Data Communication
UNIT-I

Que. What is data communication? What are the four fundamental characteristics of data communication? 6M

The word data refers to information presented in whatever form is agreed upon by the parties creating and using the data. Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable. For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs). The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.

I. Delivery- The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.

2. Accuracy- The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.

3. Timeliness- The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.

4. Jitter- Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packets are sent every 3D ms. If some of the packets arrive with 3D-ms delay and others with 4D-ms delay, an uneven quality in the video is the result.

Que. Explain various types of Data Representation techniques. (7M)

Information today comes in different forms such as text, numbers, images, audio, and video.

1. Text- In data communications, text is represented as a bit pattern, a sequence of bits (Os or Is). Different sets of bit patterns have been designed to represent text symbols. Each set is called a code, and the process of representing symbols is called coding. Today, the prevalent coding system is called Unicode, which uses 32 bits to represent a symbol or character used in any language in the world.

The American Standard Code for Information Interchange (ASCII), developed some decades ago in the United States, now constitutes the first 127 characters in Unicode and is also referred to as Basic Latin.

2. Numbers-Numbers are also represented by bit patterns. However, a code such as ASCII is not used to represent numbers; the number is directly converted to a binary number to simplify mathematical operations.

3. Images-Images are also represented by bit patterns. In its simplest form, an image is composed of a matrix of pixels (picture elements), where each pixel is a small dot. The size of the pixel depends on the resolution. For example, an image can be divided into 1000 pixels or 10,000 pixels. In the second case, there is a better representation of the image (better resolution), but more memory is needed to store the image. After an image is divided into pixels, each pixel is assigned a bit pattern. The size and the value of the pattern depend on the image. For an image made of only black and white dots (e.g., a chessboard), a I-bit pattern is enough to represent a pixel.If an image is not made of pure white and pure black pixels, you can increase the size

of the bit pattern to include gray scale. For example, to show four levels of gray scale, you can use 2-bit patterns. A black pixel can be represented by 00, a dark gray pixel by 01, a light gray pixel by 10, and a white pixel by 11.

There are several methods to represent color images. One method is called RGB,so called because each color is made of a combination of three primary colors: red,green, and blue. The intensity of each color is measured, and a bit pattern is assigned to it. Another method is called YCM, in which a color is made of a combination of three other primary colors: yellow, cyan, and magenta.

4. Audio-Audio refers to the recording or broadcasting of sound or music. Audio is by nature different from text, numbers, or images. It is continuous, not discrete. Even when we use a microphone to change voice or music to an electric signal, we create a continuous signal.

5. Video-Video refers to the recording or broadcasting of a picture or movie. Video can either be produced as a continuous entity (e.g., by a TV camera), or it can be a combination of images, each a discrete entity, arranged to convey the idea of motion. Again we can change video to a digital or an analog signal.

Que. Explain the five components of Data Communication System? Or

Explain different components of data communication with neat block diagram. (7M)

The five components are :

1. Message - It is the information to be communicated. Popular forms of information include text, pictures, audio, video etc. Text is converted to binary, number does not converted, image is converted to pixels, etc.

2. Sender - It is the device which sends the data messages. It can be a computer, workstation, telephone handset etc.

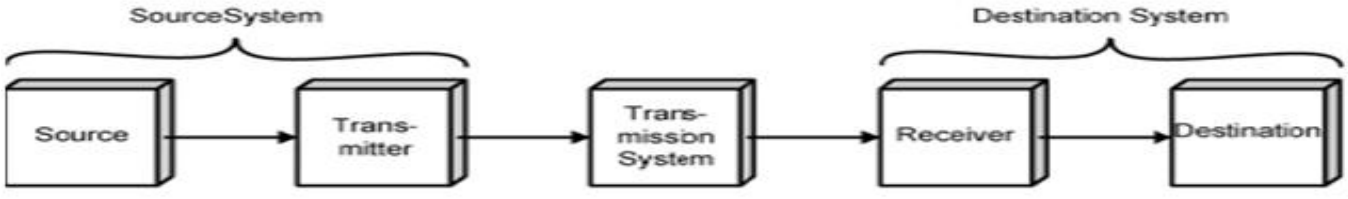
3. Receiver - It is the device which receives the data messages. It can be a computer, workstation, telephone handset etc.

