UNIT-3

STUDY OF INPUT AND OUTPUT DEVICES

CHAPTER OUTLINE

INPUT DEVICES

3.1 Various Input Devices used with a General Purpose Computer

3.2 Working Principle of Keyboard (Wired & Wireless Keyboard)

3.3 Working Principle of Opto-mechanical Mouse and Optical Mouse (Wired & wireless Mouse)

3.4 Various Scanners

3.5 Working of Flat Bed Scanner and Hand Held Scanner

3.6 Working of a Webcam

OUTPUT DEVICES

3.7 Various Output Devices used with a General Purpose Computer

3.8 Working Principle of CRT Monitor

3.9 The Working Principle of LCD/TFT/LED/OLED Monitors

3.10 Different Categories of Printers (Impact and Non-Impact)

3.11 Working Principle of Dot Matrix Printer

3.12 Working Principle of Inkjet Printer

3.13 Working Principle of Laser Printer

3.14 Multi-Function Printer

INPUT DEVICES

3.1 VARIOUS INPUT DEVICES USED WITH A GENERAL PURPOSE COMPUTER

To interact with your computer, you need input devices. An input device for a compute allows you to enter information into it. The most fundamental information we inp are keystrokes on a keyboard and clicks with a mouse. These two input devices a essential for you to interact with your computer. Many other input devices exist fo entering other types of information, such as images, audio and video. Input device represent one type of computer peripheral - the other two types are output device and storage devices.

3.2 WORKING PRINCIPLE OF KEYBOARD (WIRED & WIRELESS KEYBOARD)

Wired Keyboards : A wired keyboard means there is a wire connecting your keyboard to your computer. At the end of the wire is a USB plug that goes into a USB port on your computer. Wired keyboards are extremely reliable

Wireless Keyboards : A wireless keyboard works just like a wireless mouse; you plug a receiver into one of the USB ports on your computer. The receiver then sends a signal to your battery-powered keyboard.

Working principle of bot wired and wire-less keyboard are the same but the data transmission techniques differ.

When a key gets pressed, the top and bottom contact layers come together and the keyboard sends a signal to your computer which carries the unique code of the specific key, via the cable connected to the computer.

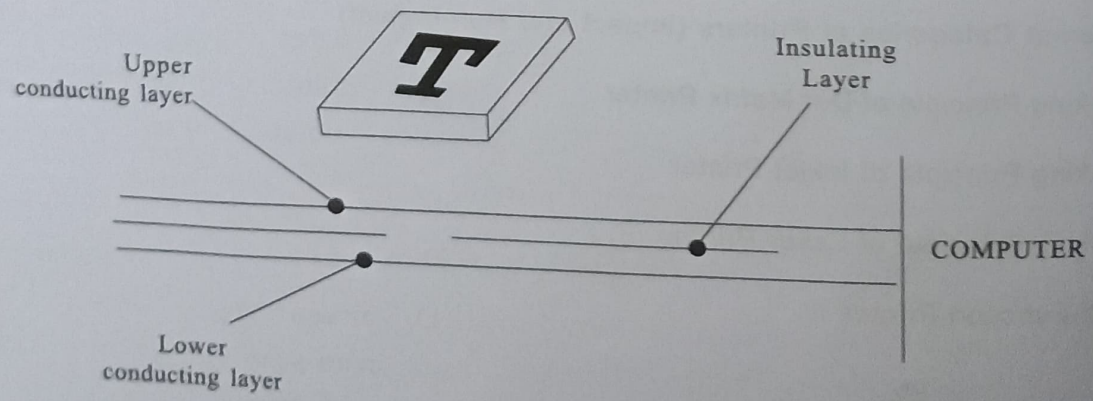

FIG 3.1 : Working of Keyboard key

3.3 WORKING PRINCIPLE OF OPTO-MECHANICAL MOUSE AND OPTICAL MOUSE (WIRED & WIRELESS MOUSE)

Optical Mouse : The main components of the optical mouse are:

- Inbuilt optical sensor.
- High speed camera which can take 1000 pictures at a time.
- LED.

Optical mouse do have an in built optical sensor. The optical sensor reads the movements of the optical mouse (moved by the user) with the help of the light rays which comes out from the bottom. (The area in which a light glows). When the user moves the optical mouse, the LED (Light Emitting Diode) present inside the mouse emits the light according to the minute movements. These movements are sent to the camera as light rays. The camera captures the difference in light rays as images. When the camera captures the images, each and every picture and compared to one another with the digital technology. With the comparison, the speed of the mouse and the direction of the movement of the mouse are rapidly calculated. According to the calculation, the pointer moves on the screen.

FIG 3.2 : Opto Mechanical Mouse

Opto Mechanical Mouse : The optical-mechanical or opto mechanical mouse consists of a ball that rolls one of two wheels inside the mouse. Each wheel contains a circle of holes or notches, allowing an LED light to shine through and be detected by a sensor. As the wheel spins these lights represent an X or Y axis for the mouse pointer on your screen. This mouse is more accurate than a mechanical mouse that uses only wheels and rollers, however, is not as good as an optical mouse.

3.4 VARIOUS SCANNERS

There are three types of Scanners Available : Drum scanner, flatbed, and handheld scanners. The publishing industry primarily uses drum scanners to print high-quality images, while flatbed scanners are generally used in schools and offices. On the other hand, libraries and shopping malls make use of handheld scanners.

- **Feed-in or Sheet-fed Scanners :** These are simple scanners that have the limitation of scanning paper documents only as they have a feeder tray that takes in the paper kept in the tray. Thus, scanning anything in book form is not possible here. However few advanced models do have the option of scanning several pages in sequence.
- **Flatbed Scanner :** This is very commonly used and available in the markets readily These have a flat surface for screening with a cover that must be lifted to place the material that has to be scanned. This model is viable for scanning books like magazines educational content that is bound to be bulky.
- **Handheld scanners :** These are essentially used to scan barcodes, thus useful for business transactions and general use.

3.5 WORKING OF FLAT BED SCANNER AND HAND HELD SCANNER

Flat bed scanner is a type of optical scanner that consists of a flat surface on which you lay documents to be scanned. Flatbed scanners are particularly effective for bound documents. The document you put in scanner is scanned by the machine and sends it to the computer in the form of an image.

Any flatbed scanner will have the following devices.

- Charge-coupled device (CCD) array.
- Lens.
- Control circuitry.
- Mirrors.
- Stepper motor.
- Filters.
- Belt.
- Scan head.
- Power supply.
- Interface ports.
- Glass plate.
- Lamp.
- Stabilizer bar.
- Cover.

FIG 3.3 : Flat bed Scanne

The document has to be placed on the glass bed. There will also be a cover to close the scanner. The lamp brightens up the text to be scanned. Most scanners use a Cold Cathode Fluorescent Lamp (CCFL). A stepper motor under the scanner moves the scanner head from one end to the other. The movement will be slow and

controlled by a belt. The scanner head consists of mirrors, lens, CCD sensors and also the filter. The scan head moves parallel to the glass bed and that too in a constant path from one end of the machine to the other. A stabilizer is placed to control its deviation. When it has reached the other end the scanning of the document has been completed. As the scan head moves under the glass bed, the light from the lamp hits the document and is reflected back with the help of mirrors angled to one another. The mirrors will be angled in such a way that the reflected image will be hitting a smaller surface. In the end, the image will reach a lens which passes it through a filter and causes the image to be focussed on CCD sensors. The CCD sensors convert the light to electrical signals according to its intensity. The electrical signals will be converted into image format inside a computer.

