UNIT 1 : INTRODUCTION TO COMPUTER

UNIT STRUCTURE

1.1 Learning Objectives
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1.4 Components of a Computer
1.6 Generations of Computers
1.7 Classifications of Computers
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1.1 LEARNING OBJECTIVES

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

- define the term 'Computer'
- explain the key characteristics of a Computer
- describe the generations of Computer
- identify the types of Computer
- describe the applications of Computer

1.2 INTRODUCTION

Computer is the most powerful tool man has ever created. Computers have made a great impact on our everyday life.Today, computer technology has permeated every sphere of existence of modern human being. With the growing need of information, the computer has become one of the vital components for the survival of the business houses. Their presence is felt almost in every working place from bus and railway ticket reservation to satellite launching, from retail stores to medical diagnosis and from home use to research and design organization - everywhere, we witness the elegance, sophistication and efficiency possible only with the

help of computers.

In this unit, we shall introduce you to the computer fundamentals including its various components and functionality. We shall also discuss the characteristics of computers as well as its evolution and generations. Also, we shall discuss the categories of computers along with its application in the various fields of the modern world.

1.3 COMPUTER – A DEFINITION

The term ***computer*** is derived from the word ***compute***, which means ***to calculate.*** In the simplest form a computer can be defined as a ***programmable machine***. In a more formal way it can be defined as an ***Electronic machine*** capable of performing calculations and other manipulations of various types of data, under the control of a stored set of instructions. A computer accepts data from an input device and processes it into useful information which it displays on its output devices. Actually, a computer is a collection of **hardware** and **software** components that help you accomplish many different tasks. The machine itself is the hardware; and the instructions are the program or software.

Most of today's computer designs are based on the concepts developed by **John Von Neumann** refered to as the " **Von Neumann architecture**". According to this structure a computer must have two units - a processing unit and a single separate storage unit. The term "*storedprogram computer*" is generally used to mean a computer of this design. The processing unit is termed as **central processing unit (CPU)** which mainly comprises other two units namely Arithmetic and Logic Unit (**ALU**) and Control Unit (**CU**). The ALU performs the arithmetic operations on data such as addition, subtraction,multiplication and division, and the logical operations such as, >, <, >=. <= etc. The control unit directs the ALU to perform specific arithmetic and logical functions on the data.

The storage unit is used to store instructions and data temporarily. This component is referred to as memory. The memory unit stores all the information in a group of memory cells, also called memory locations, as **binary digits**(bits). Each memory location has a unique address and can be addressed independently.

The instruction and data can be put into the computer with the help of the

input module. Similarly, it needs another component that will report the results in proper format and form. This component is called output module.

The following figure shows the basic structure of a conventional Von Neumann machine :

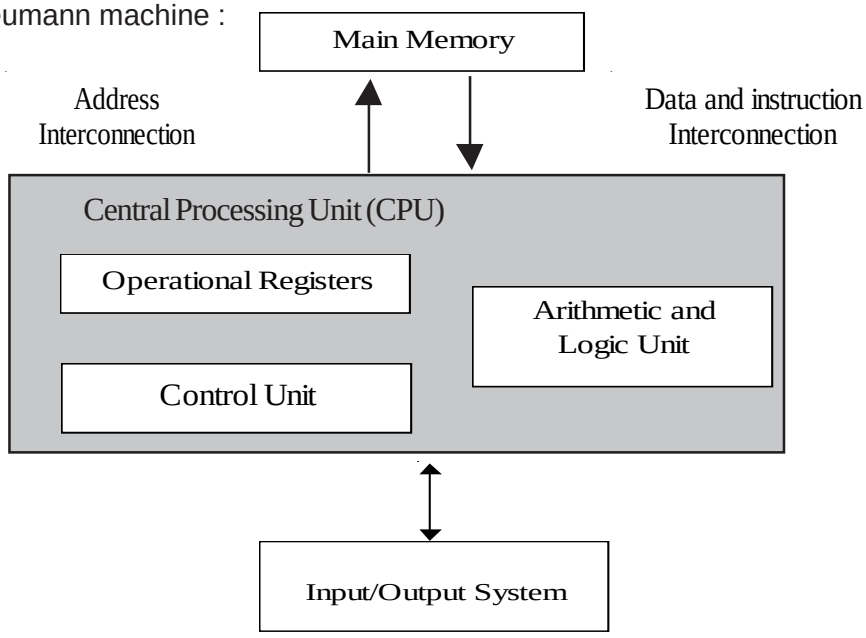


Fig. 1.1 : Von Neumann Architecture

Register:

All the arithmetic and logical operations are performed in the CPU in special storage areas called registers. The size of the register is one of the important considerations in determining the processing capabilities of the CPU. Register size refers to the amount of information that can be held in a register at a time for processing. The larger the register size, the faster may be the speed of processing CPU. Processing power is measured in Million Instruction Per Second (MIPS).

1.4 COMPONENTS OF A COMPUTER

All general-purpose computer requires the following hardware components :

Input Unit : This is the unit through which data and instructions are entered into a computer. Usually a keyboard and mouse are the common input devices. The other input devices are *light pen, joy stick, scanner, touch screen, magnetic ink character reader*(MICR), *optical mark reader*(OMR) and *bar code reader* etc. A group of input devices are shown in the following figure :



Joy stick



Scanner



Bar code reader



Touch screen



Optical Mark Reader



Mouse



Keyboard

Fig. 1.2 : Input Devices

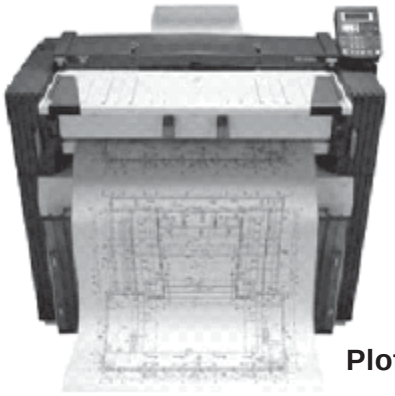
Output Unit: This unit communicates the results to the user. A display screen or monitor, printers etc.are the common devices that lets you see what the computer has accomplished. The cmmon output devices are shown in the following figure :



Monitor



Printer



Plotter

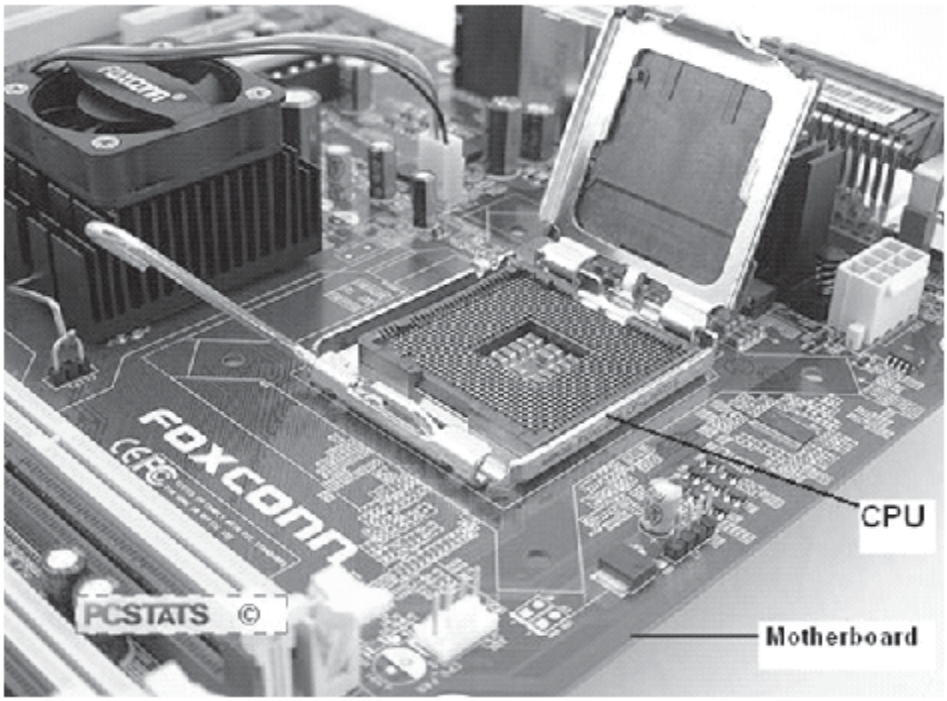
Fig. 1.3 : Output devices

Central Processing Unit(CPU): The CPU is the brain of the computer which is responsible for carrying out arithmetic and logic functions as well as execution of instructions. Modern CPU's are what we called 'integrated chips'. The idea of an integrated chip is that several processing components are integrated into a single piece of silicon. Without the CPU, a computer cannot function. The CPU is composed of millions of transistors. A complete central processing unit (CPU) contained on a single silicon chip is called a ***microprocessor***.

We have already mentioned that the CPU consists of two major components - ALU and CU. The **arithmetic and logic unit** (ALU) is the part where actual computations take place. It consists of circuits which perform arithmetic operations e.g. addition, subtraction, multiplication, division, on data received from the memory and is capable to compare numbers. The control unit of a CPU controls the entire operation of the computer. It controls all other devices such as memory, input and output

devices connected to the CPU. It gives instruction to the ALU what operation is to be performed. It generates timing and control signals, and provides them for all operations. It controls the data flow between the CPU and the peripherals (including memory).

The physical image of a central processing unit which is attached to a motherboard is shown below :



(a) Processor on a Motherboard



(b) AMD Athlon Processor

Fig 1.4 : Processor

Memory : The memory enables a computer to store the data and programs temporarily. The term *memory* identifies data storage that comes in the form of chips, and the word *storage* is used for memory that exists on

tapes or disks. Every computer comes with a certain amount of physical memory, usually referred to as main memory or RAM (Random Access Memory).

From the above discussion, we have come to know that, a computer system consists of various components like input unit, output unit, the CPU and the memory. Now, if we depict the block diagram of a computer system it will look like the following :

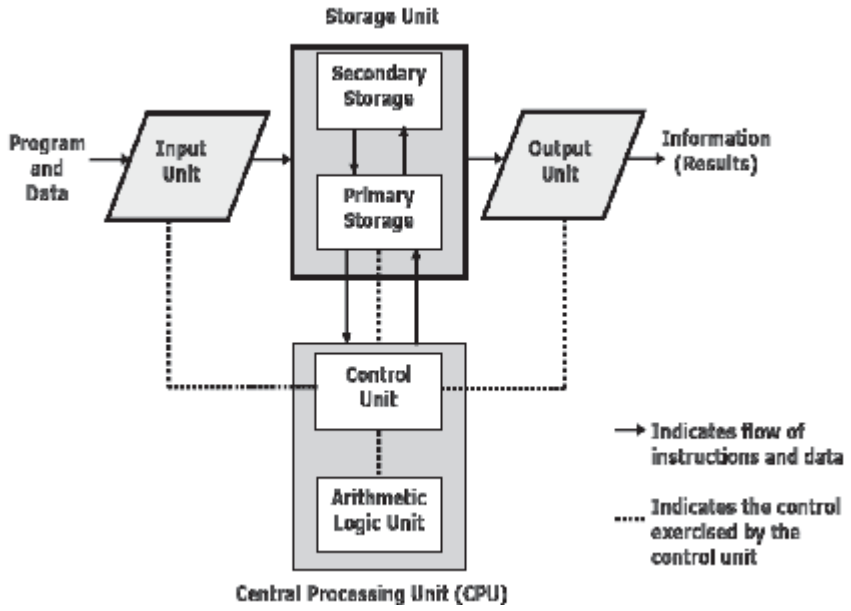


Fig. 1.5 : Block diagram of a computer

Characteristics of Computer :

Some of the main characteristics of a computer that make it an essential part of every emerging technology and a desirable tool in human development can be cited as follows :

- **Speed :** In a few seconds a computer can perform such a huge amount of task that a normal human being may take days or even years to complete. At present, a powerful computer can perform billions of operations in just one second.
- **Accuracy :** Computers are very accurate. The level of accuracy depends on the instructions and the type of machine used.
- **Deligence :** Being a machine, computers do not suffer from tiredness and lack of concentration even if the same job has to be done

repeatedly unlike in case of human beings. It can perform even millions of calculations all with the same accuracy and speed.

- **Reliability :** Computers are reliable, because at the machinery level, they do not require any human intervention between its processing operations. Computers also have built-in diagnostic capabilities, which help in continuous monitoring of the system.
- **Storage Capacity :** Computers can store large amounts of data and can recall the required information almost instantaneously.
- **Versatility :** Computers can perform multiple tasks simultaneously.
- **Resource Sharing :** With the tremendous growth in computer technologies resource sharing is easily possible.
- **Lack of Intelligence** : A computer can only perform what it is programmed to do. It cannot take any decision. This is the main limitation of a computer.

1.6 GENERATION OF COMPUTERS

The history of computer development is often considered with reference to the different generations of computing device. Each generation of computer is characterized by a major technological development that fundamentally changed the way computers operate, resulting in increasingly smaller, cheaper, more powerful and more efficient and reliable devices. There are five generations of computers as follows :

First Generation (1945 – 55)

Examples of computers of this generation are :

ENIAC – Electronic Numerical Integrator And Calculator

EDSAC – Electronic Delay Storage Automatic Calculator

EDVAC – Electronic Discrete Variable Automatic Computer

UNIVAC – Universal Automatic Computer IBM 701

Characteristics of First generation computers :

- Vacuum tubes were used – basic arithmetic operations took few milliseconds
- Bulky i.e. very large in size

- Consume more power with limited performance
- High cost
- Uses assembly language – to prepare programs. These were translated into machine level language for execution.
- Mercury delay line memories and Electrostatic memories were used
- Punched cards and paper tape were invented to feed programs and data and to get results.
- Magnetic tape / magnetic drum were used as secondary memory
- Mainly used for scientific computations.

Second Generation (1955 – 65)

Examples of computers of this generation are– IBM 7030, Digital Data Corporation's PDP 1/5/8 Honeywell 400.

Characteristics of Second generation computers :

- Transistors were used in place of vacuum tubes
- Small in size
- Lesser power consumption and better performance
- Lower cost
- Magnetic ferrite core memories were used as main memory which is a random-access nonvolatile memory
- Magnetic tapes and magnetic disks were used as secondary memory
- High level languages such as FORTRAN, COBOL etc were used
- Separate input-output processors were developed that could operate in parallel with CPU.
- Punched cards continued during this period also.
- Increasingly used in business, industry and commercial organizations for preparation of payroll, inventory control, marketing, production planning, research, scientific & engineering analysis and design etc.

Third Generation (1965 – 75)

Examples of computers of this generation are - 360 Mainframe from IBM, PDP-8 Mini Computer from Digital Equipment corporation).

Characteristics of Third generation computers :

- ICs were used
- Small Scale Integration and Medium Scale Integration technology were implemented in CPU, I/O processors etc.
- Smaller & better performance
- Comparatively lesser cost
- Faster processors
- In the beginning magnetic core memories were used. Later they were replaced by semiconductor memories (RAM & ROM)
- Introduced microprogramming
- Operating system software were introduced
- Cache and virtual memories were introduced (Cache memory makes the main memory appear faster than it really is. Virtual memory makes it appear larger)
- Database management, multi-user application, online systems like closed loop process control, airline reservation, interactive query systems, automatic industrial control etc. emerged during this period.