4. Transmission Medium - It is the physical path by which a message travels from sender to receiver. Some examples include twisted-pair wire, coaxial cable, radio waves etc.

5. Protocol - It is a set of rules that governs the data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating.

Que. Explain the Communication Model with example. (7M)

The fundamental purpose of a communications system is the exchange of data between two parties.
Let us consider a simple communication model Figure(a), the key elements of the model are,



(a) General block diagram

Source: This device generates the data to be transmitted; examples are telephones and personal computers.
Transmitter: the data generated by a source system are not transmitted directly in the form in which they were generated. A transmitter transforms and encodes the information in the form which is suitable for the transmission and then transmit it across a transmission system.

Transmission System: This can be a single transmission line or media that connects source and destination and share data between both entities.
Receiver: The receiver accepts the signal from the transmission system and converts it into a form that can be handled by the destination device (original form in which the data was generated by source)
Destination: Takes the incoming data from the receiver.

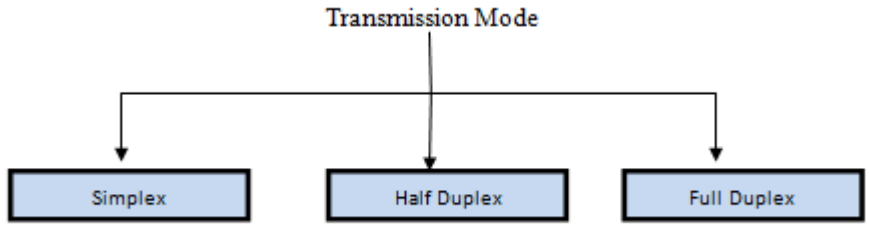
Data Communication System Tasks

There are some tasks performed by the communication systems are
1. Signal Generation-To transmit the data over the transmission system, communicating device must be able to generate and receive these signals.
2. Interface-Device must interface with the transmission system to communicate or transfer the data over network.
3. Data Synchronization-It is the process of establishing consistency among data from a source to destination devices and vice versa and continuous harmonization of the data over time.
4. Error Detection and Correction-In any communication system transmitted data is prone to error. Either it is because of transmitted signal getting distorted in the transmission medium leading to misinterpretation of signal or errors introduced by the intermediate devices. Error detection and correction is required in cases where there is no scope for error in the data transaction.
5. Flow Control-At the time of transmission of data, source computer is generating data faster than receiver device capable to receive it. To handle such problem, there is some kind of flow control mechanism used**6.Addressing**
when more than two devices share a transmission facility, a source system must somehow indicate the identity or address of the destination. Addresses are in form of IP.
7. Routing-Routing means to send data to appropriate destinations. It is used to find shortest path among devise or server.

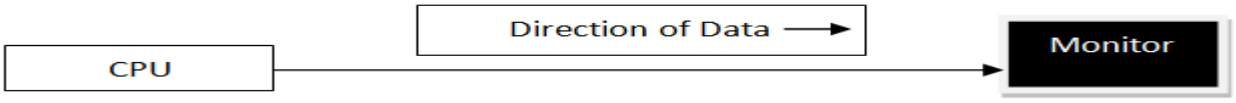
Que.Explain Data Flow techniques simplex, half duplex, full duplex with the help of diagram. 7M

Transmission mode refers to the mechanism of transferring of data between two devices connected over a network. It is also called **Communication Mode**. These modes direct the direction of flow of information. There are three types of transmission modes. They are:

1. Simplex Mode
2. Half duplex Mode
3. Full duplex Mode

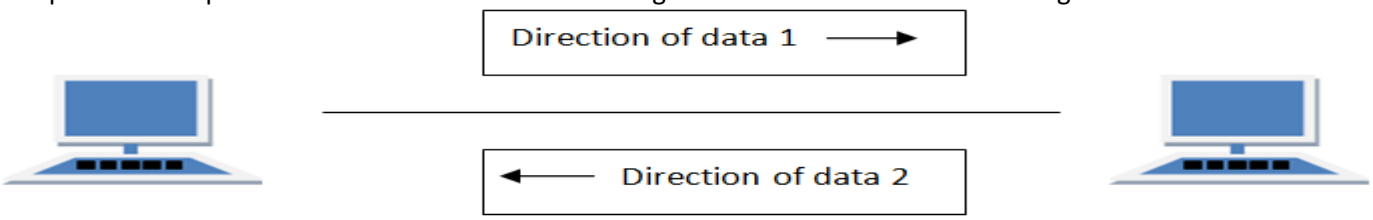


1. SIMPLEX Mode
In this type of transmission mode, data can be sent only in one direction i.e. communication is unidirectional. We cannot send a message back to the sender. Unidirectional communication is done in Simplex Systems where we just need to send a command/signal, and do not expect any response back.
Examples of simplex Mode are loudspeakers, television broadcasting, television and remote, keyboard and monitor etc.

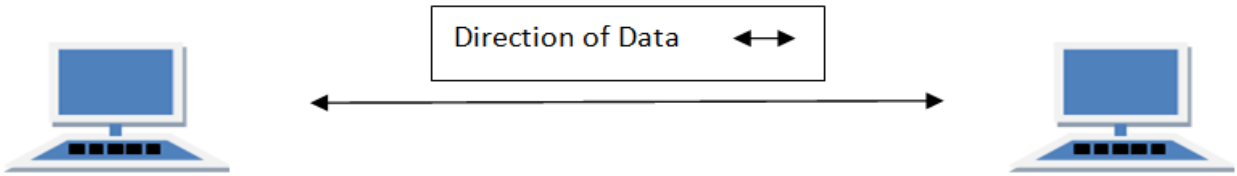


2. HALF DUPLEX Mode
Half-duplex data transmission means that data can be transmitted in both directions on a signal carrier, but not at the same time.
For example, on a local area network using a technology that has half-duplex transmission, one workstation can send data on the line and then immediately receive data on the line from the same direction in which data was just transmitted. Hence half-

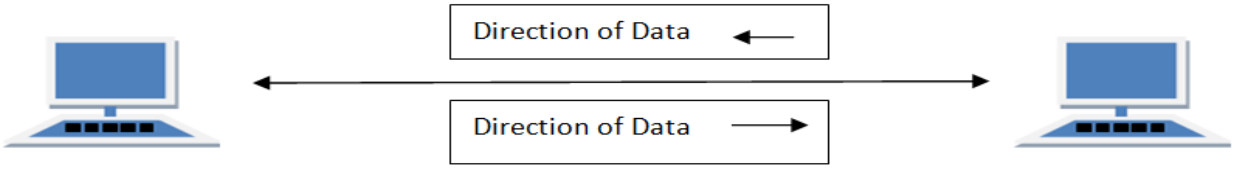
duplex transmission implies a bidirectional line (one that can carry data in both directions) but data can be sent in only one direction at a time.
Example of half duplex is a walkie- talkie in which message is sent one at a time but messages are sent in both the directions.



3. FULL DUPLEX Mode
In full duplex system we can send data in both the directions as it is bidirectional at the same time in other words, data can be sent in both directions simultaneously.
Example of Full Duplex is a Telephone Network in which there is communication between two persons by a telephone line, using which both can talk and listen at the same time.



In full duplex system there can be two lines one for sending the data and the other for receiving data.