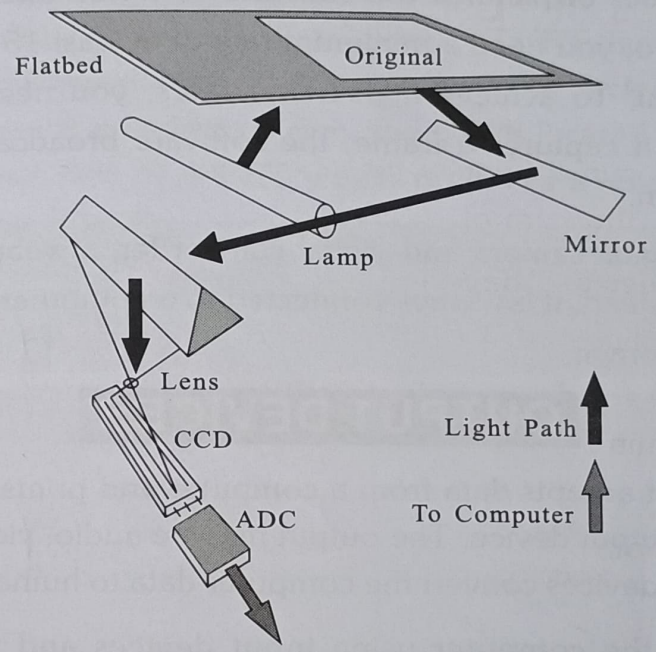

FIG 3.4 : Diagram of the Workings of a FLATBED Scanner

Hand Held Scanner : A handheld scanner is a bar-shaped electronic device that digitally captures and stores images. Portable and running on batteries, it has controls and a display for selecting different scan modes, showing the amount of memory available for documents and indicating the status of a scan. Mobile professionals such as salespeople use handheld scanners to capture memos, contracts, sketches and photos with high resolution.

Hand held scanner use the same basic technology as a flatbed scanner, but rely on the user to move them instead of a motorized belt. This type of scanner typically does not provide good image quality, but only used to scan small images like bar codes on the products. However, it can be useful for quickly capturing text.

3.6 WORKING OF A WEBCAM

A **webcam** is a hardware camera and input device that connects to a **computer** and the **internet** and captures either still pictures or motion video of a user or other object. Today, most webcams are either embedded into the display with laptop computers or connected to the USB or FireWire port on the computer.

A webcam will have an optical lens to capture the images/videos and a small hole to capture sound. Webcam software **"grabs a frame"** from the digital camera at a preset interval and transfers it to another location for viewing. If you are using your Webcam for streaming video, you'll want a Webcam system with a high frame rate. Frame rate indicates the number of pictures the software can grab and transfer in one second. For streaming video, you need a minimum rate of at least 15 frames per second (fps) and 30 fps is ideal. To achieve high frame rates, you need a high-speed Internet connection. Once it captures a frame, the software broadcasts the image over your Internet connection.

Note : Unlike a digital camera and digital camcorder, a webcam does not have any built-in storage. Instead, it is always connected to a computer and uses the computer hard drive as its storage.

OUTPUT DEVICES

Any peripheral that accepts data from a computer and prints, projects, or reproduces it is known as an output device. The output may be audio, video, hard copy – printed paper, etc. Output devices convert the computer data to human understandable form.

We give input to the computer using input devices and the computer performs operations on the data and displays the output to the user using the output device.

3.7 VARIOUS OUTPUT DEVICES USED WITH A GENERAL PURPOSE COMPUTER

An output device is any peripheral that receives data from a computer, usually for dispaly, projectio, or physical reproduction. Example of an output device is a computer monitor, which displays an image that is received from the computer. Monitors and printers are two of teh most common output devices.

Some of the Output Devices are :

(a) 3D printer
(b) Braille embosser
(c) Braille reader
(d) Flat panel

(e) GPS
(f) Headphones
(g) Computer Ouput Microfilm (COM)
(h) Monitor
(i) Plotter
(j) Printer (Dot matrix printer, Inkjet printer, and laser printer).
(k) Projector.
(l) Sound card
(m) Speakers.

3.8 WORKING PRINCIPLE OF CRT MONITOR

Cathode Ray Tube (CRT) is a computer display screen, used to display the output in a standard composite video signal. The working of CRT depends on movement of an electron beam which moves back and forth across the back of the screen. The source of the electron beam is the electron gun; the gun is located in the narrow, cylindrical neck at the extreme rear of a CRT which produces a stream of electrons through thermionic emission. Usually,

A CRT has a fluorescent screen to display the output signal. A simple CRT is shown in below.

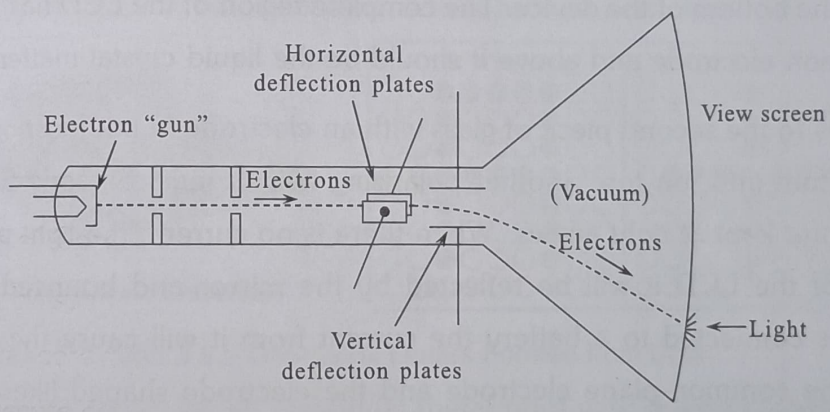

FIG 3.5 : Working Principle of CRT Monitor

The operation of a CRT monitor is basically very simple. A cathode ray tube consists of one or more electron guns, possibly internal electrostatic deflection plates and a phosphor target. CRT has three electron beams – one for each Red, Green, and Blue. The electron beam produces a tiny, bright visible spot when it strikes the phosphor-coated screen. In every monitor device the entire front area of the tube is scanned repetitively and systematically in a fixed pattern called a raster. An image (raster) is displayed by scanning the electron beam across the screen. The phosphor's targets are begins to fade after a very short span of time, the image needs to be refreshed continuously. Thus CRT produces the three color images which are primary colours.

3.9 THE WORKING PRINCIPLE OF LCD/TFT/LED/OLED MONITORS

A liquid crystal display or LCD draws its definition from its name itself. It is combination of two states of matter, the solid and the liquid. LCD uses a liquid crystal to produce a visible image. Liquid crystal displays are super-thin technology display screen that are generally used in laptop computer screen,TVs, cell phones and portable video games. LCD's technologies allow displays to be much thinner when compared to cathode ray tube (CRT) technology.

The principle behind the LCD's is that when an electrical current is applied to the liquid crystal molecule, the molecule tends to untwist. This causes the angle of light which is passing through the molecule of the polarized glass and also cause a change in the angle of the top polarizing filter. As a result a little light is allowed to pass the polarized glass through a particular area of the LCD. Thus that particular area will become dark compared to other. The LCD works on the principle of blocking light. While constructing the LCD's, a reflected mirror is arranged at the back. An electrode plane is made of indium-tin oxide which is kept on top and a polarized glass with a polarizing film is also added on the bottom of the device. The complete region of the LCD has to be enclosed by a common electrode and above it should be the liquid crystal matter.

Next comes to the second piece of glass with an electrode in the form of the rectangle on the bottom and, on top, another polarizing film. It must be considered that both the pieces are kept at right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back. As the electrode is connected to a battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. That particular rectangular area appears blank.

3.10 DIFFERENT CATEGORIES OF PRINTERS (IMPACT AND NON-IMPACT)

A printer is an output device that prints characters, symbols, and perhaps graphics on paper. The printed output is generally referred to as hardcopy because it is in relatively permanent form. Softcopy refers to temporary images such as those displayed on a monitor. Printers are categorized according to whether or not the image produced is formed by physical contact of the print mechanism with the paper. Impact printers have contact; nonimpact printers do not.

Impact Printers : An impact printer has mechanisms resembling those of a typewriter. It forms characters or images by striking a mechanism such as a print hammer or wheel against an inked ribbon, leaving an image on paper. Impact printers are used very less now a days.

Some of the impact printers are :

- Dot-Matrix Printers.
- Drum Printer.
- Line Printer.
- Daisy-Wheel Printer.
- Chain Printer.

Non-impact Printers : Nonimpact printers, used almost everywhere now, are faster and quieter than impact printers because they have fewer moving parts. Nonimpact printers form characters and images without direct physical contact between the printing mechanism and the paper. Two types of nonimpact printers often used with microcomputers are laser printers and ink-jet printers.

3.11 WORKING PRINCIPLE OF DOT MATRIX PRINTER

The most popular impact printer is the dot-matrix variety. The dot matrix printer technique relies in the force of physical impact to produce the image on paper. As shown in the following figure the dot matrix printer letters formed from dots.

