5 NETWORKING TECHNOLOGY

COMPUTER NETWORKING

Computer Networking is the practice of connecting computers together to enable communication and data exchange between them. In general, Computer Network is a collection of two or more computers. It helps users to communicate more easily.

A computer network is a set of devices connected through links. A node can be computer, printer, or any other device capable of sending or receiving the data. The links connecting the nodes are known as communication channels.

Computer Network uses distributed processing in which task is divided among several computers. Instead, a single computer handles an entire task, each separate computer handles a subset.

NETWORK

Many organizations use separate PCs in operation, often located apart. Each computer uses separate printer, separate program software and other essential resources. For example, a company has many departments and two or more sister organizations they have computer at each department. They may have similar software and common data files. This old system results into inefficient use of machines and becomes isolated system of machine also undergoes into lack of communication and becomes expensive due to independent resources.

At some point management has to decide to make a system which will provide communication, exchange of information access to any file and sharing software so that the system will work efficiently, reliably and economical. All these requirements can be achieved by means of networking only.

The main goals of networking are

i) Network provides resource sharing.
ii) It provides high reliability by using other machine if one machine fails in the network like military, banking, air, and traffic control.
iii) Access to any fde and data.
iv) Finally the system is saving money by network only.

If we think of Wide Area Network it also provides access to remote programs, access to remote database and communication facility. For example, if a company has produced a model or product they can put all necessary information on the network so that clients can log-in over the network to see the product rates, specifications. All these applications use networking for economic reasons because the telephone call rate is expensive for long duration call but via network the line is used during the data transmission only.

NETWORKS IN COMMUNICATIONS

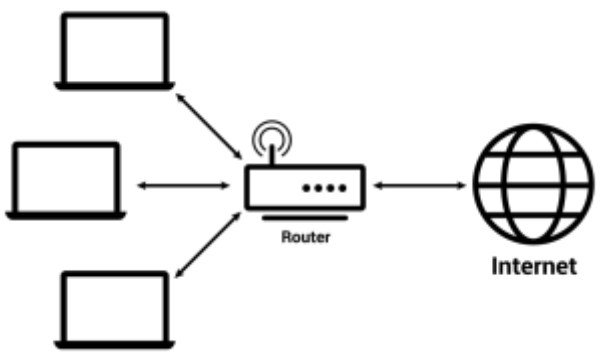
A network is an interconnected system that provides communication links among the two or more stations. Each station in a network is known as node. Below figure shows a simple communications network with four nodes A,B,C and D. Each node is connected with other three nodes.

There are different electronic communication networks, which can be broadly classified according to their coverage area. These are as follows:

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

1. LAN (Local Area Network)

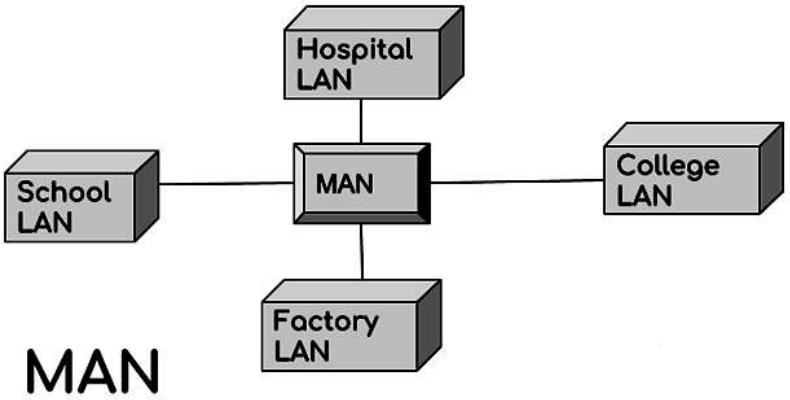
LAN (Local Area Network) is defined as a computer network that is responsible for connecting local areas like schools, residents, universities, etc. The main function of the local area networks is to link the computers, thereby providing access to the printers, photocopies, and other services. LAN has client-server architecture.
There are two types of LAN, i.e., peer-to-peer LAN and client/ service LAN. All these networks are connected to one central security database. It is interesting to note that LAN has wired networks, and all the computers and printers are connected through these wires. A LAN is used as an exclusive network for organizations, schools, universities, etc. One of the major examples of LAN is the computers in school. All the computers are connected through wires with one central database.