Criteria for a Data Communication Network

The major criteria that a Data Communication Network must meet are:

1. Performance
2. Reliability
3. Security

1. Performance:
It can be measured in many ways, including transmit time and response time. Performance is a measurement of various factors such as the amount of time requires for messages to travel from one device to another, the time it requires to get a response starting from an inquiry. Performance of a network, however also depends on a number of factors such as number of active users, type of the transmission medium, capabilities of the connected hardware and efficiency of the software etc.
2. Reliability: It is measured by frequency of failure, the time it takes a link to recover from a failure, and the network's robustness. Network reliability is measured by the frequency of failure, time it takes to recover from failure, the network's robustness.
3. Security: Security issues include protecting data from unauthorized access and virus. Network must be secured. The data that is sent should reach its destination safely without any third-party reading or altering or destroying the data in the midway.

Ques. How can computer network are classified.

Types of Connection in Computer Networks (6M)

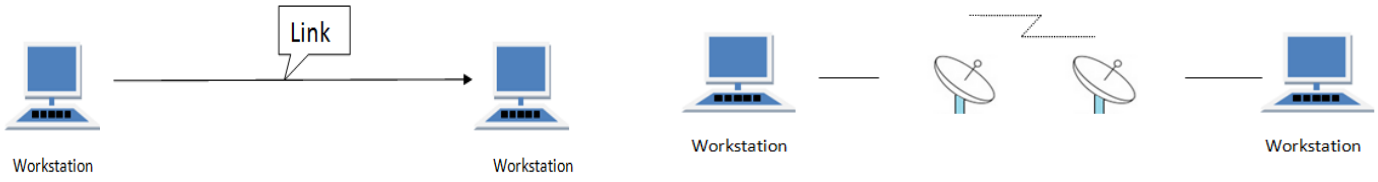
A Network is nothing but a connection made through connection links between two or more devices. Devices can be a computer, printer or any other device that is capable to send and receive data. There are two ways to connect the devices:

1. Point-to-Point connection
2. Multipoint connection

1. Point-To-Point Connection

It is a protocol which is used as a communication link between two devices. It is simple to establish. The most common example for Point-to-Point connection (PPP) is a computer connected by telephone line. We can connect the two devices by means of a pair of wires or using a microwave or satellite link.

Example: Point-to-Point connection between remote control and Television for changing the channels.

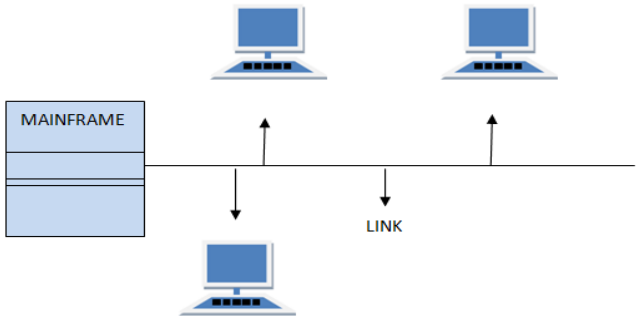


2. Multipoint Connection

It is also called Multidrop configuration. In this connection two or more devices share a single link.

There are two kinds of Multipoint Connections:

- If the links are used simultaneously between many devices, then it is spatially shared line configuration.
- If user takes turns while using the link, then it is time shared (temporal) line configuration.

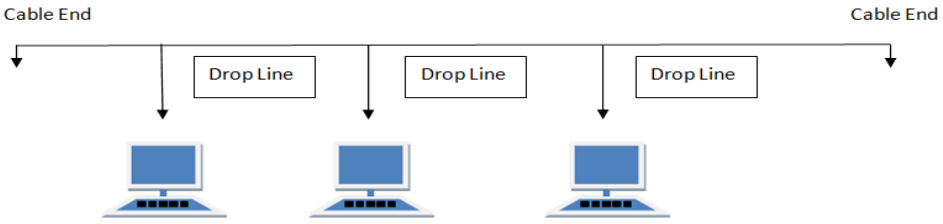


Types of Network Topology

Network Topology is the schematic description of a network arrangement, connecting various nodes(sender and receiver) through lines of connection.