Fourth Generation (1975 – 89)

Examples of computers of this generation are - Intel's 8088, 80286, 80386, 80486 .., Motorola's 68000, 68030, 68040, Apple II, CRAY I/2/X/MP etc.).

Characteristics of Fourth generation computers :

- Microprocessors were introduced as CPU– Complete processors and large section of main memory could be implemented in a single chip
- Tens of thousands of transistors can be placed in a single chip (VLSI design implemented)
- CRT screen, laser & inkjet printers, scanners etc were developed.

- Semiconductor memory chips were used as the main memory.
- Secondary memory was composed of hard disks – floppy disks & magnetic tapes were used for backup memory
- Parallelism, pipelining, cache memory and virtual memory were applied in a better way
- Local Area Networks (LAN) and Wide Area Networks (WAN) were developed
- Introduced C language and Unix OS
- Introduced Graphical User Interface (GUI)

Fifth Generation (1989 to present)

Examples of computers of this generation are– IBM notebooks, Pantium PCs-Pentium 1/2/3/4/Dual core/Quad core., SUN workstations, Origin 2000, PARAM 10000, IBM SP/2).

Characteristics of Fifth generation computers :

- Computers based on artificial intelligence are available
- Computers use extensive parallel processing, multiple pipelines, multiple processors etc.
- Massive parallel machines and extensively distributed system connected by communication networks fall in this category.
- Introduced ULSI (Ultra Large Scale Integration) technology – Intel's Pentium 4 microprocessor contains 55 million transistors millions of components on a single IC chip.
- Superscalar processors, Vector processors, SIMD processors, 32 bit micro controllers and embedded processors, Digital Signal Processors (DSP) etc have been developed.
- Memory chips up to 1 GB, hard disk drives up to 180 GB and optical disks up to 27 GB are available (still the capacity is increasing)
- Object oriented language like JAVA suitable for internet programming has been developed.
- Portable note book computers introduced

- Storage technology advanced – large main memory and disk storage available
- Introduced World Wide Web. (and other existing applications like e-mail, e Commerce, Virtual libraries/Classrooms, multimedia applications etc.)
- New operating systems developed – Windows 95/98/XP/…, LINUX, etc.
- The recent development in the application of internet is the Grid technology which is still in its upcoming stage.
- Quantum mechanism and nanotechnology will radically change the phase of computers.

1.7 CLASSIFICATION OF COMPUTER

Computers can be classified according to their size and power as follows :

- Micro computer
- Mini computer
- Mainframe
- Super computer

Micro Computers

- A microcomputer uses a microprocessor as its Central Processing Unit. Microcomputers are tiny computers that can vary in size from a single chip to the size of a desktop model
- They are designed to be used by only one person at a time
- Small to medium data storage capacities 500MB – 2GB or more

The common examples of microcomputers are chips used in washing machines, TVs, Cars and Notebook/Personal computers.

E.g. : IBM PC, PS/2 and Apple Macintosh

Applications

Micro computers are used in the field of desktop publishing, accounting, statistical analysis, graphic designing, investment analysis, project management, teaching, entertainment etc. The different models of microcomputers are given below :

a) **Personal computers** :- The name PC was given by the IBM for its micro computers. PCs are used for word processing, spreadsheet calculations, database management etc.

b) **Notebook or Laptop** :- Very small in terms of size – can be folded and carried around – Monitor is made up of LCD and the keyboard and system units are contained in a single box. It has all the facilities of a personal computer (HDD, CDD, Sound card, N/W card, Modem etc) and a special connection to connect to the desktop PC which can be used to transfer data.

c) **Palmtop** :- Smaller model of the microcomputer- size is similar to that of a calculator – pocket size. It has a processor and memory and a special connection to connect to the desktop PC which can be used to transfer data.

d) **Wrist PC** :- Smallest type of microcomputer – can be worn on our wrist like a watch. It has a processor and memory and a wireless modem.

The following figures shows the various types of micro computers :

a) Personal computer





b) Notebook computer



c) Laptop computer





d) Palmtop computer **e) PDA (personal digital assistant)**

Fig. 1.6 : Micro Computer

Mini Computers

- Perform better than microcomputers
- Large in size and costlier than microcomputers
- Designed to support more than one user at a time
- Posses large storage capacities and operates at higher speed
- Support faster peripheral devices like high speed printers
- Can also communicate with main frames



Fig. 1.7 : Mini computer

Applications

- These computers are used when the volume of processing is large for e.g. Data processing for a medium sized organization
- Used to control and monitor production processes
- To analyze results of experiments in laboratories
- Used as servers in LANs (Local Area Networks)

Examples of mini computers are - Digital Equipments PDP 11/45 and VAX 11 etc. A mini computer is shown in figure 1.7 :

Main Frame Computers

- Able to process large amount of data at very high speed
- Supports multi-user facility
- Number of processors varies from one to six.
- Cost: 3500 to many million dollars
- Kept in an air conditioned room to keep them cool
- Supports many I/O and auxiliary storage devices
- Supports network of terminals



Fig. 1.8 : Mainframe computer

Applications

- Used to process large amount of data at very high speed such as in the case of Banks/ Insurance Companies/ Hospitals/ Railways…which need online processing of large number of transactions and requires massive data storage and processing capabilities

- Used as controlling nodes in WANs (Wide Area Networks)
- Used to mange large centralized databases

Examples of main frame computers are– IBM 370, IBM 3081, IBM 3000 series, Univac 1180, DEC IBM 3000 series, CDC Cyber - 2000V etc.

Super Computer

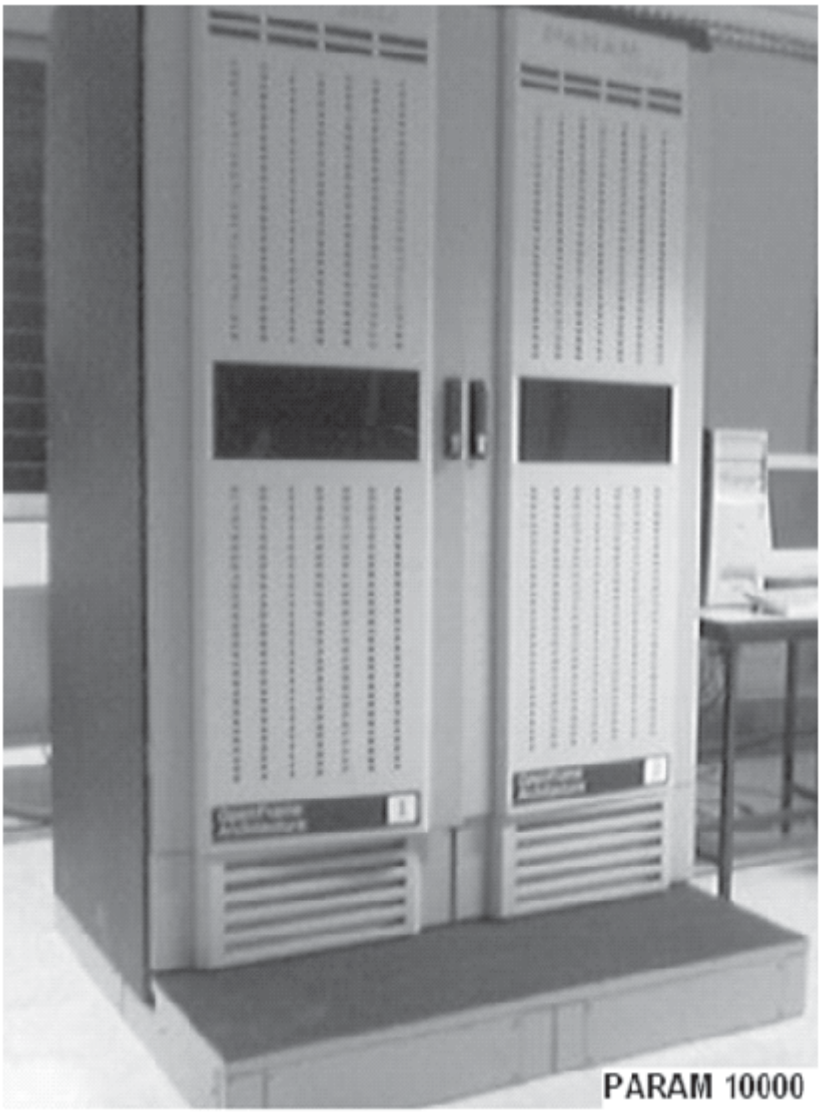
Super computer is a broad term for one of the fastest computers currently available. The main characteristics of a super computer are :

- Most powerful system - needs a large room
- Minimum world length is 64 bits
- CPU speed: 100 MIPS (Million instruction per second)
- Equivalent to 4000 computers
- High cost: 4 – 5 millions
- Able to handle large amount of data
- High power consumption
- High precision

Applications

- In petroleum industry - to analyze volumes of seismic data which are gathered during oil seeking explorations in order to identify areas where there is possibility of getting petroleum products inside the earth
- In Aerospace industry - to simulate airflow around an aircraft at different speeds and altitude. This helps in producing an effective aerodynamic design for superior performance
- In Automobile industry – to do crash simulation of the design of an automobile before it is released for manufacturing – for better automobile design
- In structural mechanics – to solve complex structural engineering problems for ensuring safety, reliability and cost effectiveness. Eg. Designer of a large bridge has to ensure that the bridge must be proper in various atmospheric conditions and pressures from wind, velocity etc and under load conditions.

- Meteorological centers use super computers for weather forecasting
- In Biomedical research – atomic nuclear and plasma analysis – to study the structure of viruses such as that causing AIDS
- For weapons research and development, sending rockets to space etc.



PARAM 1000 Series Super Computer

Examples of supercomputers are : Cray-1(1976), Cray-2(1985), Cray T3D(1993), NEC's SX-S/44(1991), Fujitsu VP 2600/10(1991), Hitachi 820/80(1987), C-DAC's PARAM Series of supercomputers etc. A PARAM 10000 series super computer of IIT Guwahati is shown in the above figure.

1.8 APPLICATIONS OF COMPUTER

Now a days computer is being used almost in every aspects of life. Every company , small or large, government offices, educational institutions are now directly or indirectly dependent on computers mainly for information processing. Computer based railway and airway reservation system is a common example of computer application. Computer system is helping in the efficient management of the banking sector, hospital records, payroll records and so on. Some of the areas where computers are being used mostly can be listed as below:

Science : Scientists are using computers to carryout their research works based on complex computations because of computer's fast speed and the accuracy.

Education : In schools and colleges, to make education much more interesting, computers are used now a days. Computer Aided Education (CAE) and Computer Based Training (CBT) packages are making learning much more interactive.

Health and Medicine : Starting from diagnosing the illness to monitoring a patient's status during a surgery , in pathological analysis ,in CAT scans or MRI scans etc. , doctors are using computers. Some special purpose computers are available which can even be operated within the human body.

Engineering : Engineers and architects are using computers in designing machineries, drawing design layouts. Architects can object that can be viewed from all the three dimensions by using techniques like virtual reality. In manufacturing industries, using computerized robotic arms hazardous jobs can be performed. The packages like Computer Aided Designing (CAD), Computer Aided Manufacturing (CAM) and so on are used in designing the product, ordering the parts and planning production.

Entertainment : With the use of multimedia facilities , computers are now greatly used in entertainment industry. Computers are used to control and bring special effects on image and sound.

Communication : Computer network and finally the Internet has brought a drastic change in communication system. Through E-mail or Electronic mail,

it is possible to send messages and reports very fast from one person to another or a group of persons with the aid of computers and telephone lines.

Business and Banking : Computer network and finally the Internet has brought a drastic change in communication system. Through E-mail or Electronic mail, it is possible to send messages and reports very fast from one person to another or a group of persons with the aid of computers and telephone lines.

In order to deposit or withdraw cash from bank, people can use ATM (Automated Teller Machine) services 24 hours of the day. Through the computer networks among different branches of a bank, inter branch transactions can be carried out without delay.

Apart from the above mentioned applications , there are many other applications of computers that can be seen in our day to day activities.



CHECK YOUR PROGRESS

1. State True or False:
   - i) PARAM is a super computer.
   - ii) A laptop is a portable computer.
   - iii) Vacuum tubes were part of the second generation computers.
   - iv) Micro computers are more powerful than mini computers.
   - v) EDSAC is an example of a second generation computer.
2. Fill in the blanks:
   - i) Physical components of a computer are called .....
   - ii) The basic components of first generation computers was .....
   - iii) PDA stands for .....
   - iv) ..... is a very small computer that can be held in the palm of the hand.
   - v) Analytical Engine was developed by .....



1.9 LET US SUM UP

1. Computer is an electronic device that is used to perform diverse operations with the help of instructions to process the data in order to produce desired results.
2. Speed ,accuracy, reliability, versatility, diligence, lack of intelligence are the characteristics of computers.
3. Computer development is divided into five generations.
4. The first generation of computers used **vacuum tubes** for circuitry and **magnetic drums** for memory, and were often enormous, taking up entire rooms.
5. In the second generation of computers, **transistors** replaced vacuum tubes.
6. The **integrated circuits** were used in the third generation of computers.
7. The fourth generation of computers are based on **microprocessors.**
8. Fifth generation computers are based on ***artificial intelligence.***
9. Micro computer is a small , low cost digital computer and include desktop, laptop, PDA.
10. A mini computer is a small digital computer more powerful than a micro computer.



1.10 ANSWERS TO CHECK YOUR PROGRESS

1. i) True ii) True iii) False
   iv) False v) False
2. i) Hardware ii) Vacuum tubes
   iii) Personal Digital Assistant
   iv) Palmtop v) Charles Babbage.



1.11 FURTHER READING

1. Sinha P. K., "Computer Fundaments", BPB Publication.
2. Ram B., "Computer Fundaments", New Age International Publishers.



1.12 MODEL QUESTIONS

1. Who invented the concept of stored program ? Why is this concept so important ?
2. List the key hardware technologies used in building computer of each of the five generations.
3. What are the advantages of transistors over vacuum tubes?
4. What is an IC? How does it help in reducing the size of computers?
5. Discuss the important features of various generations of computers. Give some examples of the computers of each generation.
6. What is computer? What are the characteristics of a Computer? Do you think computers are superior to human being?
7. Describe the evolution of computers.
8. What are the different categories of computers?

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UNIT 2 : COMPUTER MEMORY AND STORAGE

UNIT STRUCTURE

2.1 Learning Objectives
2.2 Introduction
2.3 Mermory Representation
2.4 Primary Memory
    2.4.1 Random Access Memory
    2.4.2 Read Only Memory
2.5 Secondary Memory
    2.5.1 Magnetic Tape
    2.5.2 Magnetic Disk
    2.5.3 Optical Media
2.6 Let Us Sum Up
2.7 Answers To Check Your Progress
2.8 Further Reading
2.9 Model Questions

2.1 LEARNING OBJECTIVES

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

- explain how the computer stores data
- identify the binary number system
- describe the computer memory.