DOT MATRIX PRINTER

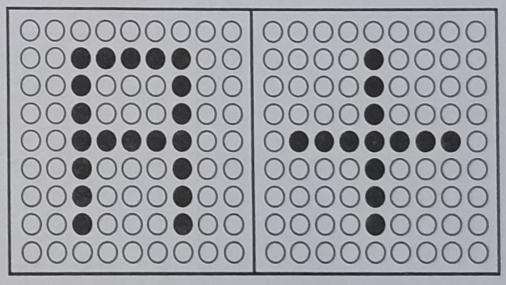

FIG 3.6 : Dot-matrix Letters Formed from Dots

Each dot is generated by an individual metal print wire driven through a solenoid as shown in the following figure

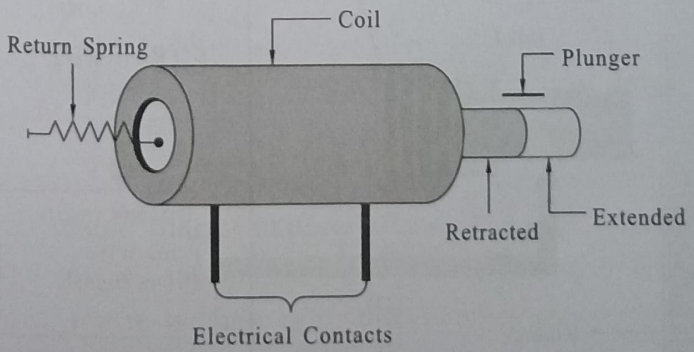

FIG 3.7 : Working of Dot Matrix Printer's Solenoid

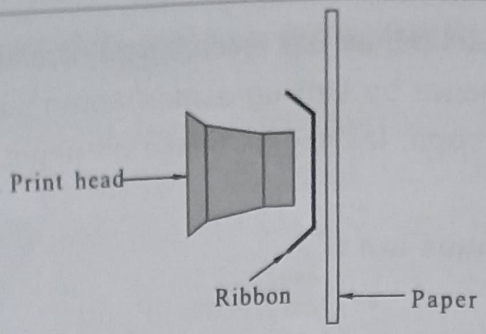

FIG 3.8 : Working Printing on a Paper

When an electric pulse reaches the solenoid, it energizes the coil and produces brie intense magnetic field. This field shoots the solenoid print wire against the page. Afte the pulse passes, the solenoids magnetic field collapses. A spring pulls the wire back to rest position. Solenoids and print wires are very small assemblies.

Dot matrix print head use an array of 9, 24 print wires arranged as vertical columns The technique of dot matrix printing is very straight forward. Data sent from a host computer is interpreted by the printers main logic and converted into a series of vertical dot patterns Printer circuits send each dot pattern to the print head in series. Each dot pattern fires the corresponding print wires through an inked ribbon to leave a permanent mark on the page

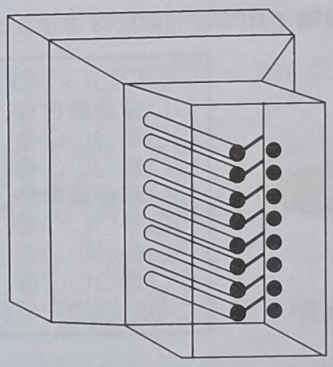

FIGURE 3.8 :

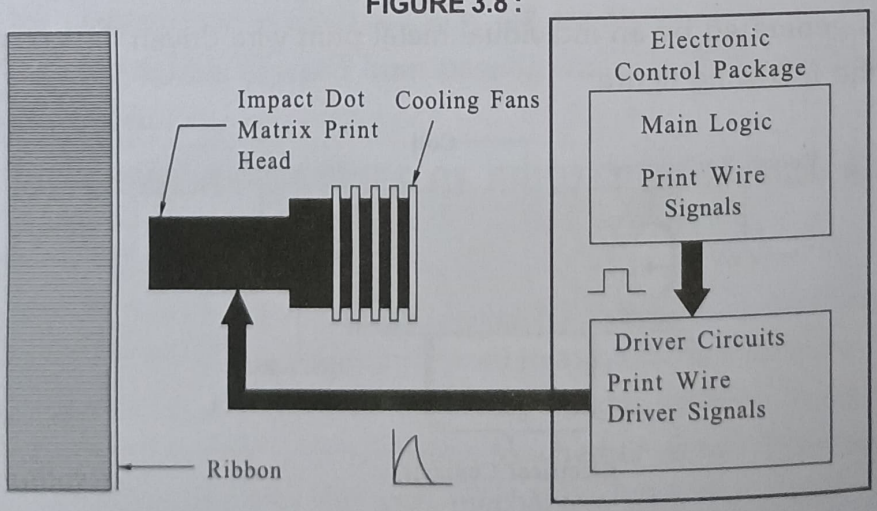

FIG 3.9 : Dots of Dot Matrix Printer

3.12 WORKING PRINCIPLE OF INKJET PRINTER

Ink jet printer comes under the category of non impact printers. It works on a principle that is similar to that of Dot matrix printer. The difference is that, instead of using hammers that hit the paper through the ribbons, ink jet printers use print heads that have tiny nozzles that spray out ink droplets. Two different technologies are used to control the flow of ink

- Thermal technology (Popular and is used with HP cannon and others)
- Piezo electric technology.(proprietary of Epson)

FIG 3.10 : Working of Inkjet printer

Thermal Technology : When the resistor located near the nozzle is heated by an electric current, it also heats up a thin layer of ink located over it. This heating causes the ink to boil forming a bubble of vapor. As the vapor bubble expands , it pushes a drop of ink through the nozzle and forces it on the paper. The volume of ejected ink droplet is about one millionth that of a drop of water from a typical eye dropper. The resistor then cools and the vapor bubble collapses. The resultant suction created pulls fresh ink from the attached reservoir. The printer head is then moves to the next position and the process is repeated again.

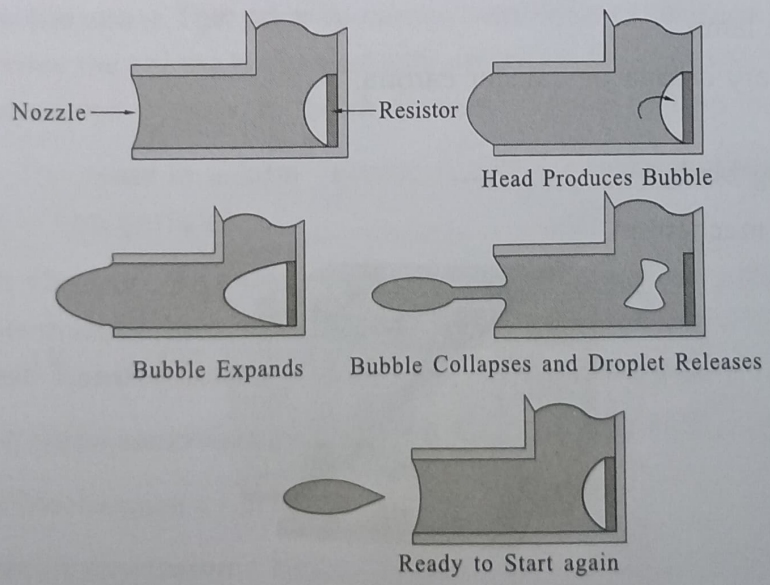

FIG 3.11 : Thermal Technology

Piezo Electric Technology : It is Epson's ink jet technology. It uses a Piezo crystal at the back of the ink reservoir. It is like a loud speaker - it flexes when an electric current flows through it. So, when ever a dot is required, a current is applied to the Piezo element, the element flexes and in doing so forces a drop of ink out of the nozzle.

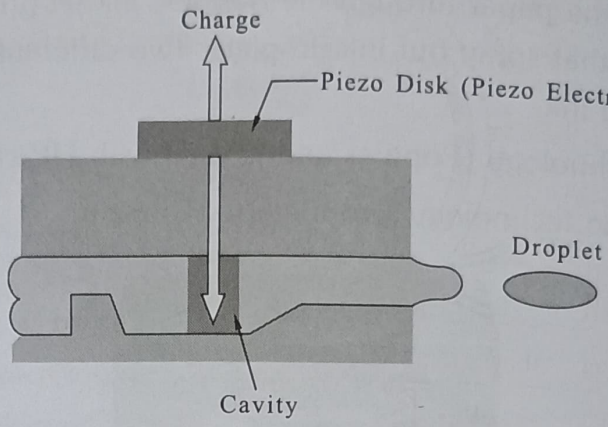

FIG 3.12 : Piezo Electric Technology

3.13 WORKING PRINCIPLE OF LASER PRINTER

A **laser printer** is a common type of ***computer printer*** that rapidly produces high quality text and graphics on plain paper. It is based on Xerox technology. Image is formed not by dots, it is formed by using light, electricity pressure and heat. So image formation is a complex process.