2. MAN(Metropolitan Area Network)

A MAN, also called the Metropolitan Area Network, is defined as the computer network that joins the metropolitan areas. MAN works either through wires/ cables or modem. Telephone company network is a common example of MAN as they provide high-speed DSL line to the consumers. The main characteristic of MAN is that it is the interconnection between several links/ networks in a metropolitan area. Point-to-point connections are used in MAN.

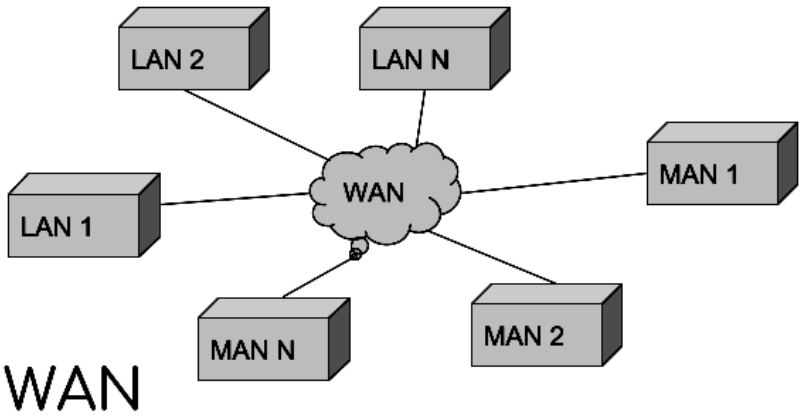
The network size of MAN ranges from 5-50 Kms. The regional sources are often shared in MAN. It is interesting to note that MAN is either owned by a group or by a network provider. Therefore, the metropolitan area network is not that expensive. The setup is quite easy, and the internet speed is relatively high. Thus, the implementation cost is saved in MAN.



3. WAN(Wide Area Network)

A WAN, also called the Wide Area Network, is defined as a telecommunications network that extends over a large area. The primary purpose of WAN is computer networking. The networks are linked to communicate with one another.

WAN is not associated with a particular location. It helps in communication and sharing the required information among the connections. WAN is the largest network as compared to MAN and LAN. A WAN may cover a country, continent, etc. Examples of WAN include broadband services, 3G or 4G connections, etc. Some of the advantages of WAN are that it covers a larger geographical area, the software, resources, and other information is shared, has a high bandwidth, the travel charges are reduced, etc. Now, there are certain contrasting points between LAN, MAN, and WAN. So, let us have a look at them.



DIFFERENCE BETWEEN LAN MAN WAN

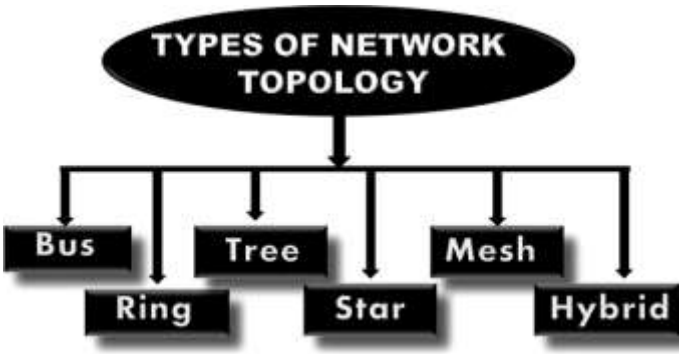
SR NO.	LAN	MAN	WAN
1.	LAN is defined as a computer network that links the local areas like schools, universities, organizations, etc.	On the other hand, MAN is defined as a computer network that links the metropolitan areas.	On the other hand, WAN is defined as the telecommunications network that covers a large geographical
2.	The full form of the LAN is Local AreaNetwork.	The full form ofMAN is Metropolitan AreaNetwork.	The full form of WAN isa Wide Area Network.
3.	LAN is a wirednetwork, i.e., all the computers and Printers are connected throughwires.	The connections in MAN are connectedthrough modem orcables/ wires.	The network of WAN isconnected through broadband services, 3G or 4G internet services, etc.
4.	The ownership of LAN is private.	The ownership of MAN might be public or private.	The ownership of WANmight be private or public.
5.	The internet speed of LAN is very high, i.e., 1000 Mbps.	The sped of MAN is moderate, i.e., 44-155 Mbps.	The speed of WAN is relatively less than MAN and LAN, i.e., 150 Mbps.
6.	Themaintenancecost of LAN is easy.	The maintenance cost of MAN is difficult.	The maintenance cost of WAN is difficult.
7.	Thebandwidth of LAN is high.	The bandwidth of MAN is less.	The bandwidth of WANis relatively low.
8.	Examples: • College • School • University • Hospital	Examples: • City • Building	Examples: • Broadband and internet throughout the country or continent.