2.2 INTRODUCTION

In the previous unit, we have discussed about a computer system and have been familiarised with its various components. Computer is not only used for processing of data but also used for storing them safely for future use. In a computer system, the unit which is used for storing data, as we have already mentioned, is called the *memory unit*. Of course, for temporarily storing the data the term memory is used and for storing permanently

the term storage is used. Thus, the computer memory can be categorised into two types, one is called *primary memory* and another is called *secondary memory*. Now in this unit, we will discuss both the types of computer memory.

2.3 MEMORY REPRESENTATION

You will be be surprised that - a computer is made up of millions of tiny electronic circuits that are not visible to us. The memory elements are also build with these tiny circuitry which are used for storing data. How are the data stored in those electronic circuit? For a better understanding of how a computer stores information let us take a closer look. For every circuit in a computer chip, there are two possibilities:

- an electric current flows through the circuit or
- an electric current does not flow through the circuit.

When an electric current flows through a circuit, the circuit is on. When no electricity flows, the circuit is off. An "on" circuit is represented by the number one (1) and an off circuit is represented by the number zero (0). The number 1 or 0 is called ***bit***. The word bit comes from **"binary digit"**. Each time a computer reads an instruction, it translates that instruction into a series of bits, 1's and 0's. On most computers every character from the keyboard is translated into eight bits, a combination of eight 1's and 0's. Each group of 8 bits is called 1 byte as shown in the following figure. Each group of four bits is called a **nibble**.

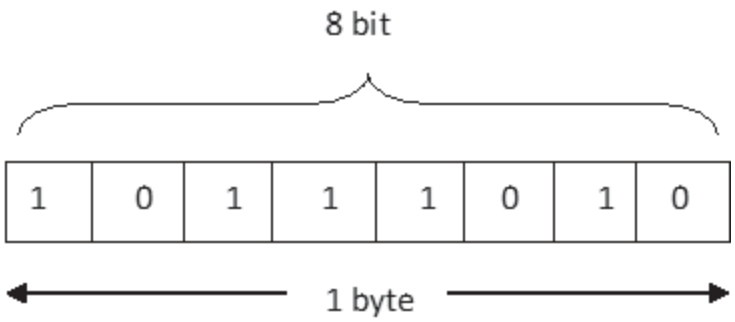


Fig. 2.1 : Representation of 1-byte

Thus, 8 bits = 1 byte and 4 bits = 1 nibble
and 1024 byte = 1 kilo byte

We know that, all the quantities, physical or abstract, can be measured in some units. For example, time is measured in second, length is measured in metres and mass in grams. Similarly, the computer memory can be measured in terms of bits, bytes, kilobytes, megabytes, gigabytes etc.
The followings are the measuring units given in terms of bytes :

1 kilobyte (KB) = 1,024 byte

1 megabyte (MB) = 1,048,576 bytes

1 gigabyte (GB) = 1,073,741,824 bytes

1 terabyte = 1,099,511,627,776

2.4 PRIMARY MEMORY

The term ***memory*** usually refers to a form of semiconductor storage and sometimes other forms of fast but temporary storage. Similarly**,** today the term ***storage*** more commonly refers to mass storage such as optical discs, forms of magnetic storage like hard disks and other types. All these are slower than memory, but of a more permanent nature. Generally , the computer memory is divided into two category : **primary memory** and **secondary memory**. The term primary memory is used to represent the ***memory*** and the term secondary memory is used to represent the ***storage.***

Primary memory is directly accessible to the CPU. The CPU continuously reads instructions stored there and executes them. Any data actively operated on is also stored there in uniform manner. It is a form of semiconductor storage known as random access memory (**RAM**) and sometimes other forms of fast but temporary storage. It is small-sized, light, but quite expensive. This type of memory is divided into the following two types :

a) RAM (Random Accress Memory)

b) ROM (Read Only Memory)

2.5.1 Random Access Memory (RAM)

A computer's **main memory** is often referred to as RAM - an area in the computer system unit that temporarily holds user data, operating system instructions and program instructions. Every time we turn on our computer, a set of operating system instructions is copied from hard disk into RAM. These instructions, which help control basic computer functions, remain in RAM until we turn the computer off.

RAM features:

a) RAM is the place which holds the data that has to be processed by the computer's preocessor. Moreover, it holds the operating system and other application programs also.

b) RAM is made up of different ICs (Integreted Circuits). They are also called *semiconductor memory*.

c) Each element of RAM is a memory location in which data can be stored. Each location has a **unique address**. Using this address data can be directly retrieved or stored.

d) Since RAM must hold both the data to be processed and the instructions for processing, its size or capacity is one of the measure of power of the computer.

e) RAM is a volatile memory and losses its data when the computer turned off.

There are generally two broad categories of random access memory :

i) **DRAM** memories (*Dynamic Random Access Memory*)

ii) **SRAM** memories (*Static Random Access Memory*)

DRAM :

Dynamic RAM is a type of RAM in which data is stored in a storage cell, consisting of transistors and capacitors. A common property of a capacitor is its tendency to get discharged; it means the current goes down in the circuit and finally the data cannot be hold for long time. To over come this effect, the DRAM needs to be continuously refreshed with power supply and thus it has one *refreshing circuit*

which rewrites the data in certain time intervals. This refreshing circuit refreshes or rewrites the data several hundreds times in a second.

SRAM :

Static RAM is a type of RAM that holds its data as long as power is supplied to the circuit. The SRAM does not need any refreshing circuit. SRAMs are used for specific applications within the PC. The SRAM has the following properties :

- **Simplicity :** SRAMs don't require external refresh circuitry in order for them to keep their data intact.
- **Speed :** SRAM is faster than DRAM.

In contrast, SRAMs have the following weaknesses, compared to DRAMs:

- **Cost :** SRAM is more expensive than DRAM.
- **Size :** SRAMs take up much more space than DRAMs

The physical image of a RAM chip is shown in the following figure :

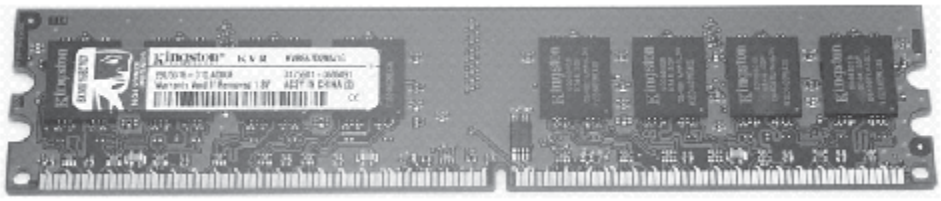


Fig. 2.2 : A RAM chip

2.5.2 Read Only Memory

One major type of memory that is used in PCs is called *read-only memory*, **(*ROM*)**. ROM is the memory that stores the data permanently i.e., the instructions in ROM are permanent whether the power is on or off. We do not have any way to change them, unless we remove the ROM chips from the main board and replace them with another set.

Read-only memory is most commonly used to store system-level programs that we want to have available to the PC at all times. For

example, the ROM-BIOS (ROM basic input and output services) programs are stored in ROM chips which are used to boot up (start up) the computer.

The following are the different types of ROMs with a description of their relative modifiability :

Programmable ROM (PROM) : This is a type of ROM that can be programmed using special equipment; it can be written to, but only once.

Erasable Programmable ROM (EPROM) : An *EPROM* is a ROM that can be erased and reprogrammed. Ultraviolet light of a specific frequency is used for erasing the EPROM and allow it to be reprogrammed again.

Electrically Erasable Programmable ROM (EEPROM) : The next level of erasability is the *EEPROM*, which can be erased under software control. This is the most flexible type of ROM, and is now commonly used for holding BIOS programs.



LET US KNOW

The important types of memory used in a computers are– the ***cache memory and registers***.

Cache memory is a special type of RAM (static RAM) which is the faster memory used in a computer system in between the CPU and main memory. It means that the accessing speed from the cache memory is faster than the main memory used in computer. So, the use of the cache memory reduces the average access time and helps the processor for fast processing. The Cache memory stores the instructions and data that are frequently needed by the processor for execution. Cache memory chip is a static memory chip. It is much expensive than the main memory. Cache size varies from 32 MB to 128MB or 512MB etc.

Registers : Registers are the small amount of storage available on the CPU whose contents can be accessed more quickly than any

other storage available in a computer system. Registers are the fastest memory element and thus provide the fastest way for a CPU to access data. Registers are normally measured by the number of bits they can hold, for example, an "8-bit register" or a "32-bit register". Registers can be classified as general purpose registers and special purpose registers.

2.5 SECONDARY MEMORY

Secondary memory or *storage* provides the facility of storing information and programs permanently . It differs from primary memory in that it is not directly accessible by the CPU. The computer usually uses its input/output channels to access secondary storage and transfers desired data using intermediate area in primary memory. Secondary storage does not lose the data when the device is kept out of power. It is non-volatile. It is less expensive than primary memory.

In modern computers, hard disks are usually used as secondary storage. Some other examples of secondary storage devices are: **optical disk, floppy disks, magnetic tape, paper tape, punch Cards, standalone RAM disks, flash memory (e.g. USB sticks or keys), and Zip drives etc**.

2.5.1 Magnetic Tape

Magnetic tapes are the plastic tapes with magnetic coating that are used for storing the data, such as text, audio or video. Magnetic tapes are similar to the normal recording tapes, which are used for audio and video recording. Magnetic tape is a medium for magnetic recording, made of a thin magnetizable coating on a long, narrow strip of plastic. A device that stores computer data on magnetic tape is called a tape drive. The data stored on the magnetic tapes can be accessed using the sequential access method. A magnetic tape is shown in the figure below :

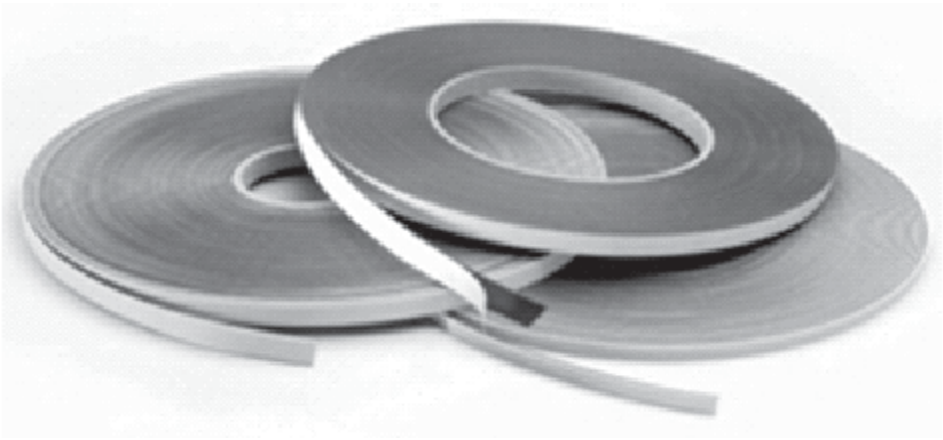


Fig. 2.3 : A magnetic tape

Major advantages of magnetic tapes are :

- Low cost
- Large storage capacity
- Easily transportable
- Easy to handle and store

2.5.2 Magnetic Disks

Magnetic disks are popular and widely used secondary storage medium. A magnetic disk consists of plastic or metal circular plate or platter. These platters are coated with magnetic oxide layer. The data stored in magnetic disks can be accessed directly. They provide high storage capacity and reliability. Data is represented as magnetized spots on a disk .The presence of a spot represents a 1 and the absence of a magnetized spot represents a 0. The information is accessed using one or more read/write **heads**.

A magnetic disk typically contains several rotating disks, or platters. There is one head for each surface, and all the heads move together. The disk rotates at around 3600 rpm (rotation per minutes) with the heads floating microscopic distances above the surfaces. Data on the magnetic disks is organized in a concentric set of circles, called **tracks**. Each track is divided into **sectors**. The following diagram shows the tracks and sectors of a platter.

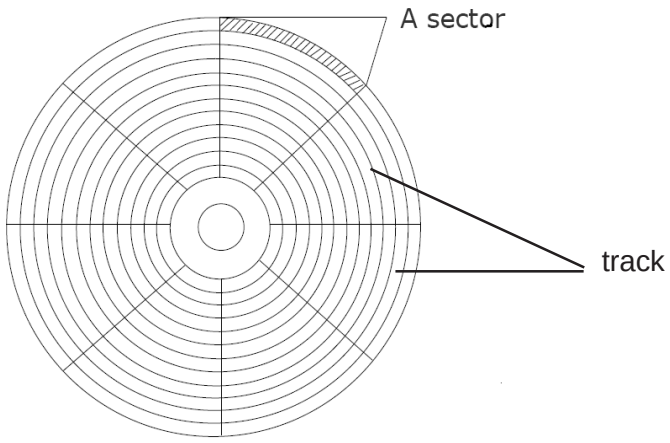


Fig. 2.4 :Sectors and Track of magnetic disk

We have already mentioned that magnetic disk uses a single read/ write head for each disk surface. The read/write head may be movable or fixed. The following figure shows a movable read/ write heads for each surface :

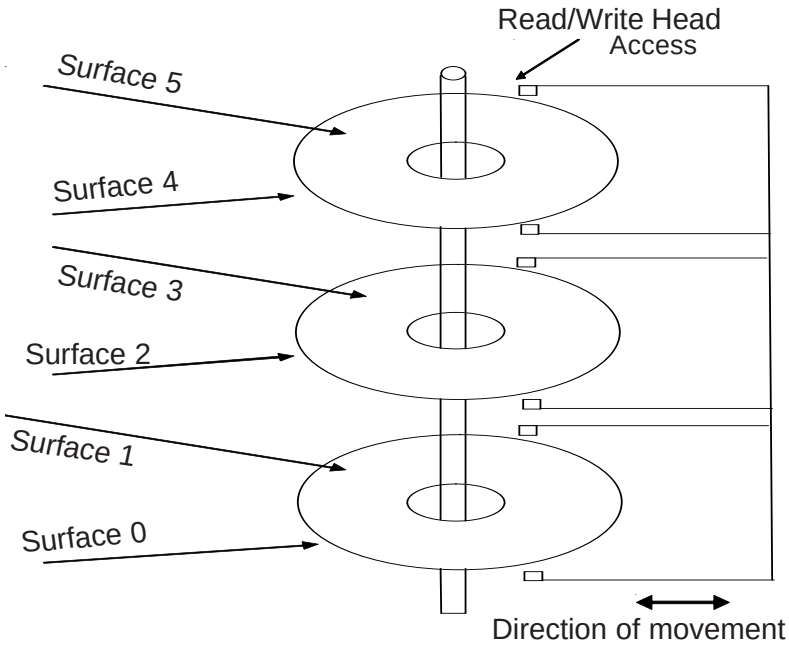


Fig. 2.5 : Magnetic disk with moving R/W head

There are two popular types of magnetic disks :

- Hard disks
- Floppy disks

Major advantages of magnetic disks are :

- High storage capacity
- Easy, direct access to data
- Easily movable from one place to another
- Better data transfer rate as compared to magnetic tapes
- Low cost compared to RAM
- Less prone to corruption of data as compared to tapes

2.5.3 Optical Media

The optical media are used for the same purpose as the magnetic storage system. We have already found that in case of magnetic media there is a coating of magnetic material on the surface of the medium. But in case of optical medium laser light is used to retrieve as well as record data. Examples of optical storage mediums are given below :

- Compact Disk - Read only memory (CD-ROM)
- Digital Video Disk (DVD)
- Compact Disk - Recordable (CD-R)
- Compact Disk - Rewritable (CD-RW)
- Digital Video Disk - Recordable (DVD-R)
- Digital Video Disk - Rewritable (DVD-RW)

Like other storage media, optical storage are non-volatile in nature as well as and also they are more reliable when compared to the magnetic medium.