BUS Topology

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two endpoints, then it is called **Linear Bus topology**.



Features of Bus Topology

1. It transmits data only in one direction.
2. Every device is connected to a single cable

Advantages of Bus Topology

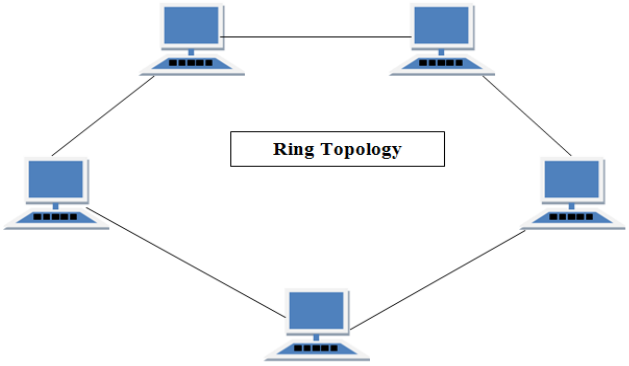
1. It is cost effective.
2. Cable required is least compared to other network topology.
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

Disadvantages of Bus Topology

1. Cables fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.
3. Cable has a limited length.
4. It is slower than the ring topology.

RING Topology

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbours for each device.



Features of Ring Topology

1. A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
2. The transmission is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called **Dual Ring Topology**.
3. In Dual Ring Topology, two ring networks are formed, and data flow is in opposite direction in them. Also, if one ring fails, the second ring can act as a backup, to keep the network up.
4. Data is transferred in a sequential manner that is bit by bit. Data transmitted, has to pass through each node of the network, till the destination node.

Advantages of Ring Topology

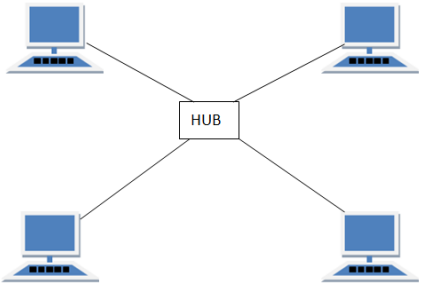
1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand

Disadvantages of Ring Topology

1. Troubleshooting is difficult in ring topology.
2. Adding or deleting the computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

STAR Topology

In this type of topology all the computers are connected to a single hub through a cable. This hub is the central node and all others nodes are connected to the central node.



Features of Star Topology

1. Every node has its own dedicated connection to the hub.
2. Hub acts as a repeater for data flow.
3. Can be used with twisted pair, Optical Fibre or coaxial cable.

Advantages of Star Topology

1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.

4. Easy to setup and modify.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

Disadvantages of Star Topology

1. Cost of installation is high.
2. Expensive to use.
3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.
4. Performance is based on the hub that is it depends on its capacity

MESH Topology

It is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other. Mesh has n(n-1)/2 physical channels to link n devices.

There are two techniques to transmit data over the Mesh topology, they are :

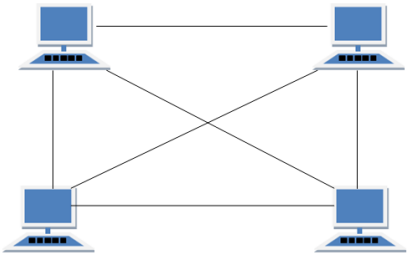
1. Routing
2. Flooding

MESH Topology: Routing

In routing, the nodes have a routing logic, as per the network requirements. Like routing logic to direct the data to reach the destination using the shortest distance. Or, routing logic which has information about the broken links, and it avoids those node etc. We can even have routing logic, to re-configure the failed nodes.

MESH Topology: Flooding

In flooding, the same data is transmitted to all the network nodes, hence no routing logic is required. The network is robust, and the its very unlikely to lose the data. But it leads to unwanted load over the network.