NETWORK TOPOLOGY

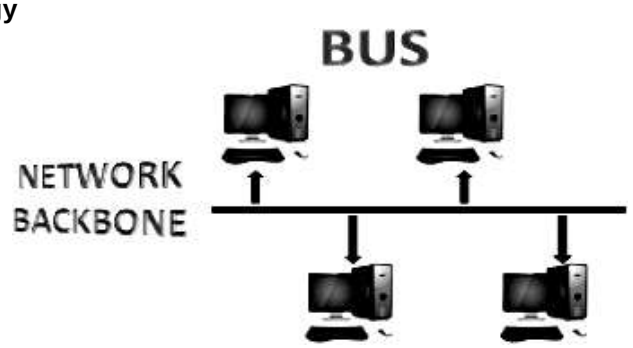
What is Topology?

Topology defines the structure of the network of how all the components are interconnected to each other. There are two types of topology: physical and logical topology.

Physical topology is the geometric representation of all the nodes in a network.



1. Bus Topology



- The bus topology is designed in such a way that all the stations are connected through a single cable known as a backbone cable.
- Each node is either connected to the backbone cable by drop cable or directly connected to the backbone cable.
- When a node wants to send a message over the network, it puts a message over the network. All the stations available in the network will receive the message whether it has been addressed or not.

The bus topology is mainly used in 802.3 (ethernet) and 802.4 standard networks.

- The configuration of a bus topology is quite simpler as compared to other topologies.
- The backbone cable is considered as a **"single lane"** through which the message is broadcast toall the stations.
- The most common access method of the bus topologies is **CSMA** (Carrier Sense Multiple Access).

Advantages of Bus topology:

- **Low-cost cable:** In bus topology, nodes are directly connected to the cable without passing through a hub. Therefore, the initial cost of installation is low.
- **Moderate data speeds:** Coaxial or twisted pair cables are mainly used in bus-based networks that support upto 10 Mbps.
- **Familiar technology:** Bus topology is a familiar technology as the installation and troubleshooting techniques are well known, and hardware components are easily available.
- **Limited failure:** A failure in one node will not have any effect on other nodes.

Disadvantages of Bus topology:

- **Extensive cabling:** A bus topology is quite simpler, but still it requires a lot of cabling.
- **Difficult troubleshooting:** It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Signal interference:** If two nodes send the messages simultaneously, then the signals of both the nodes collide with each other.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.
- **Attenuation:** Attenuation is a loss of signal leads to communication issues. Repeaters are used to regenerate the signal.

2. Ring Topology

Ring topology is like a bus topology, but with connected ends.

- The node that receives the message from the previous computer will retransmit to the next node.
- The data flows in one direction, i.e., it is unidirectional.
- The data flows in a single loop continuously known as an endless loop.
- It has no terminated ends, i.e., each node is connected to other node and having no termination point.
- The data in a ring topology flow in a clockwise direction.

- The most common access method of the ring topology is **token passing**.
- **Token passing:** It is a network access method in which token is passed from one node to another node.
- **Token:** It is a frame that circulates around the network.

Working of Token passing

- A token moves around the network, and it is passed from computer to computer until it reaches the destination.
- The sender modifies the token by putting the address along with the data.
- The data is passed from one device to another device until the destination address matches. Once the token received by the destination device, then it sends the acknowledgment to the sender.
- In a ring topology, a token is used as a carrier.

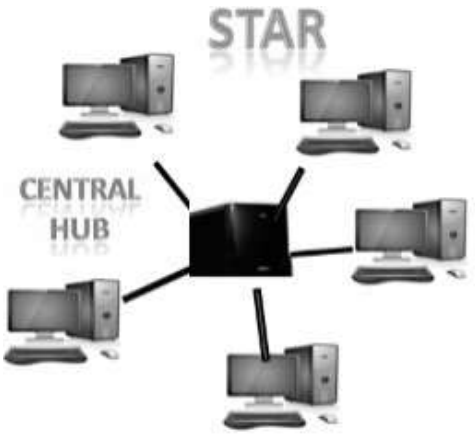
Advantages of Ring topology:

- **Network Management:** Faulty devices can be removed from the network without bringing the network down.
- **Product availability:** Many hardware and software tools for network operation and monitoring are available.
- **Cost:** Twisted pair cabling is inexpensive and easily available. Therefore, the installation cost is very low.
- **Reliable:** It is a more reliable network because the communication system is not dependent on the single host computer.