CD-ROM :

We are already familiar with CD-ROM disk which is a shiny, silver color metal disk usually of 12cm diameter. It is made of polycarbonate plastic and thin layer of pure aluminum is applied to make the surface reflective. For some good quality disks, gold layer is used. A thin layer of lacquer protects it. The surface of an optical disk con-

sists of *pits* and *land*. The information is read from pits and lands, like 1s and 0s. It is changed into binary so that computers can read it. An optical reader reads the patterns of pits that stands for bytes. One CD can hold 650MB of data or 300,000 pages of text. Most CDs are read only, which means you cannot save data to the disk. This device is not usually used as a primary storage device for data.

An optical disk is mounted on an optical disk drive for reading/writing of information on it. An optical disk drive contains all the mechanical, electrical and electronic components for holding an optical disk and for reading/writing of information on it. That is, it contains the tray on which the disk is kept, read/write **laser beams assembly**, and the motor to rotate the disk. Access time for optical disks are in the range of 100 to 300 milliseconds.

Advantages of CD-ROM are –

a) Storage capacity is much more in optical disks.
b) Multiple copies of the disk along with its contents can be made inexpensively.
c) They are transportable from one computer to another very easily.

DVD Disks :

The success of CD technology and the continuing quest for greater storage capability has led to the development of DVD. **DVD**, also known as **Digital Versatile Disk** or **Digital Video Disk**, is an optical disk storage media format, and was invented and developed by Sony, and Philips in 1995. Its main uses are video and data storage. DVDs are of the same size as compact disks (CDs), but can store more than six times of data as that of a CD.

Variations of the term *DVD* often indicate the way data is stored on the disks : DVD-ROM (read only memory) has data that can only be read and not written; DVD-R and DVD+R (recordable) can record data only once, and then function as a DVD-ROM; DVD-RW (re-writable), DVD+RW, and DVD-RAM (random access memory) can all record and erase data multiple times.



LET US KNOW

RAID TECHNOLOGY : RAID technology was first defined by a group of computer scientists at the University of California at Berkeley in 1987. The scientists studied the possibility of using two or more disks to appear as a single device to the host system. RAID is a method of combining several hard disk drives into one logical unit (two or more disks grouped together to appear as a single device to the host system). RAID technology was developed to address the fault-tolerance and performance limitations of conventional disk storage. It can offer fault tolerance and higher throughput levels than a single hard drive or group of independent hard drives.

FLASH MEMORY : Flash memory is a non-volatile computer storage chip that can be electrically erased and reprogrammed. Flash drives and pen drives are USB storage devices based on flash memory. It is primarily used in memory cards, USB flash drives, MP3 players and solid-state drives for general storage and transfer of data between computers and other digital products.



CHECK YOUR PROGRESS

1. State True or False:
   - i) The secondary memory is faster than the main memory and has limited capacity.
   - ii) In random access memory, memory locations can be accessed sequentially.
   - iii) Cache memory is faster than main memory.
   - iv) Flash memory is one kind of RAM.
   - v) High speed memories are needed to bridge the gap of speed between CPU and main memory.
   - vi) Semiconductor memories are random access memory.

2. Find out the correct answer :

i) Which one of the following memory is used to store data permanently?

a. primary memory b. secondary memory
c. cache memory d. registers

ii) Which of the following memory is the fastest type of memory?

a. primary memory b. registers
c. cache memory d. secondary memory

iii) Which of the following is the cheapest type of memory ?

a. primary memory b. registers
c. cache memory d. secondary memory

iv) Which one of the following memory is not a type of primary memory?

a. RAM b. ROM
c. cache d. SRAM

v) On which type of ROM, data can be written many times ?

a. PROM b. EPROM c. EEPROM d. EROM

vi) Which one of the following is not a type of magnetic storage device?

a. Magnetic tape b. Compact disk
c. Hard disk d. Floppy disk

vii) Which medium is used in optical storage systems for reading and recording data ?

a. Ultraviolet light b. High energy visible light
c. Laser light d. Black light



2.6 LET US SUM UP

1. Data inside a computer is stored in the form of 0s and 1s. These 0s and 1s are called bit. 4 bit constitute a nibble and 8 bit constitute a byte.
2. The ***memory*** usually refers to a form of semiconductor storage i.e. primary memory and ***storage*** refers to mass storag i.e. secondary

memory.

3. Random access memories are semiconductor memory. They are volatile in nature. RAMs are of two types - dynamic RAM and static RAM.
4. ROMs are also semiconductor memory. The instructions in ROMs are permanent whether the power is on or off. PROM, EPROM, EEPROM are the types of ROMs.
5. Cache memory is a special type of RAM which is a faster memory used in a computer system in between the CPU and main memory.
6. Secondary memory, also called secondary storage, stores information and programs permanently. In personal computer, secondary memory typically consists of hard disk or any removable media, if present, such as a CD or DVD etc.
7. Magnetic tapes are the magnetic-coated plastic tapes, which are used for storing data and audio or video files.
8. Optical storage medium uses the laser light for recording and storing data.



2.7 ANSWERS TO CHECK YOUR PROGRESS

1. i) False, ii) False, iii) True, iv) False, v) True, vi) True
2. i) b. ii) b. iii) d. iv) c. v) c. vi) b. vii) c.



2.8 FURTHER READING

1. Sinha P. K., Computer Fundaments, BPB Publication.
2. Ram B., Computer Fundaments, New Age International Publishers.



2.9 MODEL QUESTIONS

1. What do you understand by computer memory? List the two different categories of memory.
2. Differentiate between a bit and a byte.
5. What is a RAM? What are the two types of RAM? Differentiate between them.
6. What is a ROM? Why is it called so? List the different types of ROMs and their key features.
7. What is a cache memory? How is it different from a primary memory?
8. Differentiate between
   a) PROM and EPROM.
   b) Static RAM and Dynamic RAM
7. Write down the difference between a magnetic tape and a magnetic disk.
9. Write short note :
   a) Primary memory
   b) Secondary memory
   c) Magnetic tape
   d) Magnetic disk
   e) Compact disk

UNIT 3 : SOFTWARE AND MULTIMEDIA

UNIT STRUCTURE

3.1 Learning Objectives
3.2 Introduction
3.3 Computer Software Basics
3.4 System Software
3.5 Application Software
3.6 Integrated Software
3.7 Multimedia
3.8 Legal Restriction On Software
3.9 Let Us Sum Up
3.10 Answers To Check Your Progress
3.11 Further Reading
3.12 Model Questions

3.1 LEARNING OBJECTIVES

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

- identify about the computer software
- differentiate system software and application software
- explain the different types of system and application software
- discuss multimedia
- outline software licenses and copyright agreements

3.2 INTRODUCTION

In this unit, we are going to discuss computer software and its applications.The computer is the most successful and versatile machine in history. A computer's versatility is possible because of software. The software is an interpreter which translates the user's command into the understandable machine language codes which can be executed by the central processing unit. There are two major categories of software. These are *system software* and *application software*. **System Software** helps the

computer to carry out its basic operating tasks. **Application Software** helps the human user to carry out a task. System software and application software are further divided into sub categories. In this unit, we will discuss how a computer uses software and the difference between system software and application software.

The term multimedia isn't really anything new. It refers to the integrated use of multiple media, such as slides, video tapes, audio tapes, records, CD-ROMs, and photos. Computer technology is replacing or controlling many of the technologies and media that were previously used for multimedia presentations. Advances in computer technology have made it possible to combine text, photo images, speech, music, animated sequences, and video into a single interactive computer presentation. To display realistic graphic and video, your computer system must have a high resolution monitor and a CD-ROM drive.

3.3 COMPUTER SOFTWARE BASICS

Computer software determines what a computer can do; and in a sense, it transforms a computer from one kind of machine to another from a drafting station to a type setting machine, from a flight simulator to a calculator, from a filing system to a music radio and so on.The distinction between software, programs, and data is important.

Computer Program

A computer program is a set of detailed, step by step instructions that tell a computer how to solve a problem or carry out a task. The steps in a computer program are written in a language that the computer can interpret or "understand".

Data

Data are the words, numbers and graphics that describe people, events, things, and ideas. Data can be included in the software, like the data for a dictionary in a word processing program, and you can create data such as number you provide for a graph.

Software

We define software as instructions and associated data, stored in an electronic format, that direct the computer to accomplish a task. Under this definition, computer software may include more than one computer program, if these programs wash together to carry out a task. Also under this definition, software can include data, but data alone is not a software. For example, word processing software might include the data for a dictionary, but the data you create using a word processor is not referred to as software.

Two major categories of software : **System Software** and **Application Software** with their strategies are displayed in the following figure 3.1.

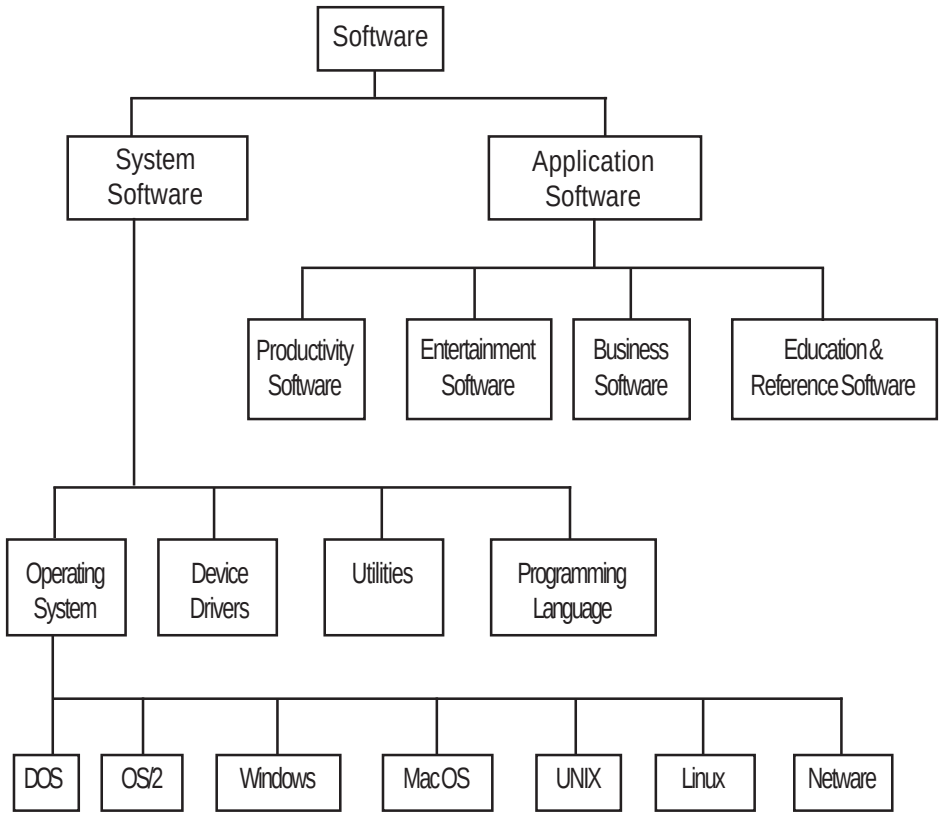


Fig. 3.1 : Classification of Softwares

3.4 SYSTEM SOFTWARE

These are software designed for the satisfactory operation of the computer system. The major categories of system software are :

(1) Operating System

(2) Utilities Software

(3) Device Drive Software

(4) Programming language.

(1) Operating System :

An Operating System is an important component of a computer system. The primary objecive of an operating system is to make computer system convenient for use and utilise computer hardware and various resources in an efficient manner.

An operating system is a large set of software which is also an interface between users and computer systems. It is also a system software. Operating system also manages computer resources of the computer system, such as memory, processor, file system and input/output devices.

Operating system can be classified into various categories as follows :

- Single User OS
- Multi User OS
- Single Tasking OS
- Multitasking OS
- Multiprogramming OS
- Real Time OS

Single-user OS

The simplest operating system which allows only one user to work on a computer at a time is known as single user operating system. For example MS-DOS, Windows 98..

Multiuser OS

This type of operating system which is running on a computer will manage the work of all different users, without letting them know that

they all are actually working on a single computer. For example UNIX, Linux, Windows XP ect.

Single tasking OS

A type of operating system which can execute a single job at a time is known as Single-tasking operating system. For example, MS-DOS operating system.

Multitasking OS

Multitasking operating system allows the user to perform more than job at the same time on a computer. For example, UNIX, LINUX, OS/2 etc are multitasking operating system.

MultiProgramming OS

In multiprogramming OS, the CPU runs several programs at the same time. Multiprogramming is implemented in such a way that many programs are being executed concurrently. Multiprogramming keeps the CPU busy.

Real time OS

Real- time operating systems work towards providing immediate processing and also response to user's commands in a very short period of time. This type of operating system is more commonly used in chemical industries for process control and scientific processing like airplane control and space vehicle control operations etc. For example, HP-RT and VTWorks etc.

Functions of Operating System

The functions of the Operating System are as follows :

- To control input/output operations i.e. use of keyboard, display screen and printer so that people can easily enter data and receive output.
- To control movement of data in the primary storage.

- To locate and load programs from secondary storage.
- To manage a large task in a smaller primary memory by using the technique of virtual memory.
- Management of I/O devices.
- Management of memory.

Some popular operating system

The names of the most popular micro computer operating system are DOS, Microsoft Windows, OS/2, MacOS, UNIX, VMS and MVS. Operating systems for micro, mini and mainframe computers perform many similar tasks.

DOS : DOS which stands for Disk Operating System, is marketed under the trade names PC-DOS and MS-DOS. Both PC-DOS and MS-DOS were developed primarily by Microsoft Corporation and are essentially the same operating system.

Windows : Microsoft took a more graphical approach to operating systems when it designed windows. Different versions of windows such as Windows 3.1, Windows 95, Window 98 etc. are developed. But the most sophisticated and developed operating system designed by Microsoft Corporation are ***Windows XP & Windows Vista***.

Windows NT : The network version of the Windows operating system is Windows NT. With Windows NT you can connect your computer to other computers to share software programs and data.

OS/2 : This operating system was designed jointly by Microsoft and IBM. If your computer uses OS/2, you can use most DOS and Windows software, as well as software designed specifically for OS/2.

UNIX : UNIX is an operating system that was developed by AT & T's Bell Laboratories in 1969 and is now used as one the foundation technologies on the information superhighway. UNIX was originally designated for minicomputers, but is now available for microcomputer and mainframe. Many versions of UNIX exist, such as AIX from IBM, XENIX from Microsoft, and ULTRIX from Digital Equipment Corporation.

(2) Utilities Software

Utilities are system software designed to augment the basic capabilities of your computer's operating system. Utilities provide use of computers with a way to control two allocation and use of hardware resources. Some utilities that are included with the operating system pertain tasks such as preparing disks to hold data, providing information about the files on a disk, and copying data from one disk to another. For example, Norton Utilities published by *Symantec* is a very popular collection of utilities software.