The Key Components in a Laser Printer are :

- Toner cartridge.
- Photo sensitive drum or OPC (Organic Photo Conductive) drum.
- Primary carona.
- Erasure lamp.
- Secondary carona or transfer carona.
- Toner.
- Cleaning blade.
- Writing mechanism.

FIG 3.13 : Laser Printer

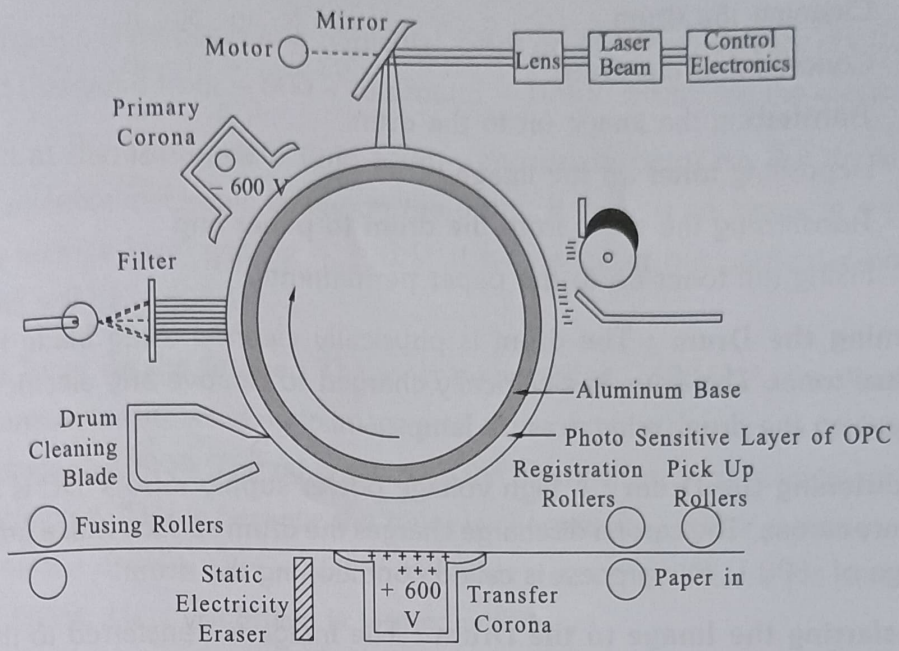

FIG 3.14 : Functional Block Diagram of Laser Printer

Toner cartridge supplies toner that creates image on the page.

Photo sensitive drum is an aluminum cylinder coated with particles of photosensitive compounds. The drum is grounded. When light hits the drum, what ever electrical charge present at that point on the drum is drains out through the grounded wire. So voltage will become zero at that point.

Erase Lamp : The erase lamp exposes the entire surface of the drum to light, so the entire drum will have uniform voltage zero.

Primary Carona : The primary carona wire located to close to the photosensitive drum. When the carona is charged with extremely high voltage, an electric field forms, enabling voltage to pass to the drum and charge a spot on the drum.

Toner : The toner in a laser printer is a fine powder made up of plastic particles bonded to iron particles.

Transfer Carona : To transfer the image from the photosensitive drum to the paper, the paper must be given a charge that will attract the toner particles from the drum to the paper. Transfer carona applies a negatively charged toner particles to the paper.

Cleaning blade removes any residual toner particles on the drum.

Writing Mechanism : Laser are used to write the image on the drum.

Principle of Operation : Before the output is actually printed on to the paper the following processes are done in sequence.

- Cleaning the drum.
- Conditioning the drum.
- Transferring the image on to the drum.
- Depositing toner on the image.
- Transferring the toner from the drum to paper and
- Fixing the toner on to the paper permanently.

Cleaning the Drum : The drum is physically cleaned using blade to remove the residual toner. The drum is electrically charged to remove any electric charge that is present on the drum using erasure lamp.

Conditioning the Drum : A high voltage power supply -600 V/DC is applied to the primary carona. The carona discharge charges the drum surface with a uniform negative charge of -600 V, this process is called conditioning the drum.

Transferring the Image to the Drum : The image is transferred to the drum using laser. The laser beam can be focused to any point on the drum using scanning mirror and beam alignment lens. The laser sweeps horizontally by reflection from the scanning mirror and drum rotates incrementally for every horizontal sweep. There is synchronization between drum movement and sweep of the laser beam.

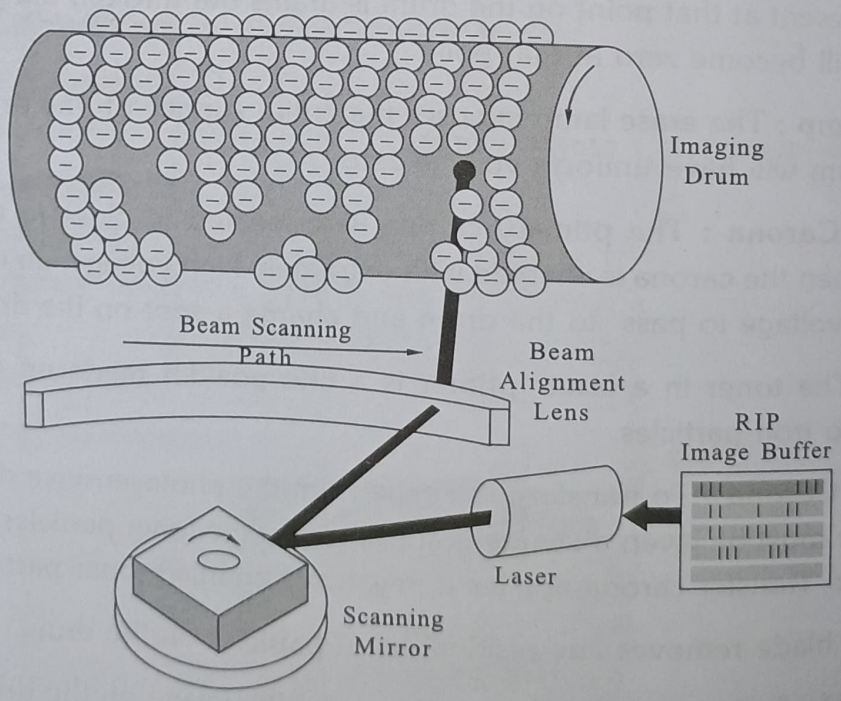

FIG 3.15 : Laser Writing Mechanism

The focusing of a laser beam at a particular point on the drum surface discharges the potential at that point from – 600 V to around – 100 V. Switching the electron beam

On and off at the appropriate time at an appropriate point on the drum surface creates an invisible electronic image on the drum. If there is an image at a particular point then voltage level will be – 100 V, if no image at the particular point then voltage level will be – 600 V.

Depositing Toner on the Image : The toner is charged at – 600 V. As the drum rotates, the toner particles are attracted on to image area of the drum as they are maintained at low negative voltage (– 100 V). The other areas on the drum where there is no image, will not get toner attracted. This is because the toner is charged at – 600 V and the voltage at that point on the drum is also – 600 V. So toner gets repelled from the points where there is no image. Here the image is formed with toner.

Transferring the Toner from the Drum to Paper : The paper is charged by transfer carona with + 600 V. As the paper is positively charged, and when it comes close to the drum the toner jumps from the drum to the paper. The paper with toner material is passed through the static charge eliminator to reduce the charge.

Fixing the Toner on to the Paper Permanently : To fix the toner on to the paper permanently the paper is passed through the fusing rollers.

These rollers will have heating element, because of this heat and friction between the roller the toner is permanently fixed on to the paper.

3.14 MULTI-FUNCTION PRINTER

An MFP (multi-function product/printer/peripheral), multi-functional, all-in-one (AIO), or multi-function device (MFD), is an office machine which incorporates the functionality of multiple devices in one, so as to have a smaller footprint in a home or small business setting (the SOHO market segment), or to provide centralized document management/distribution/production in a large-office setting. A typical MFP may act as a combination of some or all of the following devices: email, fax, photocopier, printer, scanner.