Disadvantages of Ring topology:

- **Difficult troubleshooting:** It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Failure:** The breakdown in one station leads to the failure of the overall network.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.
- Delay: Communication delay is directly proportional to the number of nodes. Adding new devices increases the communication delay.

3. Star Topology



- Star topology is an arrangement of the network in which every node is connected to the central hub, switch or a central computer.
- The central computer is known as a **server**, and the peripheral devices attached to the server are known as **clients**.
- Coaxial cable or RJ-45 cables are used to connect the computers.
- Hubs or Switches are mainly used as connection devices in a **physical star topology**.
- Star topology is the most popular topology in network implementation.

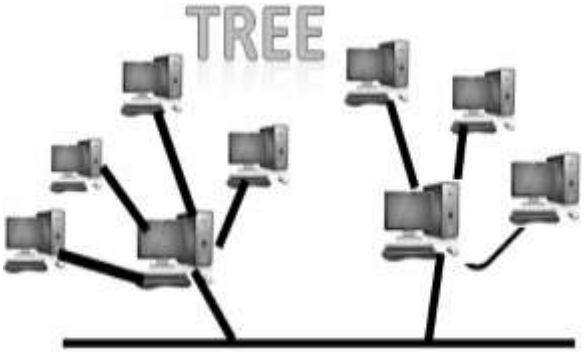
Advantages of Star topology

- **Efficient troubleshooting:** Troubleshooting is quite efficient in a star topology as compared to bus topology. In a bus topology, the manager has to inspect the kilometers of cable. In a star topology, all the stations are connected to the centralized network. Therefore, the network administrator has to go to the single station to troubleshoot the problem.
- **Network control:** Complex network control features can be easily implemented in the star topology. Any changes made in the star topology are automatically accommodated.
- **Limited failure:** As each station is connected to the central hub with its own cable, therefore failure in one cable will not affect the entire network.
- **Familiar technology:** Star topology is a familiar technology as its tools are cost-effective.
- **Easily expandable:** It is easily expandable as new stations can be added to the open ports on the hub.
- **Cost effective:** Star topology networks are cost-effective as it uses inexpensive coaxial cable.
- **High data speeds:** It supports a bandwidth of approx 100Mbps. Ethernet 100BaseT is one of the most popular Star topology networks.

Disadvantages of Star topology

- **A Central point of failure:** If the central hub or switch goes down, then all the connected nodes will not be able to communicate with each other.
- **Cable:** Sometimes cable routing becomes difficult when a significant amount of routing is required.

4. Tree topology



- Tree topology combines the characteristics of bus topology and star topology.
- A tree topology is a type of structure in which all the computers are connected with each other in hierarchical fashion.
- The top-most node in tree topology is known as a root node, and all other nodes are the descendants of the root node.
- There is only one path exists between two nodes for the data transmission. Thus, it forms a parent-child hierarchy.

Advantages of Tree topology

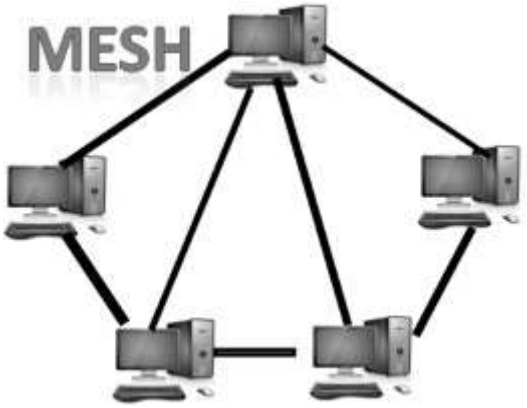
- **Support for broadband transmission:** Tree topology is mainly used to provide broadband transmission, i.e., signals are sent over long distances without being attenuated.
- **Easily expandable:** We can add the new device to the existing network. Therefore, we can say that tree topology is easily expandable.
- **Easily manageable:** In tree topology, the whole network is divided into segments known as star networks which can be easily managed and maintained.
- **Error detection:** Error detection and error correction are very easy in a tree topology.
- **Limited failure:** The breakdown in one station does not affect the entire network.
- **Point-to-point wiring:** It has point-to-point wiring for individual segments.

Disadvantages of Tree topology

- **Difficult troubleshooting:** If any fault occurs in the node, then it becomes difficult to troubleshoot the problem.
- **High cost:** Devices required for broadband transmission are very costly.

- **Failure:** A tree topology mainly relies on main bus cable and failure in main bus cable will damage the overall network.
- **Reconfiguration difficult:** If new devices are added, then it becomes difficult to reconfigure.