(**3) Device Drivers** are system software that helps the computer control a peripheral device. When you purchase a new peripheral device, the installation instruction that comes with the device usually tell you how to install both the device (hardware) and necessary device drivers (software). In order for your computer to use a device driver, you must install it according to the instructions. Once the device driver is installed correctly, the computer uses it to communicate with the device.

(4) Programming Language

Programming language is a system of communication in the software technology. As such, all the types of programming languages such as machine language, assembly language and procedure and object oriented language, high level languages are considered to be system software.



CHECK YOUR PROGRESS - 1

1. Fill in the blanks with appropriate words :
   (i) _____ system is the software that controls the computer hardware functions.
   (ii) Computer based satellite control is an example of _____ software.

(iii) _____ is a communication facility within a city.

(iv) The network version of the windows operating system is _____.

(v) _____ is an operating system developed by AT & T's Bell Laboratories.

3.5 APPLICATION SOFTWARE

These are softwares developed for the specific area of application of the user. Application software helps you to produce documents, perform calculations, manage financial resources, create graphics, compose music, play games, maintain files of information and so on. We can classify the application software using the following categories :

(1) productivity software

(2) education and reference software

(3) entertainment software

(4) business software

The following discussion will familiarize you with the application software branch of the software hierarchy chart.

(1) Productivity Software

Productivity software helps you work more effectively. The classification of this software are : (a) Word Processing, (b) Spread sheets, (c) Database Management, (d) Electronic Mail, (e) Graphics, (f) Desktop Publishing

(a) Word processing software helps you to produce documents such as reports, letters, papers and manuscripts. Word processing is the most popular type of application software.

(b) Spreadsheet Software helps you work with number. The software displays a grid of rows and columns on the screen. Each box formed by this grid is called a cell. Each cell shows an address that indicates its row and column position. Spreadsheets

are frequently used by financial analysis to examine investment opportunities, by managers to create budgets, by entrepreneurs to create business plans, and even by the educators to keep track of the gfrades of students.

(c) Database Management Software helps you work with facts and figures, such as the customer names and addresses you might store on file cards. It also helps hospitals and doctors to keep track of patient records and the phone company to keep track of names, addresses, and phone numbers etc.

(d) Electronic mail software provides you with a computerized mail box that collects documents or “mail” you receive electronically from other computer's users. You can send electronic mail messages, you can read you electronic mail on your computer screen, you can save or throw away your electronic mail after you read it or you can compose electronic replies to the mail you receive.

(e) Graphics Software helps you draw pictures, 3-D images and animations. Presentation graphics software helps you represent information using screen-based slide shows of bulleted lists, graphics and charts.

(f) Desktop Publishing Software provides you with computerized tools for page payout and design that combine text and graphics. Although many desktop publishing features are available in today’s sophisticated word processing software, desktop publishing software provide additional features to help you produce professional looking, quality output for newspaper, newsletters, and brochures.

(2) Education and Reference Software

Educational software is designed to help you learn more about a particular topic. One sub category of educational software is called CAI or tutorial software. CAI stands for “Computer Aided Instruction”.
Reference software, such as electronic encyclopedia, helps you look up facts on any topic.

(3) Entertainment Software :

It is no surprise that entertainment software is designed to entertain you. With entertainment software, you can play different types of games, battle monsters or explore new world. For example, the "Paper Planes" software is entertaining while showing you how to construct several types of paper airplanes.

(4) Business Software:

Business Software is divided into two categories : horizontal market software and vertical market software.

(a) Horizontal Market software

A "horizontal market" is a group of different types of business that, despite their difference, have some of the same software needs. Horizontal market software refers to generic software packages that can be used for many different kinds of business. Productivity software, such as word processing, spreadsheet, or database management applications, can be considered horizontal market software because they can be used in virtually in any business. Accounting and payroll applications are also good examples of horizontal market software.

(b) Vertical Market Software

A "vertical market" is a group of a similar business – travel agencies, for example – that need specialised software. Vertical market software is designed for specialized tasks in a specific market or business.

3.6 INTEGRATED SOFTWARE

A software publisher sometimes combines several productivity software into a single package called integrated software. Typically integrated software include word processing, spreadsheet, database, and presentation graphics applications. Electronic mail is also included in some integrated software. Integrated software is often called a suite, office or works. Some

popular integrated software package include Microsoft works, Claris works Lotus SmartSuite, Novell Perfect Office, and Microsoft Office.

3.7 MULTIMEDIA

Multimedia computing refers to the integrated use of multiple media, such as slides, video tapes, audio tapes, records, CD-ROMs and photos. Computer technology is replacing and controlling many of the technologies and media that were previously used for multi-media presentations. Advances in computer technology have made it possible to combine text, photo image, speech, music, animated sequences, and video into a single interactive computer presentation.

Multimedia is defined as an integrated collection of computer-based text, graphics, sound, animation, photo images and video.

Multimedia applications : One example of a multimedia application is a multimedia encyclopedia. A multimedia encyclopedia provides you with a rich selection of text, graphics, sound, animation and video.

Hypertext is a key element of many multimedia products and has been used effectively in non-multimedia products as well. You are likely to use hypertext with many computer applications. The term hypertext was coined by Ted Nelson in 1965 to describe the idea of documents that could be linked to each other. Linked documents make it possible for a reader to jump from a passage in another document.

Hypermedia : The links in today's applications often involve graphics, sound and video, as well as text. This type of multimedia hypertext is referred to as hypermedia. Hypertext and hypermedia are important computer-based tools because they help you easily follow a path that makes sense to you through a large selection of text, graphical, audio and video information.

3.8 LEGAL RESTRICTIONS ON SOFTWARE

Like books and movies, most computer software is protected by a copyright. In addition to copyright protection, computer software is often pro-

tected by the terms of a software license. Some of the major aspects for legal restrictions on software are as follows —

(a) Copyright material : A copyright is a form of legal protection that grants certain exclusive rights to the author of a program or the owner of the copyright. The owner of the copyright has the exclusive right to copy the software, to distribute or sell the software and to modify the software. If you are not the owner of the copyright, it is illegal to copy, distribute, or sell the software unless you obtain permission from the copyright owner.

(b) Copyright act : The copyright act states the circumstances under what you can and cannot legally copy copyright software. When you purchase copyright software, you do not become the owner of the copyright. Instead, you own only a copy of the software.

(c) Copyright symbol : Copyrighted materials, such as software, display a copyright notice that contains the word “Copyright” (or the (c) symbol), the year of publication, and the name of the copyright holder.

(d) Licensed software : A software license is a legal contract that defines the ways in which you may use a computer program.

(e) Public domain software is owned by the public rather than by the author. The program is available to everyone for use without restriction. Public domain software may be freely copied, distributed, and even sold.

(f) Shareware is copyright software marketed under a “try before you buy” policy. Shareware usually includes a license that allows you to use the software for a trial period. If you want to continue to use it, you must become a registered user by sending a registration fee.



CHECK YOUR PROGRESS - 2

1. Write true or false for the following statements :
   (i) Word Processing software helps you to work with numbers.

(ii) Business software is divided into two categories as horizontal and vertical market software.

(iii) Graphics software helps you to produce documents.

(iv) Multimedia is defined as an integreted collection of computer based text, graphics, sound, animation, photo images and video.

(v) Shareware is copyright software marketed under a "try before you buy" policy.



3.9 LET US SUM UP

a) There are two types of software.

i) application software, ii) system software

b) System software helps the computer to carry out its basic operating tasks. System software is also divided into subcategories such as Operating system, device drivers, utilities etc.

c) Application software helps the human user to carry out a task. Application software are further divided into sub categories such as productivity software, entertainment software, business software, education and reference software etc.

d) Operating system acts as an interface between the user and thecomputer. There are different types of operating system like Single User OS, Multi User OS, Single Tasking OS, Multitasking OS, Multiprogramming OS, Real Time OS.

e) Application software is utilized for different categories to accomplish different specific tasks using the computer. Different categories are developed for different purposes.

f) Multimedia means being able to communicate in more than one way for better communication. The executive of text, sound graphics and animation simultaneously is called as Multimedia.

g) Computer software is protected by a copyright which is a form of legal protection that grants legal rights to the author of a program or the owner of the copyright.



3.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress-1

1. (i) Operating, (ii) real time processing, (iii) Metropolitan area net work, (iv) Windows NT, (v) UNIX.

Check Your Progress-2

1. (i) False, (ii) trure, (iii) False, (iv) True, (v) True.



3.11 FURTHER READING

1. Sinha P. K., Computer Fundaments, BPB Publication.
2. Ram B., Computer Fundaments, New Age International Publishers.



3.12 MODEL QUESTIONS

1. What is a Software ? Discuss the importance of software in a computer system.
2. Differentiate between system software and application software.
3. Discuss the different types of Operating Systems.
4. What is an application software ? Explain why application software is so important to the computer user?
5. What is multimedia ? Discuss the application of Multimedia with examples.
6. Discuss the legal restrictions on software.

UNIT- 4 : BASIC HARDWARE COMPONENTS

UNIT STRUCTURE

4.1 Learning Objectives
4.2 Introduction
4.3 System Unit
4.4 Power Supply
4.5 Motherboard
4.6 Processor
4.7 Buses
4.8 I/O Ports and Connectors
4.9 Let Us Sum Up
4.10 Answers to Check Your Progress
4.11 Further Reading
4.12 Model Questions

4.1 LEARNING OBJECTIVES

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

- identify different components of a computer
- describe the components of motherboard
- locate the I/O ports and connectors

4.2 INTRODUCTION

So far, you have gained the basic concept about a computer system. Computer system is an integration of different hardware units and the CPU works as the brain of the system. We have also discussed that the computer stores data in primary or secondary memory in binary format. In addition, we came to know that the softwares are responsible for performing the various functions inside the computer.

In this unit, we will introduce you to the basic hardware units of a computer system so that you can identify the components and also know what services are being provided by them.

4.3 SYSTEM UNIT

The large box that contains the CPU and the disk drive is called the system unit. A horizontally oriented system unit lies flat on a desk top. A system unit that stands upright is a tower unit. The system unit houses the motherboard, the disk drives, the power supply, and the expansion ports.

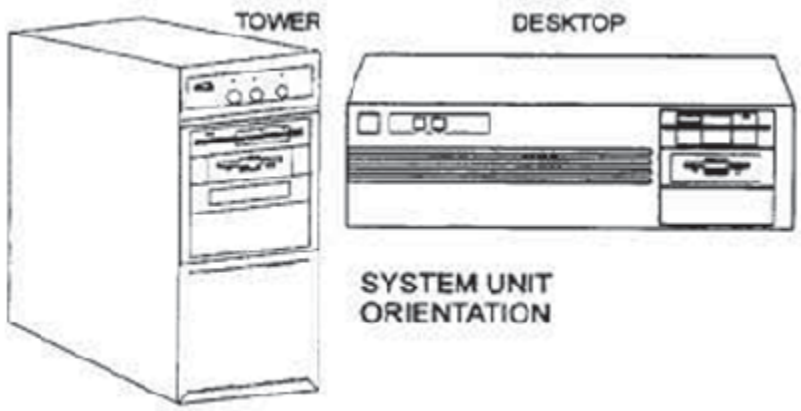


Fig. 4.1 : A system unit

4.4 POWER SUPPLY

Electronic devices require electricity to operate. Most internal components are DC (direct current) but the line voltage is AC (alternating current.) One of the roles of the power supply is, therefore, to convert AC to DC voltage. The power supply may also include a cooling fan which minimize the overheating. The power supply is fitted at the back panel of the system unit. It is also called **Switched Mode Power Supply (SMPS)** and it is shown in the following figure.

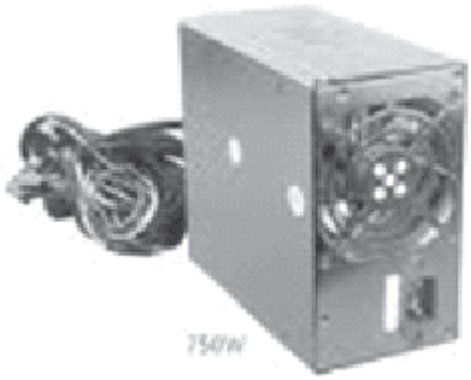


Fig. 4.2 : A power supply

4.5 MOTHERBOARD

The term motherboard is perhaps familiar to you. Motherboard is a large printed circuit board, which has lots of chips, connectors and other electronics mounted on it. The motherboard is a big plastic sheet which is full of electrical conductors. The conductors run across and down, and in several layers, in order to connect all the individual components, and transfer data through them.

Inside the PC, data is constantly being exchanged between or via the various *devices*. Most of the data exchange takes place on the motherboard itself, where all the components are connected to each other. The following figure shows some important components of a typical motherboard.

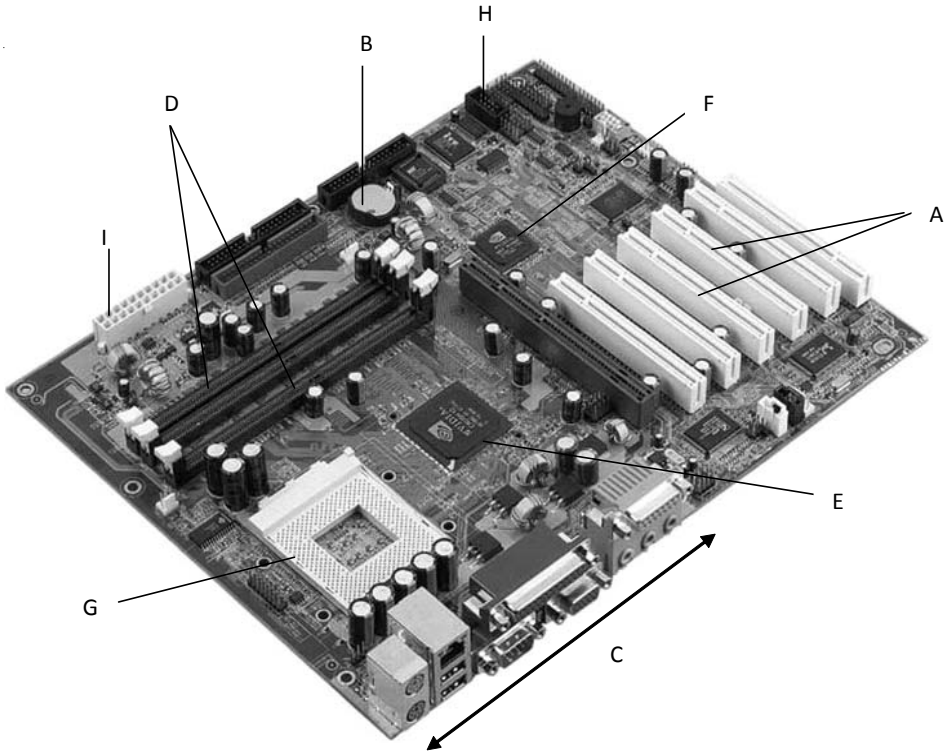


Fig. 4.3 : A Motherboard

A – PCI Slots
B – Lithium Battery
C – Back Panel Connectors
D – DDR SDRAM Slots
E – North Bridge Chipset
F – South Bridge Chipset
G – CPU Socket
H – ROM-BIOS
I – Motherboard Power Plug-ins

A **PCI Slot** – *Peripheral Component Interconnect*. The PCI bus is used to connect I/O devices (such as NIC or RAID controllers) to the main logic of the computer.