These devices focus on scan and print functionality for home use, and may come with bundled software for organising photos, simple OCR and other uses of interest to a home user. An All-in-one will always include the basic functions of Print and Scan, with most also including Copy functionality and a lesser number with Fax capabilities.

REVIEW QUESTIONS

Part-A

1. What is an input device?
2. What is an output device?
3. List any four input devices.
4. List any four output devices.
5. List any 2 input and output devices.
6. List the different types of scanners.
7. Where are Multi-function printers used?

Part-B

1. List out the various I/O devices used generally with a computer.
2. Explain the working Hand held scanner.
3. What is the difference between Impact printer and Non-Impact printer?
4. How does an Inkjet printer work?
5. What are Multi-function printers?

Part-C

1. Explain the working principle of keyboard.
2. Explain the working mechanism of optical mouse.
3. Explain the working principle of flatbed scanner.
4. Explain how Webcam works.
5. Explain the working of CRT monitor.
6. How does a LCD monitor works?
7. Explain the working principle of Laser printer.

UNIT-4

NETWORKING BASICS AND TOPOLOGIES

CHAPTER OUTLINE

4.0 INTRODUCTION TO NETWORKS AND NETWORK TOPOLOGIES

Human communication is a process that involves people communicating with each other. This communication involves four components: the sender of the information, the receiver of the information, the language, and the medium through which communication is established.

A similar process is also followed in communication between two computers. When two or more computers communicate with each other, a communication process is agreed upon, and the medium through which the information is transferred consists of cables, satellites, microwaves, broadcast radio and infra red. Networking is a concept of connecting multiple computers so that resources like printers files etc can be shared.

To setup a network, you need to concentrate on the following points :

- The hardware and software components to be used in the network.
- The communication standards such as OSI or TCP/IP reference models.
- The different types network topologies to be used in designing the layout of the network.

The topology of a network is concerned with the structure of connection between two computers on the network and the layout in which the network devices are connected to each other. The network topology is also concerned with the type of wiring used in a network and various factors that affects the network cabling such as whether the cable will run through floors, ceiling or walls etc.

4.1 UNDERSTAND THE OVERVIEW OF NETWORKING

A computer network is a collection of devices that can store and manipulate electronic data and is interconnected in such a way that network users can store, retrieve and share information.

A network may be vast, comprising of hundreds of computers spread across continents: it may link together mainframes minicomputers and micros, printers, fax machines and pagers; its users may be host of individual enthusiasts or firms; or the network may consist of not more than two machines connected with the sole purpose of sharing a printer or hard disk.

The larger network systems are generally referred to as Wide Area Networks. Some are run by single organizations, with perhaps the biggest being the world-wide area network run by IBM for its own use, linking its many research establishments and sales organizations.

A computer network is a resource, which enables the businesses to gather, analyze, organize and disseminate the information that is essential to their profitability.

The rise of intranets and extranets is an indication of the crucial importance of computer networking to businesses. Intranets and extranets are private business networks that are based on Internet technology.

4.2 STATE THE NEED FOR NETWORKING

Networks satisfy a broad range of purposes and meet various requirements. Some of the common objectives of computer communication networks are :

To provide sharing of geographically distant resources such as information, database etc. Resource sharing is perhaps the most common objective for providing networks within the constraints of cost and reliability of transmission links.

1. To provide communication among users. Network users geographically far apart from each other can converse in an interactive session or send messages to each other.
2. To increase the reliability of processing capacity through backup and redundancy.
3. To provide centralized management and allocation of resources.
4. To provide distribution processing in which a task is divided among multiple computers. Instead of a single large machine being responsible for all aspects of a process each separate computer handles a subtask.
5. **Faster Problem Solving :** Multiple computers working on parts of a problem concurrently often can solve the problem faster than a single machine working alone.

4.3 CLASSIFICATION OF NETWORKS –LAN, MAN, WAN

There are different ways in which network can be classified like size, capabilities and the geographical distance a network cover.

Some of the most common types of networks that we are going to discuss in detail :

1. Local Area Network (LAN).
2. Metropolitan Area Network (MAN).
3. Wide Area Networks (WAN).

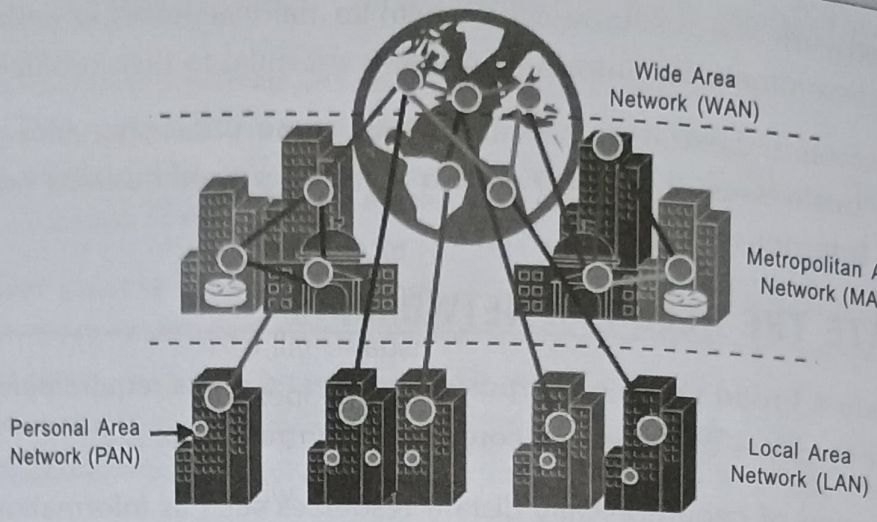

FIG 4.1 : Types of Computer Networks

1. **Local Area Network (LAN) :** Privately-owned networks covering a small geographic area, like a home, office, building or group of buildings (**Eg :** Campus). They are widely used to connect computers in company offices and factories to share resources (**Eg :** Printers) and exchange information. LANs are restricted in size, which means that the worst-case transmission time is bounded and known in advance. Knowing this bound makes it possible to use certain kinds of designs that would not otherwise be possible. It also simplifies network management. Traditional LANs run at speeds of 10 Mbps to 100 Mbps, have low delay (microseconds or nanoseconds), and make very few errors. Newer LANs operate at up to 10 Gbps.

   Early LAN (Local Area Network) networks were formed using coaxial cable, coax is an electric cable and it is used to carry radio signals. LAN (Local Area Network) setup is developed by connecting two or more than two computers with each other using a physical connection in order to share files and data overtime.

   Advantages of LAN :

   - Cost reductions through sharing of information and databases, resources and network services.
   - Increased information exchange between different departments in organization, or between individuals.
   - The trend to automate communication and manufacturing process.

   Disadvantages of LAN :

   - Special security measures are needed to stop users from using programs and data that they should not have access to.

- Networks are difficult to set up and need to be maintained by skilled technicians.
- If the file server develops a serious fault, all the users are affected, rather than just one user in the case of a stand alone machine.

2. **Metropolitan Area Network (MAN) :** Covers a larger geographical area than is a LAN, ranging from several blocks of buildings to entire cities. MANs can also depend on communications channels of moderate-to-high data rates. A MAN might be owned and operated by a single organization, but it usually will be used by many individuals and organizations. MANs might also be owned and operated as public utilities. They will often provide means for internetworking of LANs. Metropolitan Area Networks can span up to 50 km, devices used are modem and wire/cable.

Most widely used technologies to develop a MAN (Metropolitan Area Network) network are FDDI (fiber distribution data interface), ATM (Asynchronous Transfer Mode) and SMDS (switched multi megabit data service).ATM (Asynchronous Transfer Mode) is the most frequently used of all. ATM (Asynchronous Transfer Mode) is a digital data transfer technology. It was developed in 1980 to improve the transportation of real time data over a single network. ATM (Asynchronous Transfer Mode) works just like cell relay system, where data is separated in the form of fixed equal sized packets and is transferred overtime. The purpose of ATM (Asynchronous Transfer Mode) was to access clear audio and video results during a video conferencing.

