allowed to connect to the Network. APARNET quickly grew to encompass the entire American continent and became a huge success. Every university in the country wanted to become a part of ARPANET. So the network was broken into two smaller parts MILNET for managing military sites and ARPANET (smaller) for managing non-military sites. Around 1980, NSFNET (National Science Foundation Network) was created. With the advancement of modern communication facilities, other computers were also allowed to be linked up with any computer of NSFNET. By 1990 many computers were looking up to NSFNET giving birth to Internet.

How Internet functions

Internet is not a governmental organisation. The ultimate authority of the Internet is the Internet Society. This is a voluntary membership organisation whose purpose is to promote global information exchange. Internet has more than one million computers attached to it.

E-mail

E-mail stands for *electronic mail.* This is one of the most widely used features of Internet. Mails are regularly used today where with the help of postage stamp we can transfer mails anywhere in the world. With electronic mail the service is similar. But here data are transmitted through Internet and therefore within minutes the message reaches the destination may it be anywhere in the world. Therefore the mailing system is excessively fast and is being used widely for mail transfer.

IN-TEXT QUESTIONS 3

1. What is Internet?
2. What is e-mail?
3. How does Internet function?

4.7 WHAT YOU HAVE LEARNT

In this lesson we discussed the importance and modes of communication through computers. Computers can communicate with one another through computer networking. There are two types of computer network: LAN and WAN. We discussed about the physical arrangements of computer and peripherals in network topology. There are three types of network topology: star topology, bus topology and ring topology. Also we discussed about Internet and e-mail.

4.8 TERMINAL QUESTIONS

1. What is computer Network? What are its main objectives?
2. Differentiate between analog and digital transmission of data.
3. Explain in brief different communication media.
4. What is the difference between simplex and full-duplex transmission?

4.9 FEEDBACK TO IN-TEXT QUESTIONS

IN-TEXT QUESTIONS 1

1. The data communication software instructs computer systems and devices as to how exactly data is to be transferred from one place to another. The procedure of data transformation in the form of software is commonly called *protocol*.
2. In asynchronous transmission data is transmitted character by character as you go on typing on a keyboard. On the other hand, in the synchronous mode, the saved data is transmitted block by block.
3. (a) True (b) False (c) True (d) True (e) True

IN-TEXT QUESTIONS 2

1. LAN is restricted to limited geographical area whereas WAN covers great distance. In LAN the computer terminals and peripheral devices are connected with wires and coaxial cables whereas in WAN communication is done through telephone lines and satellite links. The speed of data transmission is much higher in LAN than in WAN.
2. There are three major types of network topology. They are star topology, bus topology and ring topology.
3. (a) False (b) True (c) False (d) True (e) True

IN-TEXT QUESTIONS 3

1. The Internet is a network of networks. Information in every field starting from education, science, health, medicine, history, and geography to business, news, etc. can be retrieved through Internet.
2. E-mail stands for *electronic mail.* Through e-mail we can transfer data anywhere in the world within seconds.
3. Internet is not a governmental organisation. The ultimate authority of the Internet is the Internet Society. This is a voluntary membership organisation whose purpose is to promote global information exchange.