B **CMOS Battery** – CMOS (Complementary Metal Oxide Semiconductor) provide the power when the computer is turned off. All motherboards come with a battery. These batteries mount on the motherboard in one of three ways: the obsolete external battery, the most common onboard battery, and built-in battery.

C **Back Panel Connectors** – Back Panel connectors are shown in the next section. These are consisting with I/O ports and connectors.

D **DDR SDRAM Slots** – These are the slots for RAM. Most boards will have 4 slots, but some will only have 2.

E, F There are two main chips on the motherboard usually called the *north bridge* and *south bridges*.

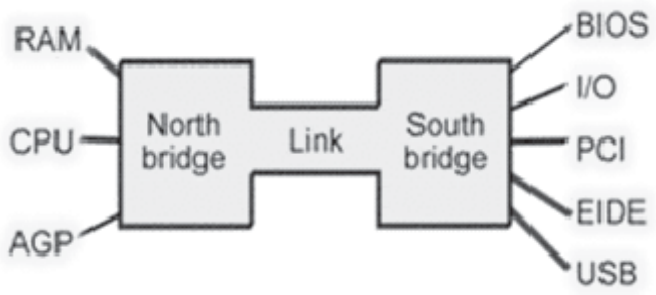


Fig. 4.4 : North bridge and south bridge

The north bridge mainly controls the data traffics of CPU and RAM. The south bridge controls the data traffics of I/O units. This is the controller for the components such as the PCI slots, onboard audio, and USB connections etc.

G **CPU Socket** – It is the place where your CPU will plug in.

H BIOS is a set of small programs (or services) that are designed to operate each major PC sub system (video, disk, keyboard, and so on). Each of these system services is called by the operating system. In addition to the system services, the BIOS executes a ***power-on-sellf-test*** (POST) program each time the PC starts up. BIOS programs reside on the motherboard in the form of ROM chip. So, it is called ROM-BIOS.

I **Motherboard Power plug-in** – This is the main power connection for the motherboard, and comes from the Power Supply.

4.6 PROCESSOR

We have already discussed that processor or CPU stands for **Central Processing Unit**. Let us briefly study that name :

It is a processor, because it processes (moves and calculates) data. It is central, because it is the center of PC data processing. It is a unit, because it is a chip, which contains millions of transistors.

The processor performs two most important jobs - it can do *calculations* and - It can *move* data. This unit is responsible for all events inside the computer. It controls all internal and external devices, performs arithmetic and logical operations. The CPU is composed of several units which are shown in the following figure (4.5) :

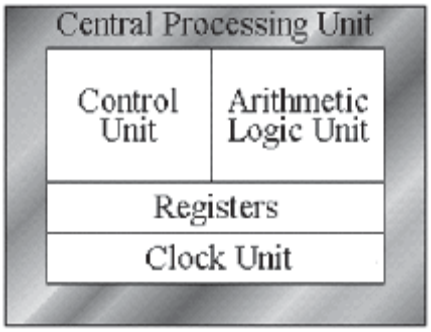


Fig. 4.5 : Components of a CPU

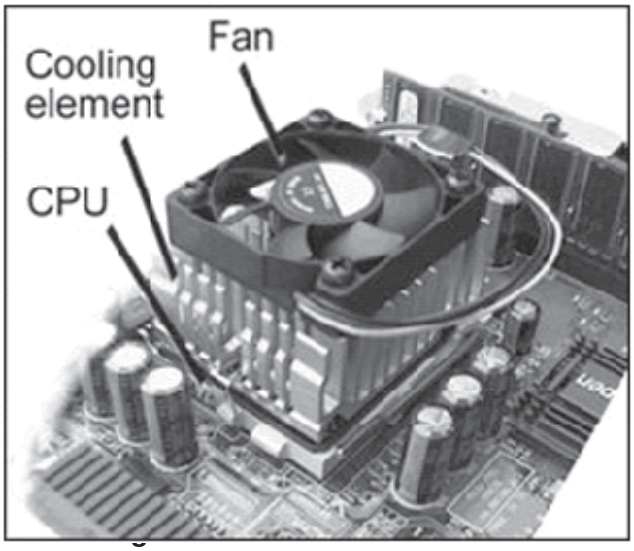
The **control unit (CU)** directs and controls the activities of the internal and external devices. It interprets the instructions fetched into the computer, determines whether any data is needed, where it is stored, where to store the results of the operation; and sends the control signals to the devices involved in the execution of the instructions.

The **arithmetic and logic unit (ALU)** is the part where actual computations takes place. It consists of circuits which perform arithmetic operations (e.g. addition, subtraction, multiplication, division) over the data received from memory. It is also capable to compare numbers.

While performing these operations the ALU takes data from the temporary storage area inside the CPU named **registers**. Registers are a group of cells used for memory addressing, data manipulation and processing.

All activities in the computer system are composed of thousands of individual steps. These steps should follow in some order in fixed intervals of time. These intervals are generated by the **clock unit**. Every operation within the CPU takes place at the clock pulse. But some operations require more than one clock pulse. The faster the clock runs, the faster the computer performs. The clock rate is measured in *megahertz (Mhz)* or million ticks per second.

Today, there are two leading manufacturers of microprocessors : Intel and Motorola.The following figure shows a processor.



4.7 BUSES

A bus is a communication pathway connecting two or more devices. The interaction between the CPU and memory, and CPU and I/O devices like keyboard, monitor takes place very frequently. To enable this interaction, some types of connectivity are needed among the between the units of a computer system. This connectivity channel is known as bus. Physically, a bus is a set of wires, which carries a group of bits in parallel and has an

associated control scheme. The bus width is defined as the number of parallel lines in the bus. Every computer has three types of buses for interconnecting the CPU and memory, and CPU and I/O devices. These buses are **data bus**, **address bus** and **control bus**.

Data Bus : The data bus is used to transfer data between the CPU and memory and CPU and I/O devices.

Address Bus : Every location in the memory has a unique address. The address of a location does not change, but the data stored in it can change. In order to retrieve some data from memory, it is necessary to specify the address of the location where the data is stored. The address bus is used to carry the address of a memory location whenever data is to be transferred to or from memory.

Control Bus : The control bus is used to send control signals to the CPU, memory and I/O devices.

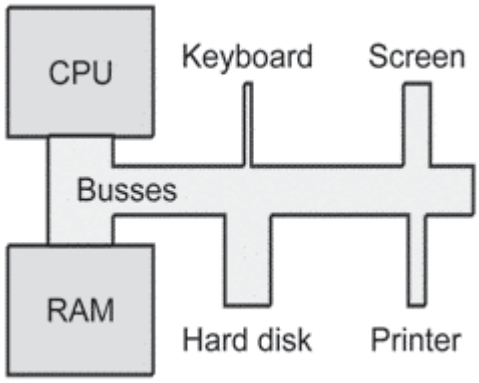


Fig. 4.7 : Bus with connected components

4.8 I/O PORTS AND CONNECTORS

The motherboard contains a number of ports and connectors to which various equipments can be connected. Most ports (also called I/O ports) can be seen where they end in a connector at the back of the PC. The following figure shows the back panel display of a motherboard where we can see the different ports and connectors.

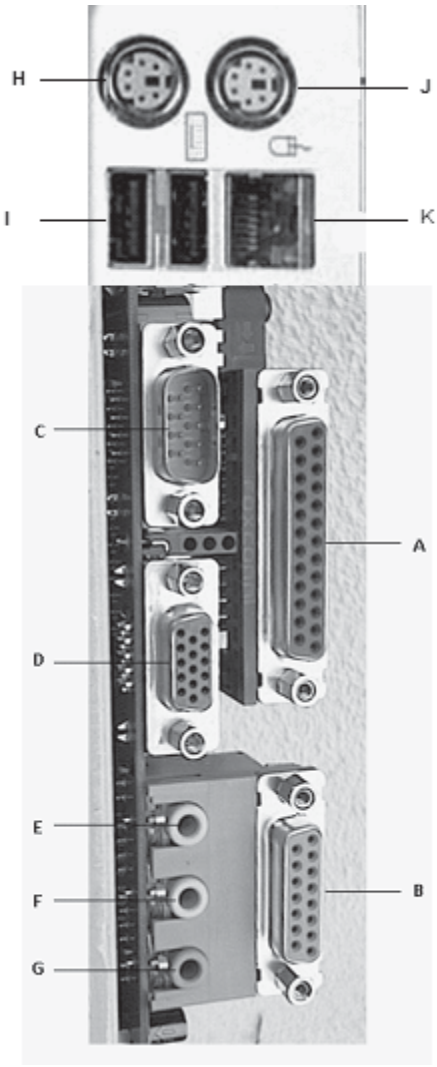


Fig. 4.8 : I/O ports and Connectors

A – Parallel port B – Game port (for Joystic)
C – Serial communication port(for modem)
D – VGA Port (for monitor)
E – Audio out Jack F – Microphone Jack
G – Line in Jack H – PS/2 Keyboard Connector
I – USB Ports J – PS/2 Mouse Connector
K – Gigabit RJ -45 Ethernet LAN Port

The above components are briefly discussed below :

Parallel Port

The parallel port mainly used for scanners and printers is also called a printer port.The printer connector on the back of the PC is a 25-pin female

connector. Parallel ports send data in parallel i.e. more than one bit at a time.

Game Port

The Game port is just a serial port normally found on a sound card. Gamepads and joysticks plug into the game port. The game port is a female connector and larger than that of the standard COM port.

Serial Port

The serial ports are the male connectors on the back of the PC, which have either 9 or 25 pins, of which often only 3-4 are used for serial transmission.

VGA Port

The VGA port is also female connector which is used to connect display devices like monitor, projector etc.

USB Port

USB stands for *Universal Serial Bus* and is an I/O standard originally developed by seven companies – Compaq, Digital, IBM, Intel, Microsoft, NEC and Northern Telecom.

USB is a cheap serial I/O bus with an open specification. This means that anyone can produce USB products, without having to pay licences to anyone. You can find USB versions of many different devices, such as mouse, keyboards, scanners, cameras, and even printers.

PS/2 Connectors

Every motherboard (ATX boards) has two PS/2 connectors, one for the mouse and the other for the keyboard. They are of same size and same shape but have different colour. This is because the Mouse and keyboard connectors are not interchangeable. Plugging the keyboard into the mouse connector and vice versa will make both of them useless. Usually, the mouse is to be plugged into the green connector and the keyboard into the purple connector.

Gigabit RJ-45 Ethernet LAN Port

The Ethernet Network port is an 8-pin RJ45 connector. This port is used to connect you to a network connection and/or to a high speed modem.



CHECK YOUR PROGRESS

1. State true or false
   a) Power supply unit converts DC voltage to AC voltage.
   b) Data exchange in a computer system takes place through a motherboard.
   c) PCI slots are used to connect I/O devices.
   d) DDR SDRAM stands for *Double data rate synchronous dynamic random access memory.*
   e) BIOS programs are stored in ROM chip.
   f) CPU registers are temporary storage area.
   g) CPU clock rates are measured in Kilo Hertz.
   h) The control bus is used to transfer data.
   i) Parallel ports are male connector.
   j) A parallel port has 9 pins.
   k) The serial ports are male connector.
   l) The VGA port is used to connect display devices.
   m) The game ports are male connectors.
   n) In PS/2 connector PS stands for *Personal System*.
   o) RJ -45 connectors are used in LAN ports.
   p) North bridge controls the data traffic of I/O units.



4.6 LET US SUM UP

In this unit, we have discussed the different components of a computer system. We have found that the system unit houses all the components of motherboard including the hard disk, CD drive, SMPS etc. We have mentioned that SMPS converts AC voltage to DC voltage. We have identified the various components of a motherboard. Central Processing Unit(CPU) is the brain of the computer system and one CPU is a combination of control unit, *arithmetic and logic unit, the registers and the clock unit*. The buses are the communication pathways in a computer system. The motherboard

of a computer consists of a number of ports and connectors to which various equipments can be connected.



4.7 ANSWERS TO CHECK YOUR PROGRESS

a) False	b) True	c) True	d) True
e) True	f) True	g) False	h) False
i) False	j) False	k) True	l) True
m) False	n) True	o) True	p) False



4.8 FURTHER READING

1. Gilster Ron, PC Hardware : A Beginner's Guide, Tata MacGraw Hill.
2. Zacker Craig, PC Hardware : The Complete Reference, John Rourke, Tata MacGraw Hill.
3. Gupta Vikash, Comdex-Hardware and Networking, Dreamtech Press.



4.9 MODEL QUESTIONS

1. What is a system unit ?
2. Write the function of a SMPS.
3. What is a motherboard ? Mention any five components of a motherboard.
4. Write down the function of any five components of a motherboard.
5. Write down the difference between north bridge and south bridge.
6. What is a POST ?
7. Write down the function of each components of a CPU.
8. What is a bus ? How many types of buses are available ?
9. Write down the function of differenet types of buses available.

10. Mention any five ports and connectors availalble on a computer system and write their functions.
11. Wrlite short notes :
    a) Power supply
    b) Motherboard
    c) North bridge and South bridge
    d) CPU
    e) Bus
    f) I/O ports and connectors

UNIT 5 : INTRODUCTION TO COMPUTER NETWORKS

UNIT STRUCTURE

5.1 Learning Objectives
5.2 Introducton
5.3 Computer Networks
    5.3.1 Goals of Computer Networks
5.4 Network Topology
    5.4.1 Bus
    5.4.2 Star
    5.4.3 Ring
    5.4.4 Mesh
    5.4.5 Tree
5.5 Categories of Network
    5.5.1 Local Area Network
    5.5.2 Metropolitan Area Network
    5.5.3 Wide Area Network
5.6 Networking Devices
5.7 Let Us Sum Up
5.8 Answers to Check Your Progress
5.9 Further Reading
5.10 Model Questions

5.1 LEARNING OBJECTIVES

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

- learn what a computer network is and what are its goals
- describe the basic network topologies
- explain the types of computer networks
- learn different networking devices with their roles in the network

5.2 INTRODUCTON

This unit is written for all learners, even those with little or no networking experience. It explains in simple terms the way computers and other devices

are put together i.e., network topology, and how data packages are sent between networks along with how data is routed to different computers in the network.

In this unit, we shall discuss the concept of computer network. We shall begin our discussion with the definition of computer network with its goals. Next, we shall come to the concept of network topology which give us the idea of the structure of networks. After that, we will discuss the types of networks. Different types of networking devices will also be covered in this unit.

5.3 COMPUTER NETWORKS

A computer network is a group of computers that shares information across wireless or wired technology. The devices on a computer network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams. A computer network is a collection of several computers and terminals interconnected by one or more transmission paths to share resources. Two computers are said to be interconnected if they are able to exchange information.