Advantages of MAN :

- It provides a good back bone for a large network and provides greater access to WANs.
- The dual bus used in MAN helps the transmission of data in both direction simultaneously.
- A man usually encompasses several blocks of a city or an entire city.

Disadvantages of MAN :

- More cable required for a MAN connection from one place to another.
- It is difficult to make the system secure from hackers and industrial espionage (spying) graphical regions.

3. **Wide Area Networks (WAN) :** Computer network that covers a large geographical area, often a country or continent. (any network whose communications links cross metropolitan, regional, or national boundaries). Less formally, a network that uses routers and public communications links.

WAN (Wide Area Network) networks are established often by seeking help from telecomm departments who provide the facility of leased lines. Router is connected to the LAN at one side and a hub is attached at the other end.

Advantages of MAN :

- Covers a large geographical area.
- Shares software and resources with connecting workstations.
- Messages can be sent very quickly to anyone else on the network. These messages can have pictures, sounds, or data include with them (called attachment).
- Expensive things (such as printers or phone lines to the internet) can be shared by all the computers on the network.
- Everyone on the network can use the same data.

Disadvantages of MAN :

- Need a good firewall to restrict outsiders from entering and disrupting the network.
- Setting up a network can be an expensive, slow and complicated. The bigger the network the more expensive it is .
- Once setup, maintaining a network is a full-time job which requires network supervisors and technicians to be employed.
- Security is a real issue when many different peopel have the ability to use information from other computer.

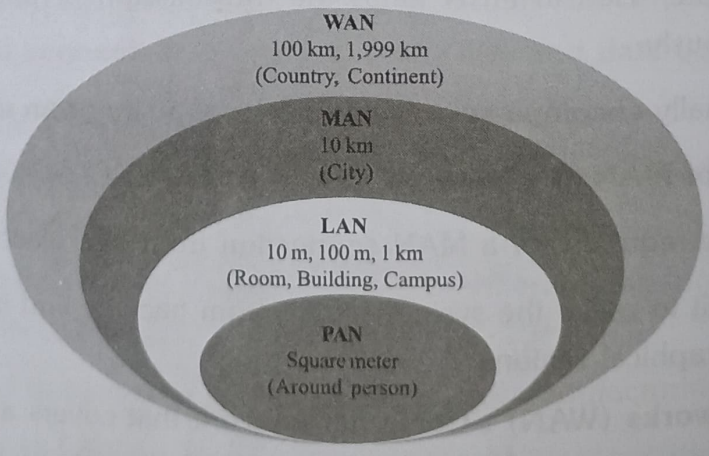

FIG 4.2 : Networks by Scale

Network Characteristics of LAN, MAN and WAN :

Network Characteristics	LAN	MAN	WAN
Geographic span	<10 km	5 km - 50 km	> 10 km
Transmission Speed	> 1 Mbps	150/60 Mbs (B-ISDN) or 41,100, 140 Mbs	> 9600 bps
Topology	Multi-point	Multi-point or point - to - point	Point-to-points
Network control	Medium access	Medium access Controlforward	Store and store and forward
Ownership	Privately independent of of traffic	Privately or Public Independent of traffic.	Public

4.4 HARDWARE AND SOFTWARE COMPONENTS OF COMPUTER NETWORK

A LAN is a combination of hardware and software.

The Hardware : The hardware consists of stations, transmission media, and connecting devices.

Stations : Stations are actual devices that connect to the network. These can be computers, printers, etc.

Transmission Media : The transmission media is the stuff through which signals travel. It can be guided as in the case of a wire, or unguided as in the case of air (wireless).

Connecting Devices : Besides the wires and stations, there are also connecting devices. There are two types:

1. Transceivers and all the other that's used to connect a station to the medium.
2. Bridges, repeaters, etc., used to connect segments of a LAN.

The Software : There are two primary categories of software, the Operating System, and Application Programs.

Network Operating System : There needs to be some software at the operating system level that manages the network connection. Most modern operating systems are capable of using the network.

Application Programs : The primary purpose of having a LAN is to allow several application programs to talk to each other.

4.5 OVERVIEW OF NETWORK TOPOLOGIES

In communication networks, a topology is a usually schematic description of the arrangement of a network, including its nodes and connecting lines.

There are two ways of defining network geometry :

- The physical topology and
- Logical (or signal) topology.

The physical topology of a network is the actual geometric layout of workstations.

Logical (or signal) topology refers to the nature of the paths the signals follow from node to node. In many instances, the logical topology is the same as the physical topology. But this is not always the case. For example, some networks are physically laid out in a star configuration, but they operate logically as bus or ring networks.

Consideration when Choosing a Topology :

1. **Money :** A liner bus network may be the least expensive way to install a network;
2. **Length of Cable Needed :** The linear bus network uses shorter lengths of cable.
3. **Future Growth :** With a star topology, adding another concentrator easily does expanding a network.
4. **Cable Type :** The most common cable is unshielded twisted pair, which is most often used with star topologies.

4.6 UNDERSTAND THE BASIC NETWORK TOPOLOGIES SUCH AS BUS, RING AND STAR AND COMPLEX TOPOLOGIES LIKE MESH AND HYBRID TOPOLOGIES

4.6.1 Bus Topology

A linear bus topology consists of a main run of cable with a terminator at each end. All nodes (file server, workstations, and peripherals) are connected to the linear cable. Ethernet and Local Talk networks use a linear bus topology.

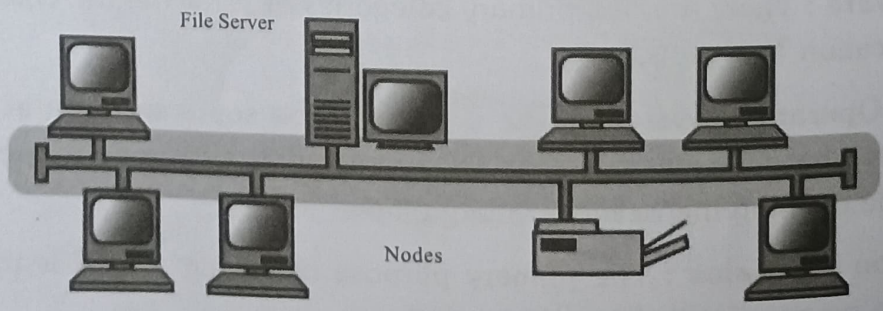

FIG 4.3 : Bus Topology

Advantages of a Bus Topology :

1. Easy to connect a computer or peripheral to a linear bus.
2. Requires less cable length than a star topology.

Disadvantages of a Bus Topology :

1. Entire network shuts down if there is a break in the main cable.
2. Terminators are required at both ends of the backbone cable.
3. Difficult to identify the problem if the entire network shuts down.
4. Not meant to be used as a stand-alone solution in a large building.

4.6.2 *Star Topology*

A star topology is designed with each node (file server, workstations, and peripherals) connected directly to a central network hub or concentrator.

Data on a star network passes through the hub or concentrator before continuing to its destination. The hub or concentrator manages and controls all functions of the network. It also acts as a repeater for the data flow. This configuration is common with twisted pair cable; however, it can also be used with coaxial cable or fiber optic cable.

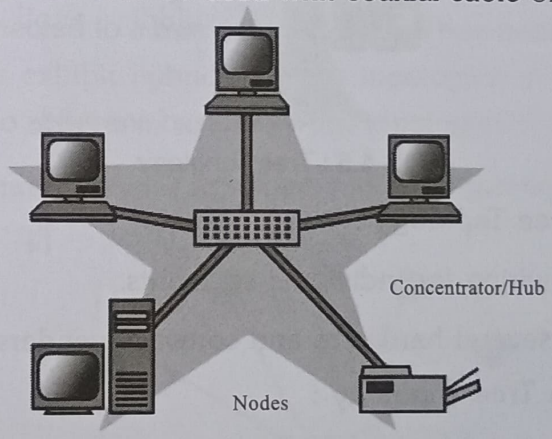

FIG 4.4 : Star Topology

Advantages of a Star Topology :

1. Easy to install and wire.
2. No disruptions to the network then connecting or removing devices.
3. Easy to detect faults and to remove parts.

Disadvantages of a Star Topology :

1. Requires more cable length than a linear topology.
2. If the hub or concentrator fails, nodes attached are disabled.
3. More expensive than linear bus topologies because of the cost of the concentrators.