Types of Mesh Topology

1. **Partial Mesh Topology :** In this topology some of the systems are connected in the same fashion as mesh topology but some devices are only connected to two or three devices.
2. **Full Mesh Topology :** Each and every nodes or devices are connected to each other.

Features of Mesh Topology

1. Fully connected.
2. Robust.
3. Not flexible.

Advantages of Mesh Topology

1. Each connection can carry its own data load.
2. It is robust.
3. Fault is diagnosed easily.
4. Provides security and privacy.

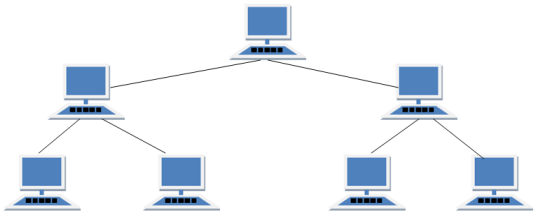
Disadvantages of Mesh Topology

1. Installation and configuration is difficult.
2. Cabling cost is more.
3. Bulk wiring is required.

TREE Topology

It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology.

It should at least have three levels to the hierarchy.



Features of Tree Topology

1. Ideal if workstations are located in groups.
2. Used in Wide Area Network.

Advantages of Tree Topology

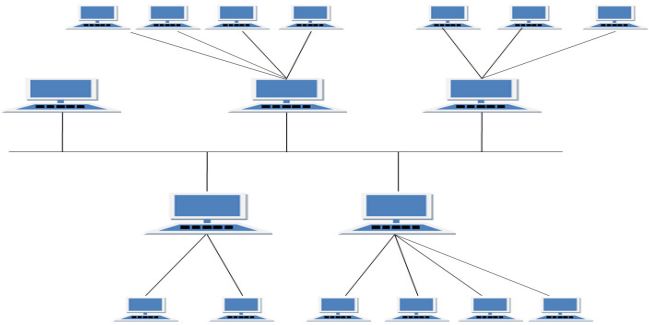
1. Extension of bus and star topologies.
2. Expansion of nodes is possible and easy.
3. Easily managed and maintained.
4. Error detection is easily done.

Disadvantages of Tree Topology

1. Heavily cabled. 2. Costly.
3. If more nodes are added maintenance is difficult. 3. Central hub fails, network fails.

HYBRID Topology

It is two different types of topologies which is a mixture of two or more topologies. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology).



Features of Hybrid Topology

1. It is a combination of two or topologies
2. Inherits the advantages and disadvantages of the topologies included

Advantages of Hybrid Topology

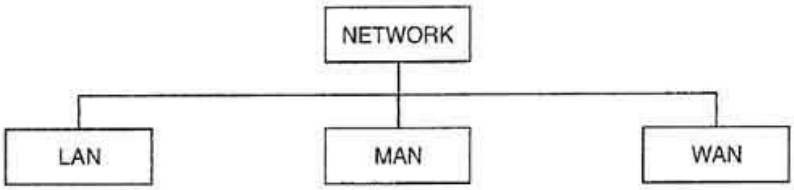
1. Reliable as Error detecting and trouble shooting is easy. 2. Effective.
3. Scalable as size can be increased easily. 4. Flexible.

Disadvantages of Hybrid Topology

1. Complex in design. 2. Costly.

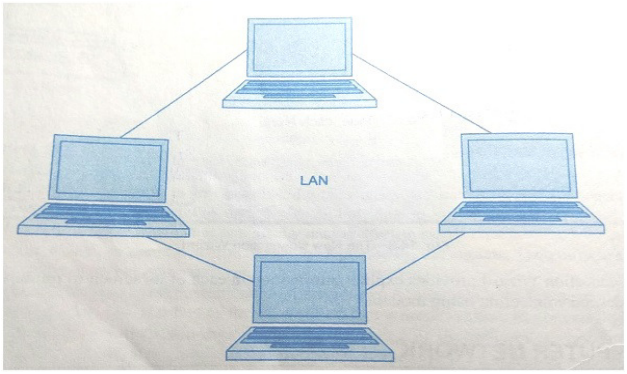
Categories of Network Or Types Of Computer Network