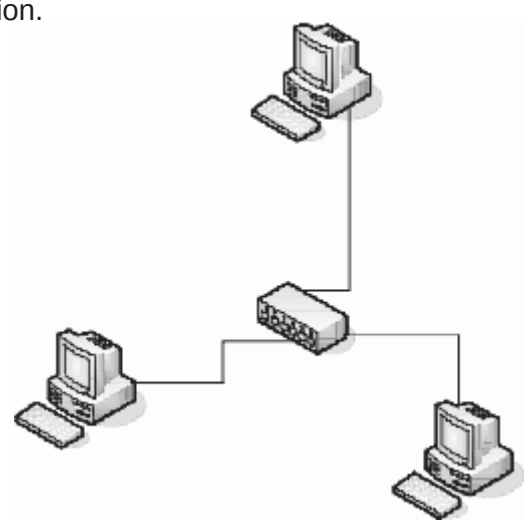


Fig. 5.1 : A simple Computer Network

5.3.1 Goals of Computer Networks

The primary goals of computer networks are as follows :

- **Resource Sharing**

  The main goal of networking is resource sharing. By using computer networks, it is possible to share programs, data and other resources among several users on the network. The sharing of resources is independent of the physical location of the user and the resource. Files on a particular computer of an user can be shared on the network or files can be placed on a file server, which provides a central location for all files needed by the users on the network. Users can also share devices such as printers, CD-ROM drives, and hard drives etc. It also makes upgrading an application easier because upgradation can be performed on the server itself. Thus, we donot need seperate resource for each computer.

- **High Reliablity**

  Another goal of networking is to provide high reliablity by having alternative sources of supply. For example, all files could be replicatied on two or three machines, so if one of them is unavailable, the other copies could be available.

- **Cost Reduction**

  Another goal of networking is reduction of cost. Resource sharing automatically reduces cost, and hence money can be saved. For example, there are ten users and each requires a printer. If they had to work individually, then ten printers would have to be purchased. If these ten users are allowed to work in a network, then, only two or three printers would be sufficient.

- **Communication Medium**

  Computer networks provide a powerful communication medium among people who are in same or different geographical location. A file that was updated or modified on a network, can be seen by the other users on the network immediately.

5.4 NETWORK TOPOLOGY

In computer networking, "***topology***" refers to the layout or design of the connected devices. In this section, we will illustrate the way computers and other devices are put together to form a network topology.

Network topologies can be *physical* or *logical*. ***Physical topology*** means the physical design of a network including the devices, location and cable installation. Several physical topologies are in use for networks today. Some of the common include the *bus*, *ring*, *star*, *tree* and *mesh*. More complex networks can be built as *hybrids* of two or more of the above basic topologies. The ***logical topology*** defines how the systems communicate across the physical topologies. The two most common types of logical topologies are ***broadcast*** and ***token passing***.

Let us briefly discuss the physical topologies one by one.

5.4.1 Bus Topology

A network of bus topology consists of a long single cable to which all the computers and other devices are connected (Fig.5.2). Any node attached to the bus can send signals down the cable to all the nodes of the network; that means a bus is a broadcast medium. When more than one node starts sending data through the bus, they mix with each other, and the sent data become a garbage. This is called *collision.* To avoid collision there must be some agreement between the nodes so that when one computer starts to send data, others refrain themselves from sending data. To ensure correct data communication, both ends of the cable is terminated by a special device called end terminator.

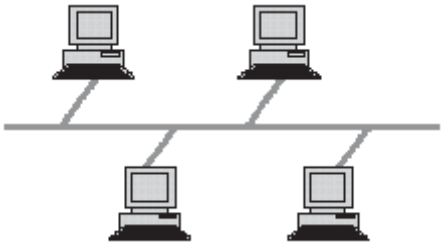


Fig. 5.2 : A Bus Topology

Ethernet bus topologies are relatively easy to install and do not require much cabling compared to the alternatives. 10Base-2 (Thin) and

10Base-5 (Thick) both were popular Ethernet cabling options for bus topologies. Some advantages and disadvantages of the bus topology are listed below:

Advantages :

- Bus topology is inexpensive in installation
- It requires less cable than other topologies
- Good for smaller networks do not require higher speed.
- It is easy to add systems to network.

Disadvantage:

- Out-of-date technology. Bus topology was used in the early days of networking because it was inexpensive to use and relatively easy to set up.
- If the backbone cable fails, the entire network effectively becomes unusable.
- It is unmanageable in a large network. If more than a few dozen computers are added to a network bus, it is likely that performance problems will occur.
- It is difficult to troubleshoot.

5.4.2 Ring Topology

In ring topology the computers are connected between each other in such a way that they form a close loop. In practice, a cable connects the first computer to the second computer, another cable connects the second computer to the third and so on until the last computer is connected back to the first to complete the loop. It should be noted that the topology may not physically look like a ring or circle. The ring means that the computers are connected with each other in a logical ring. The interconnecting cables may take any shape in practice. All messages travel through a ring in the same direction (either “clockwise” or “counter clockwise”).

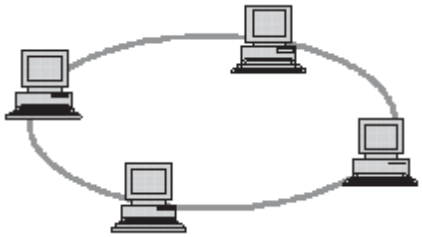


Fig. 5.3 : A Ring topology

In ring topology the communicating computers must follow some agreement between them to avoid collision as it is also a broadcast network. The main difference between the bus and the ring is that the ring topology does not require termination. Because the systems are connected together in a loop, and there is no beginning and end point as found with the bus topology. A failure in any cable or device breaks the loop and can take down the entire network. Two major network types used in the ring topology are:

i) *Fiber Distributed Data Interface* (FDDI) where a large, high speed networks use fiber optic cables in a physical ring topology.

ii) *Token-Ring networks* that use logical ring topology.

Advantages :

- No collision of data as data travel in one direction only.
- Easier to find fault. If any point gets broken, you can trace that easily.
- No terminator required.

Disadvantages :

- Ring topology requires more cable than bus topology
- A break in ring will take the whole network down.
- Addition or removal of any node can affect entire network.

5.4.3 Star Topology

In the *star* topology, all computers and network devices connect to a central device (controller) called a ***hub*** as depicted in the figure.5.4.

Each connected device requires a single cable to be connected to the hub. A hub normally accept data from a sending computer and delivers it to the computer for which the data is addressed. Hence a star network is not a broadcast network, rather a point-to-point network.



Fig. 5.4 : A Star Topology

Using a separate cable to connect to the hub allows the network to be expanded without causing any disruption in the network. Because, each computer uses a separate cable to connect to the hub, the failure of a network connection affects only the single machine concern. The other computers can continue to function normally. Fast Ethernet (100Base-TX & 100Base-FX) in a star topology is the most commonly used LAN today. *10Base-T Ethernet* and *1000Base-TX Gigabit Ethernet* also use star topology.

Adavntages :

- Star networks are easily expanded without disruption to the network.
- Easy to add/remove devices to/from network.
- One break does not bring whole network down. Cable failure affects only a single user.
- Easy to troubleshoot and isolate problems.
- Widely used centralized management.

Disadvantages :

- Costs are usually higher than with bus or ring networks.

- Requires more cable than most of the other topologies.
- If the hub fails, any device connected to it will not be able to access the network.

5.4.4 Mesh Topology

The mesh topology incorporates a unique network design in which each computer on the network connects to every other, creating a point-to-point connection between every device on the network. A mesh topology is used when there can be absolutely no break in communications, for example the control systems of a nuclear power plant. The purpose of the mesh topology is to provide a high level of redundancy. If a network cable, computers or other components fail, the data always has an alternative path to get to its destination.

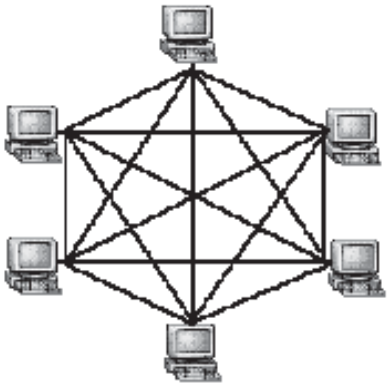


Fig. 5.5 : A Mesh Topology

A fully connected mesh network has n(n-1)/2 cables to link 'n' devices. Therefore, every device on the network must have 'n-1' input/output (I/O) ports. For example, in the Fig. 5.5, we have six systems that require 15 cables to create a mesh network. This topology is mainly used in environments where high availability outweighs the costs associated with this amount of interconnection. We can see in the figure that the wiring for a mesh network can be very complicated. Further, troubleshooting a failed cable can be tricky. Because of this, the mesh topology is rarely used.

Advantages :

- Provides alternative paths between devices in the network.

- The network can be expanded without disruption to current users.

Disadvantages :

- It is expensive because a large number of cabling are required.
- Routing network traffic can be difficult because of all the different possible paths between nodes.
- It is very expensive to wire up.

5.4.5 Tree Topology

A tree topology combines characteristics of bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable (Fig. 5.6). This bus/star hybrid approach supports future expandability of the network much better than a bus (limited in the number of devices due to the broadcast traffic it generates) or a star (limited by the number of hub connection points)

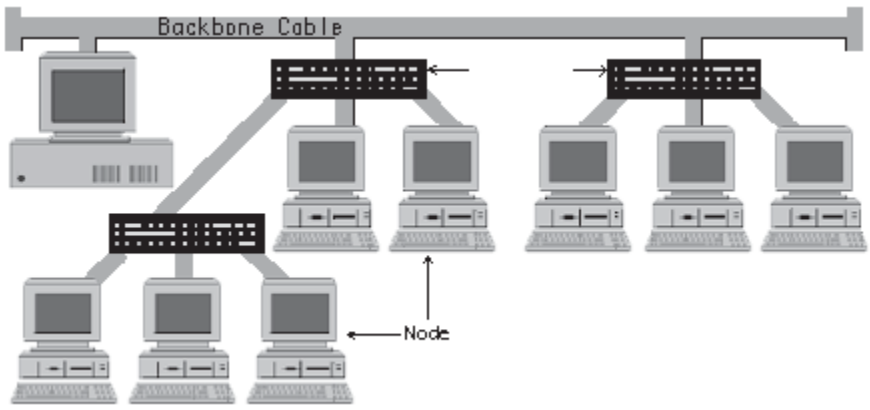


Fig. 5.6 : A Tree Topology

Advantages:

- The network is easy to extend by just adding another branch.
- Fault isolation is relatively easy.

Disadvantages :

- If the backbone cable breaks, the entire network goes down.
- More difficult to configure and wire than other topologies.

- If any hub goes down, all branches of that hub go down.

There are also ***hybrid*** network topology which can be built of two or more above mentioned topologies. Hybrid networks are the complex networks. The best known example is the star-wired ring topology that is used to implement IBM Token Ring networks.



CHECK YOUR PROGRESS - 1

1. Fill in the blanks:
   i) _____ defines the physical or logical arrangement of links in a network.
   ii) In _____ topology, every device has a dedicated point-to-point link to every other device.
   iii) _____ topology is the combination of different types of topologies.
   iv) The topology in which multiple nodes are connected to a central component is called a _____ topology.
   v) _____ topology provides alternative paths between devices in the network.
   vi) Ring topology requires _____ cables than bus topology.
   vii) The topology used in Ethernet is _____ topology.
   viii) _____ topology uses central controller or hub.
2. What topology is used by 10Base-5 and10Base-2 Ethernet?
3. What topology is used by FDDI?

5.5 CATEGORIES OF NETWORK

Whenever we have a set of computers or networking devices to be connected, we make the connections, depending on the physical layout and the requirements. On the basis of geographical area covered, computer networks can be classified under the following three categories:

- Local Area Network
- Metropolitan Area Network

- Wide Area Network

5.5.1 Local Area Network

A ***local area network*** or **LAN**, is a high-speed data network that covers a relatively small geographical area such as a building, a laboratory, or a school. It typically connects workstations, personal computers, printers, servers, and other devices. LANs offer computer users many advantages, including shared access to devices and applications, file exchange between connected users, and communication between users via electronic mail and other applications. LANs differ in the way the computers are connected (i.e., their topology), in how information moves around the network (i.e., their transmission technology) and their size.

IEEE (Institute of Electrical and Electronic Engineers) is a US publishing and standard organization responsible for many LAN standards such as the 802 series. *IEEE 802.3,* popularly called *Ethernet* is the most popular LAN , usually operating at 10 Mbps to 10 Gbps and is present in many large organizations and offices. In a typical LAN configuration, one computer is designated as the *server*. It stores all of the software that controls the network, as well as the software that can be shared by the computers attached to the network. Computers connected to the server are called *workstations*. Two most commonly used LAN implementations are depicted below:

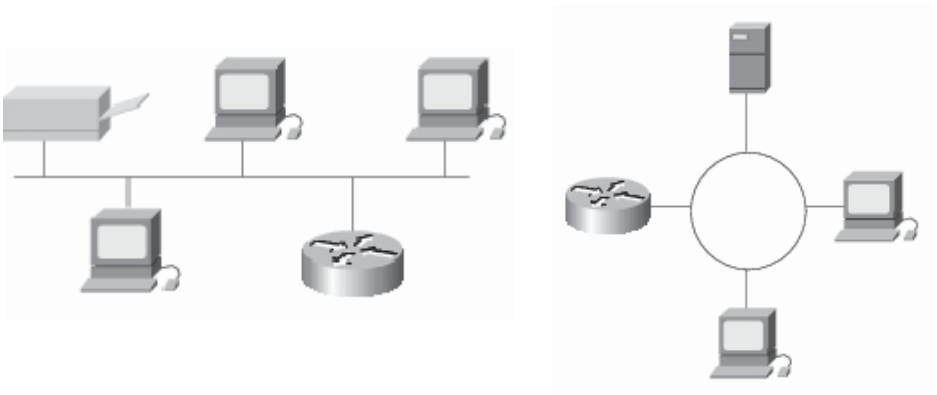


Fig. 5.7 : (a) Ethernet or IEEE 802.3 (b) Token Ring or IEEE 802.5

LAN protocols function at the lowest two layers, i.e., the *physical* and the *data link layer* of the OSI reference model.

5.5.2 Metropolitan Area Network

A ***Metropolitan Area Network***, or **MAN**, is basically a bigger version of a LAN and normally uses similar technology. It might cover a group of nearby corporate offices or a city and might be either private or public.

A MAN often provides efficient connections as it has high-speed transmission capabilities which uses some of the telecomminication components to handle long-distance transmission. MAN is basically a bigger version of a LAN with similar technology. One very common example of MAN is the cable television network. Another important example is the high-speed wireless Internet access, which has been standardized as *IEEE 802.16.*

5.5.3 Wide Area Network

A ***wide area network*** or **WAN** is a computer network covering multiple distance areas, which may spread across the whole world. WANs often connect multiple smaller networks, such as local area networks (LANs) or metropolitan area networks (MANs).

Typically, a WAN consists of a number of interconnected switching nodes. A transmission from any one device is routed through these internal nodes to the specified destination device. These nodes are not concerned with the content of the data; rather, their purpose is to provide a switching facility that will move the data from node to node until they reach their destination. Traditionally, WANs have been implemented using either *circuit switching* or *packet switching* technologies. More recently, frame relay and *ATM* (*Asynchronous Transfer Mode*) networks have assumed major roles.