The protocols used with star configurations are usually Ethernet or LocalTalk. Token Ring uses a similar topology, called the star-wired ring.

4.6.3 *Tree Topology*

A tree topology combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable. Tree topologies allow for the expansion of an existing network, and enable schools to configure a network to meet their needs.

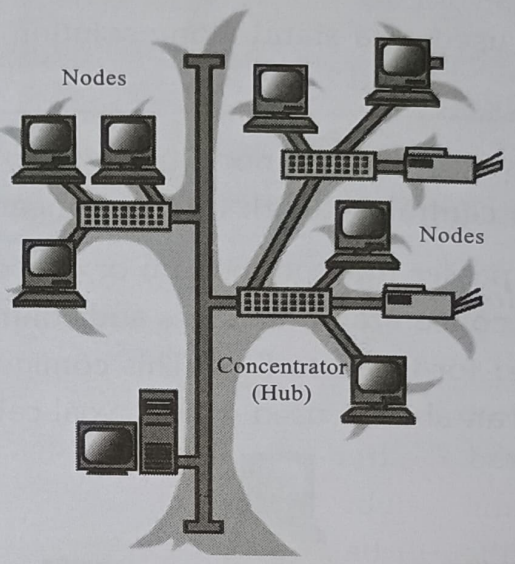

FIG 4.5 : Tree Topology

Advantages of a Tree Topology :

1. Point-to-point wiring for individual segments.
2. Supported by several hardware and software venders.

Disadvantages of a Tree Topology :

1. Overall length of each segment is limited by the type of cabling used.
2. If the backbone line breaks, the entire segment goes down.
3. More difficult to configure and wire than other topologies.

Physical Topology	Common Cable	Common Protocol
Linear Bus	Twisted Pair	Ethernet
	CoaxialFiber	Local Talk
Star	Twisted Pair	Ethernet
	Fiber	LocalTalk
Star-Wired Ring	Twisted Pair	Token Ring
Tree	Twisted Pair	Ethernet
	Coaxial	Fiber

Comparison Between Bus and Ring Topology :

Bus Topology	Ring Topology
Cable is shared.	No sharing.
Bus requires proper termination, Cable cannot be left unterminated.	Termination not required
Bus is a passive network topology.	Ring is an active network topology.
There is loss in data integrity as the bus length increases.	Transmission errors are minimized because transmitted signal is regenerated at each node.
It uses point to multipoint links. Recommended when large number of devices are attached.	It uses point to point communication links. Recommended when moderate number of devices are attached.

4.6.4 *Hyrid Topology*

A hybrid topology is a combination of any two or more network topologies in such a way that the resulting network does not have one of the standard forms. For example, a tree network connected to a tree network is still a tree network, but two star networks connected together exhibit hybrid network topologies. A hybrid topology is always produced when two different basic network topologies are connected.

Example : Combination of star topology and Bus topology.

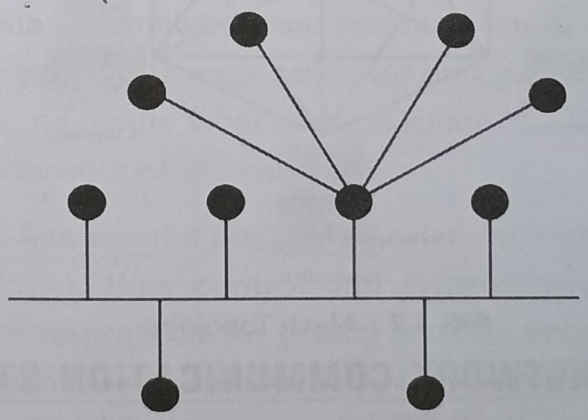

FIG 4.6 : Hybrid

4.6.5 *Mesh Topology*

In a mesh topology every device has a dedicated point to point link to every other device. The term dedicated means that the link carriers traffic only between the two devices it connects.

A fully connected mesh topology has $\frac{n(n-1)}{2}$ physical channels to link 'n' devices.

To accommodate many links, every device on the network must have n–1 I/O (input/output) ports.

Advantages :

1. Eliminating the traffic problems because dedicated links between the every two devices.
2. It is a robust because one link becomes fails, all other links remain active.
3. Fault identification is easy.

Disadvantages :

1. The amount of required cabling is very large.
2. If large number of devices are used in a network, the requirement of I/O ports are high.
3. Installation and reconfiguration are difficult.
4. This topology is expensive.

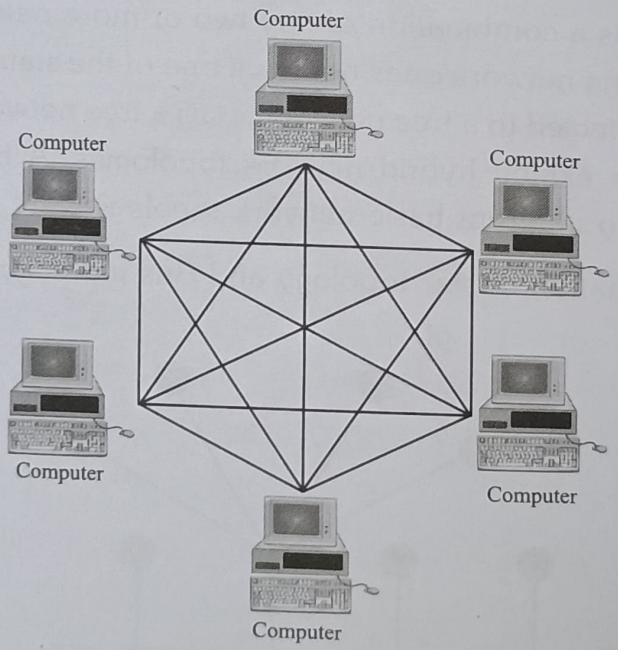

FIG 4.7 : Mesh Topology

4.7 VARIOUS NETWORK COMMUNICATION STANDARDS

Computers on a network may use different software, hardware and protocols. For the two computers to communicate with each other, they need to follow certain communication standards. Two such standards are :

1. OSI reference model.
2. TCP/IP reference model.

4.8 OSI REFERENCE MODEL

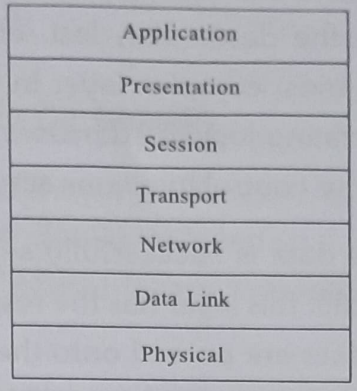

FIG 4.8 : OSI Layers

The Open System Interconnection (OSI) model includes a set of protocols that attempt to define and standardize the data communications process. The OSI protocols were defined by the International Organization for Standardization (ISO).

The OSI model is not a single definition of how data communications actually takes place in the real world. Numerous protocols may exist at each layer. The OSI model states how the process should be divided and what protocols should be used at each layer. If a network vendor implements one of the protocols at each layer, its network components should work with other vendors' offerings. The OSI model has seven layers.

1. The Physical layer provides the electrical and mechanical interface to the network medium (the cable). This layer gives the data-link layer (layer 2) its ability to transport a stream of serial data bits between two communicating systems; it conveys the bits that move along the cable. It is responsible for making sure that the raw bits get from one place to another, no matter what shape they are in, and deals with the mechanical and electrical characteristics of the cable.
2. The Data-Link layer handles the physical transfer, framing (the assembly of data into a single unit or block), flow control and error-control functions over a single transmission link; it is responsible for getting the data packaged for the Physical layer. The data link layer provides the network layer (layer 3) reliable information-transfer capabilities. The data-link layer is often subdivided into two parts-Logical Link Control (LLC) and Medium Access Control (MAC)-depending on the implementation.
3. The Network layer provides for the transfer of data in the form of packets across the communication networks. It establishes, maintains, and terminates logical and physical connections across multiple interconnected networks. A key aspect of this transfer is the routing of packets from the source to the destination machine typically traversing a

number of transmission links and network nodes where routing is carried out. Routing is the process by which a path is selected out of many available paths to the destination so that data packet reaches the destination fast, efficiently, reliably as required. This function makes the network most complex layer in the reference model. Also network layer is responsible for translating logical addresses, or names, into physical (or data-link) addresses. It provides flow-control functions across the computer-network interface.