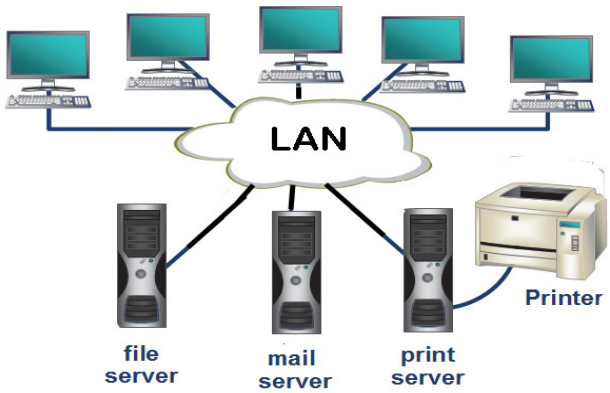
Computer Network is a system of interconnected computers that enable the computers to communicate with each other and share their resources, data and applications.



1) Local Area Network (LAN)

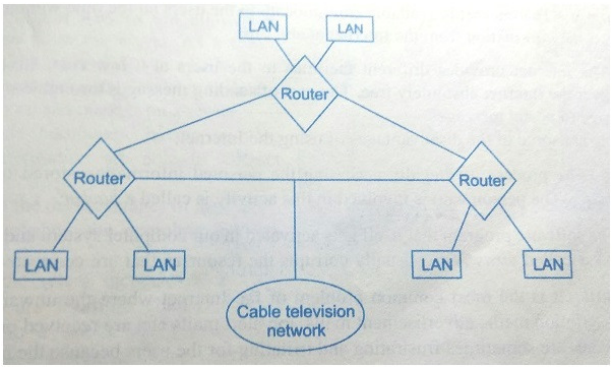
LAN is a group of computers, that are connected in a small area such as building, home, etc. Through this type of network, users can easily communicate with each other by sending and receiving messages. LAN is generally used for connecting two or more personal computers through some medium such as twisted pair, coaxial cable etc. Through the number of computers connected in a LAN is limited, the data is transferred at an extremely faster rate.

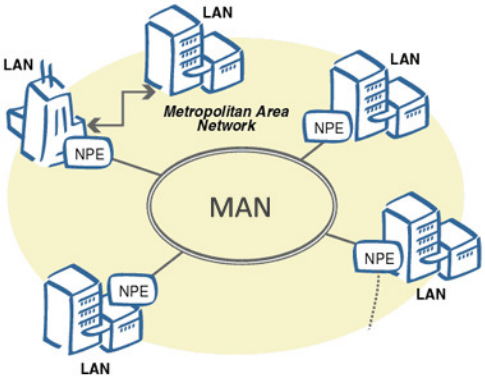




2) Metropolitan Area Network (MAN)

MAN is a network of computers that covers a large area like city. The size of the MAN generally lies between LAN and WAN, typically covering a distance of 5 km to 50 km. The geographical area covered by MAN is comparatively larger than LAN but smaller than WAN. MAN is generally owned by private organizations. MAN is generally connected with the help of optical fibers, copper wires etc. One of the most common examples of MAN is cable television network within a city as shown in Fig. A network device known as router is used to connect the LANs together. The router directs the information packets to the desired destination.





NPE-N/w Processing Engine

3) Wide Area Network (WAN)

WAN is a group of computers that are connected in a large area such as continent, country, etc. WAN is generally used for connecting two or more LANs through some medium such as leased telephone lines, microwaves, etc. In WAN, data is transferred at slow rate. A typical WAN network is shown in Fig .