The ***Internet*** is the best known example of a WAN. Some segments of the Internet are also WANs in themselves. The Internet is a system of linked networks that are worldwide in scope and facilitate data communication services such as *remote login*, *file transfer*, *e-mail*, the *World Wide Web* etc. With the rise in demand for connectivity, the Internet has become a communication highway for millions of users. The Internet was initially restricted to military and academic institutions, but now it is a full-fledged conduit for all forms of information and commerce. Internet websites now provide personal, educational, political and economic resources to every corner of the planet.

5.6 NETWORKING DEVICES

The networking devices are the vital tools for communication. Here, we will gain some information about the various hardware that is used to maintain connections between the networks.

- ***Network Interface Card (NIC)***

  A ***network interface card***, also known as a ***network adapter***, is a very important hardware which is responsible for connecting a particular computer to a network. The NIC mediates between the computer(and its user) and the network. Usually an NIC consists of a printed circuit board containing different electronic components. It possesses a ROM chip that contains a unique number known as the media access controll (MAC) address. The MAC address identifies the device uniquely on the LAN. It also contains DMA (Direct Memory Access) circuit that allows the NIC to transmit or receive bits from memory without the involvement of the CPU. A NIC contains one or many connectors which provides plug-in facility to the network cable. It exists on the Data Link Layer of the ISO-OSI reference model. NIC handles all the details of packet transmission and reception.

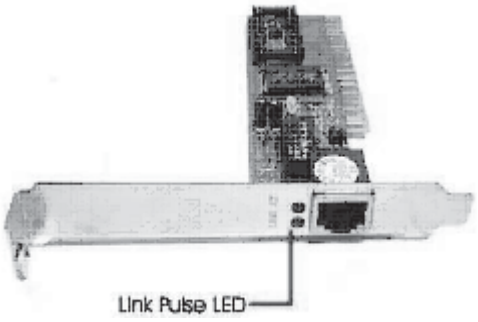


Fig. 5.8 : A Network Interface Card

- ***Modem***

A modem (***mo***dulation-***dem***odulation) is a communication device that converts binary electrical signals into analog signals for transmission over telephone lines and converts these signals back into binary form at the receiving end. Conversion to analog form is called *modulation;* and the reverse process is known as *demodulation.*

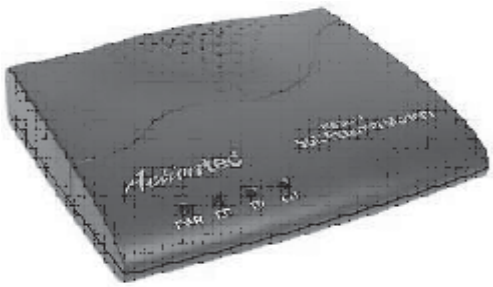


Fig. 5.9 : A Modem

At the transmitting end, a bits stream arrives at the modem from computer's serial port. These bits are converted into analog form (modulation) using a predefined modulation technique. This analog signal is transmitted along telephone lines. At the receiving end, the analog signal is converted back to digital form(demodulation). The resulting serial stream is sent on to the computer at the receiving end.

- ***Repeater***

Signals can only travel so far through media before they weaken, and become garbled. This weakening of signals is called *attennuation*.

Repeaters are used to regenerate the analog as well as digital signals which are distorted by transmission loss. These are Layer 1(Physical layer) internetworking devices used to combat attenuation. Repeaters take in weakened signals, clean them up, regenerates them, and send them on their way along the network. By using repeaters, the distance over which a network can operate is extended.

For example, 10Base-T (a wiring standard) is allowed to run 100 meters. One repeater can double this distance to 200 meters, as decpicted in figure 5.10.

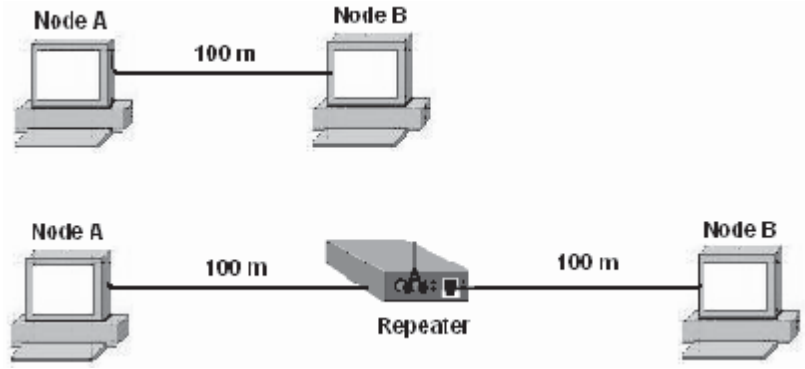


Fig. 5.10 : A repeater extending network without attenuation

- **Bridges and Gateways**

As the size of local area networks grow, the management of the networks became more difficult. Controlling traffic flow, maintaing fault monitoring, and adding and deleting stations from the system required more and more sophisticated system management. An alternate method to handling larger networks is to divide them into smaller networks that are interconnected using hardware/software systems called *bridges* and *gateways*.

Bridges are mainly used to connect multiple LANs which operate in the Data Link Layer to construct a larger LAN. The type of data transferred between the LANs must have the same format. A bridge can regenerate a signal it receives like a repeater. The basic function of a bridge is to transfer the frames from one LAN to another LAN. Bridge also has the capacity of frame filtering. It examines the header of each incoming frame, and based on this information bridge decides whether to discard or forward this frame. Bridge stores the MAC

address of received frame, keep record on which port it has received, and which address belongs to which computer on the LAN.



Fig. 5.11(a) : A typical bridge

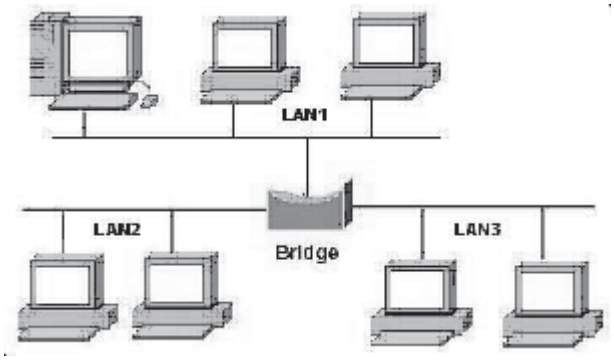


Fig. 5.11(b) : A bridge connecting 3 LANs

Gateways are similar in functions to bridges in that they connect more than one networks. The main difference between bridges and gateways is that the latter can interconnect networks with differing message formats. A bridge does not perform any protocol translation in transferring packets between networks. Whereas, gateway takes an application message, read it and interprets it. Hence, it can be used as a connecting device between two inter networks that use different model of references. One of them may use OSI model whereas the other uses TCP/IP model. A gateway is capable of receiving a frame coming from one model, make necessary conversions and send it to the other system of model. Thus, gateway relay packets among networks that have different protocols (e.g. between a LAN and a WAN). A gateway can provide security also.

- ***Hub***

Hubs are Physical layer(Layer 1) devices. Data that comes in one port is sent out of all other ports, except for the port it came in. Hub does not read the data passing through it and does not know the

source and destination points. It simply receives the data packets, amplify the electrical signal and then retransmit the data packets on the network. Hubs usually accomodate four or eight nodes, and many hubs include connectors for linking to other hubs. A hub connects nodes that have a common network architecture.

The types of hubs that exists in the network are: *Passive hub* and *active hub*. *Passive hub* receives data packet and retransmits them on the network without amplifing the electrical signal. A multiport repeater is called an *active hub*. They receive the data packets, amplify them and retransmit them on the network. For amplification they need the electrical signal.

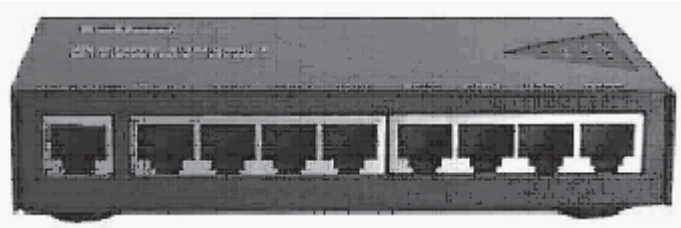


Fig. 5.12 : A hub

- ***Switch***

Switches are the core devices in today's modern LANs. A network ***switch*** is a hardware device that is used to connect computers that required high bandwidth and used to connect hubs to form large network. Switches are more expensive but provide better performance to hubs. Unlike hubs, network switches are capable of inspecting data packets as they are received, determining the source and destination device of each packet, and forwarding them appropriately. By delivering messages only to the connected device intended, a network switch conserves network bandwidth and offers generally better performance than a hub.

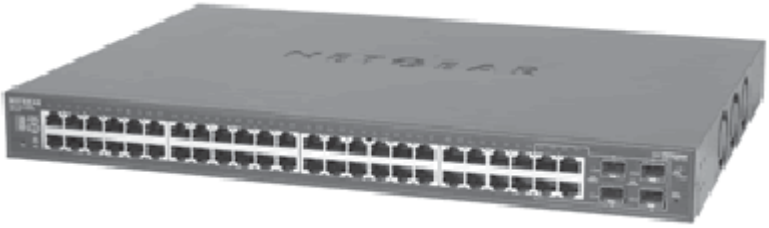


Fig. 5.13 : A Switch

Two types of switches exists which are:

Layer- 2 switches : These types of switches are based on the bridging technology. They establish connection between the ports based on the MAC address stored in the address table.

Layer-3 switches : These types of switches are based on the routing technology and are responsible for setting up connection between the ports based on the network address.

- ***Router***

A router is the primary device responsible for connecting multiple networks together. The function of a router is to provide a path from a node on one network to a node on another network. The two networks may be separated by several intervening networks and possibly, by many miles. The purpose of a router is to forward data packets between networks. It examines incoming packets, choose the best path for them through the network, and then switch them to the proper outgoing port. Routers are normally used to connect LANs and WANs in the Internet. It performs routing of packets based on their logical addresses. It has a routing table to take decision about the routes of packets. The table is constructed and updated dynamically by following some routing algorithm. Routers work at Layer 3, the Network Layer. In the figure, routers connect nodes on different networks.

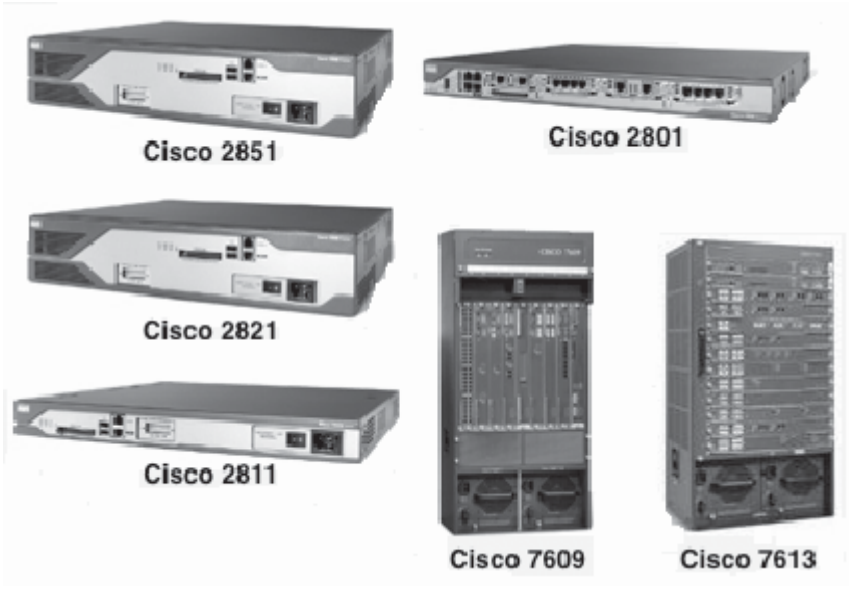


Fig.5.14 (a) : Some images of Cisco routers

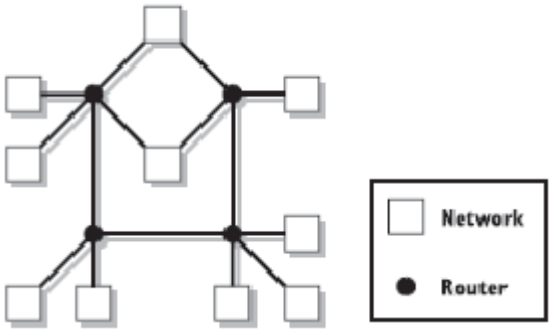


Fig. 5.14 (b) : Networks connected with routers



CHECK YOUR PROGRESS - 2

1. State True or False:
   i) Conversion of analog signals to digital form is called modulation; and the reverse process is known as demodulation.
   ii) A hub connects nodes that have a common network architecture.
   iii) The world's most popular WAN is the Internet.
   iv) Cable TV network is an example of MAN.
   v) Ethernet is an example of LAN.
   vi) Routers operates at physical layer.



5.8 LET US SUM UP

The key points to keep in mind from this unit are :

- **Networking** is the interconnection of workstations, peripherals, terminals and other devices.
- A ***network*** consists of two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or

allow electronic communications. In brief, all network must have the following:

- Something to share (i.e., data or information)
- A pathway (i.e., transmission medium)
- Rules of communication (i.e., protocols)
- ***Topology*** defines the structure of the network. There are different kinds of network topologies: ***bus***, ***star***, ***ring***, ***mesh*** etc. A better network can be built if we have the knowledge of these topologies and if we know the difference between each topology.
- A misconfigured network can result in a waste of time and energy as well as many troubleshooting methods to resolve the issue. So, the basic understanding of the network topologies and devices is a must to build a good network.
- Netwoks can be divided into LANs, MANs, WANs, and internetworks.
- A ***LAN*** is a network that is confined to a relatively small area. It is generally limited to a geographic area such as a computer laboratory, school, or a building.
- ***MAN*** is usually the interconnection between various LANs in a particular geographical area like a metropolitan city like Delhi, Mumbai etc. Hence the name is given.
- ***WAN*** consists of machines that may be spread out over larger areas, such as across a college campus, an industrial park, a city, or a state. WANs usually include some type of remote bridges or routers, which are used to connect groups of nodes by telephone or other dedicated lines.
- An ***Internet*** is an internetwork, which is a network consisting of two or more smaller networks that can communicate with each other.
- A protocol is a set of predefined rules that govern how two or more processes communicate and interact to exchange data. The processes can be on the same machine or on different machines.



5.9 ANSWERS TO CHECK YOUR PROGRESS

CHECK YOUR PROGRESS - 1

1. i) Topology ii) mesh iii) Hybrid iv) star
   v) Mesh vi) more vii) bus viii) star
2. Bus topology
3. Ring topology

CHECK YOUR PROGRESS - 2

1. i) False ii) True iii) True iv) True
   v) True vi) False



5.10 FURTHER READING

1. Tanenbaum Andrew S., "*Computer Networks*", PHI publication
2. Stallings William, "*Data and Computer Communications*", Pearson Prentice Hall.



5.11 MODEL QUESTIONS

1. What do you mean by a computer network?
2. Briefly describe each of the main network topologies:bus, star and ring.
3. What are the different types of networking devices?
4. What are the basic differences of the function of bridges and gateways in a computer network?
5. Give the advantages of star topology over bus topology.
6. What is Local Area Network?

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