4. The Transport layer ensures data is successfully sent and received between two end nodes. If data is sent incorrectly, this layer has the responsibility to ask for retransmission of the data. Also it ensures data are passed onto the upper layers in the same order in which they were sent. Specifically, it provides a reliable, network-independent message-interchange service to the top three application-oriented layers. This layer acts as an interface between the bottom and top three layers. By providing the session layer (layer 5) with a reliable message transfer service, it hides the detailed operation of the underlying network from the session layer.

5. The Session layer decides when to turn communication on and off between two computers. It provides the mechanisms that control the data-exchange process and coordinates the interaction between them. It sets up and clears communication channels between two communicating components. Unlike the network layer (layer 3), it deals with the programs running in each machine to establish conversations between them. Some of the most commonly encountered protocol stacks, including TCP/IP, don't implement a session layer.

6. The Presentation layer performs code conversion and data reformatting (syntax translation). It is the translator of the network, making sure the data is in the correct form for the receiving application. Of course, both the sending and receiving applications must be able to use data subscribing to one of the available abstract data syntax forms. Most commonly, applications handle these sorts of data translations themselves rather than handing them off to a Presentation layer.

7. The Application layer provides the interface between the software running in a computer and the network. It provides functions to the user's software, including file transfer access and management (FTAM) and electronic mail service.

Unfortunately, protocols in the real world do not conform precisely to these neat definitions. Some network products and architectures combine layers. Others leave layers out. Still others break the layers apart. But no matter how they do it, all working network products achieve the same result - getting data from here to there.

Tip : A sentence To remember the order of the layers in OSI model is Please Do Not Touch Swapna's Pet Animal 9Physical, Data link, Network, Transport, Session, Presentation, Application)

4.9 TCP/IP REFERENCE MODEL

TCP/IP originated out of the investigative research into networking protocols that the US Department of Defense (DoD) initiated in 1969. In 1968, the DoD Advanced Research Projects Agency (ARPA) began researching the network technology that is called packet switching.

The original focus of this research was that the network be able to survive loss of subnet hardware, with existing conversations not being broken off. In other words, DoD wanted connections to remain intact as long as the source and destination nodes were functioning, even if some of the machines or transmission lines in between were suddenly put out of operation. The network that was initially constructed as a result of this research to provide a communication that could function in wartime, then called ARPANET, gradually became known as the Internet. The TCP/IP protocols played an important role in the development of the Internet. In the early 1980s, the TCP/IP protocols were developed. In 1983, they became standard protocols for ARPANET.

Because of the history of the TCP/IP protocol suite, it's often referred to as the DoD protocol suite or the Internet protocol suite.

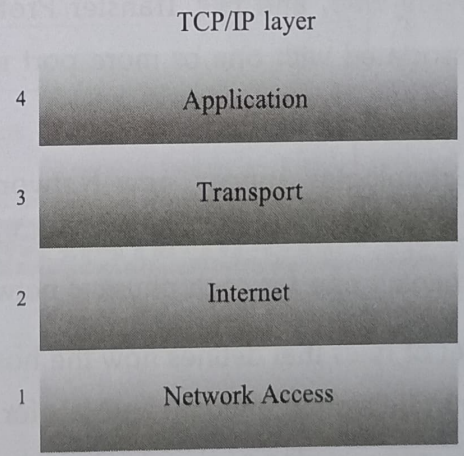

FIG 4.9 : TCP/IP Model Layers

Network Access Layer : The lowest layer of the TCP/IP protocol hierarchy. It defines how to use the network to transmit an IP datagram. Unlike higher-level protocols, Network Access Layer protocols must know the details of the underlying network (its

packet structure, addressing, etc.) to correctly format the data being transmitted to comply with the network constraints. The TCP/IP Network Access Layer can encompass the functions of all three lower layers of the OSI reference Model (Physical, Data Link and Network layers).

Internet Layer : Provides services that are roughly equivalent to the OSI Network layer. The primary concern of the protocol at this layer is to manage the connections across networks as information is passed from source to destination. The Internet Protocol (IP) is the primary protocol at this layer of the TCP/IP model.

Transport Layer : It is designed to allow peer entities on the source and destination hosts to carry on a conversation, just as in the OSI transport layer. Two end-to-end transport protocols have been defined here TCP and UDP Both protocols will be dicussed later.

Application Layer : Includes the OSI Session, Presentation and Application layers as shown in the Fig. 4.10. An application is any process that occurs above the Transport Layer. This includes all of the processes that involve user interaction. The application determines the presentation of the data and controls the session. There are numerous application layer protocols in TCP/IP, including Simple Mail Transfer Protocol (SMTP) and Post Office Protocol (POP) used for e-mail, Hyper Text Transfer Protocol (HTTP) used for the World-Wide-Web, and File Transfer Protocol (FTP). Most application layer protocols are associated with one or more port number. Port numbers will be dicussed later.

As new hardware technologies appear, new Network Access protocols must be developed so that TCP/IP networks can use the new hardware. Consequently, there are many access protocols - one for each physical network standard.

Access protocol is a set of rules that defines how the hosts access the shared medium. Access protocol have to be simple, rational and fair for all the hosts.

Functions performed at this level include encapsulation of IP datagrams into the frames transmitted by the network, and mapping of IP addresses to the physical addresses used by the network. One of TCP/IP's strengths is its universal addressing scheme. The IP address must be converted into an address that is appropriate for the physical network over which the datagram is transmitted.

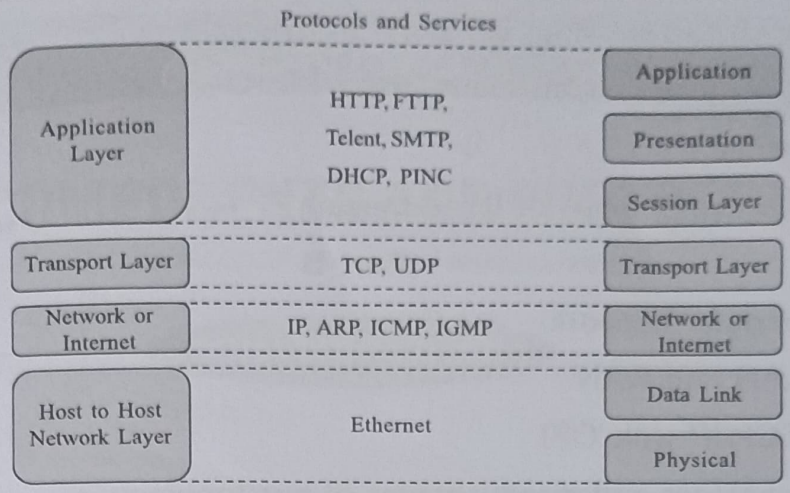

FIG 4.10 : OSI and TCP/IP

TABLE : TCP/IP Model Vs OSI Model

S.No.	TCP/IP Reference Model	OSI Reference Model
1.	Defined after the advent of internet.	Defined before advent of internet.
2.	Service interface and protocols were not distinguished.	Service interface and protocol are clearly clearly distinguished Before.
3.	TCP/IP supports Internet working.	Internet working not supported.
4.	Loosely layered.	Strict layering.
5.	Protocol Dependant standard.	Protocol independent standard.
6.	More CredibleLess Credible.	
7.	TCP reliably delivers packets, IP does not reliably deliver packets.	All packets are reliably delivered.

REVIEW QUESTIONS

Part-A

1. Why computer network is needed.
2. List hardware & software components in LAN.
3. List the layer in OSI reference model.
4. List the layers in TCP/IP reference model.
5. List various LAN components.
6. What are the various connectors used in LAN.

7. What is NICcard ?
8. What is repeater ?
9. What is a switch ?
10. What are the components of IP addressing ?

Part-B

1. Classify computer network.
2. Compare LAN and WAN.
3. Compare TCP/IP with OSI.
4. List the advantages and disadvantages of bus topology.
5. What are the advantages and disadvantages of ring topology ?
6. Compare FTP &Telent.
7. Compare various transmission media.
8. What are the advantages and disadvantages of star topology ?
9. Compare bus topology with ring topology.

Part-C

1. Explain about various types of network.
2. Explain about OSI reference model.
3. Explain about TCP/IP reference model.
4. Explain about the various network topologies.
5. Explain about LAN cables.
6. Explain about various LAN devices.
7. Explain about transmission media.