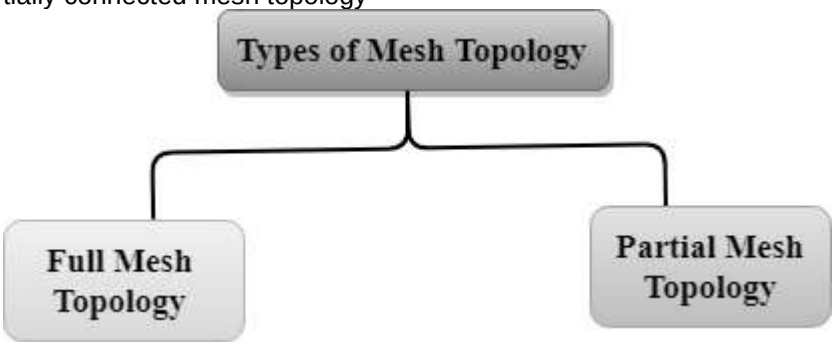
5. Mesh topology



- Mesh technology is an arrangement of the network in which computers are interconnected with each other through various redundant connections.
- There are multiple paths from one computer to another computer.
- It does not contain the switch, hub or any central computer which acts as a central point of communication.
- The Internet is an example of the mesh topology.
- Mesh topology is mainly used for WAN implementations where communication failures are a critical concern.
- Mesh topology is mainly used for wireless networks.

Mesh topology is divided into two categories:

- Fully connected mesh topology
- Partially connected mesh topology



- **Full Mesh Topology:** In a full mesh topology, each computer is connected to all the computers available in the network.
- **Partial Mesh Topology:** In a partial mesh topology, not all but certain computers are connected to those computers with which they communicate frequently.

Advantages of Mesh topology:
Reliable: The mesh topology networks are very reliable as if any link breakdown will not affect the communication between connected computers.

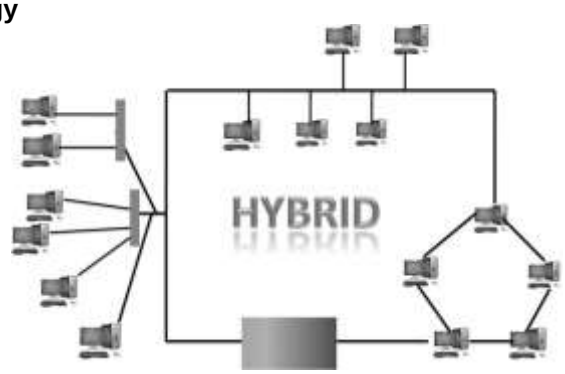
Fast Communication: Communication is very fast between the nodes.

Easier Reconfiguration: Adding new devices would not disrupt the communication between other devices.

Disadvantages of Mesh topology

- **Cost:** A mesh topology contains a large number of connected devices such as a router and more transmission media than other topologies.
- **Management:** Mesh topology networks are very large and very difficult to maintain and manage. If the network is not monitored carefully, then the communication link failure goes undetected.
- **Efficiency:** In this topology, redundant connections are high that reduces the efficiency of the network.

6. Hybrid Topology



- The combination of various different topologies is known as Hybrid topology.
- A Hybrid topology is a connection between different links and nodes to transfer the data.
- When two or more different topologies are combined together is termed as Hybrid topology and if similar topologies are connected with each other will not result in Hybrid topology. For example, if there exist a ring topology in one branch of ICICI bank and bus topology in another branch of ICICI bank, connecting these two topologies will result in Hybrid topology.

Advantages of Hybrid Topology

- **Reliable:** If a fault occurs in any part of the network will not affect the functioning of the rest of the network.
- **Scalable:** Size of the network can be easily expanded by adding new devices without affecting the functionality of the existing network.
- **Flexible:** This topology is very flexible as it can be designed according to the requirements of the organization.
- **Effective:** Hybrid topology is very effective as it can be designed in such a way that the strength of the network is maximized and weakness of the network is minimized.

Disadvantages of Hybrid topology

Complex design: The major drawback of the Hybrid topology is the design of the Hybrid network. It is very difficult to design the architecture of the Hybrid network.

- **Costly Hub:** The Hubs used in the Hybrid topology are very expensive as these hubs are different from usual Hubs used in other topologies.
- **Costly infrastructure:** The infrastructure cost is very high as a hybrid network requires a lot of cabling, network devices, etc.

PHYSICAL TRANSMISSION MEDIA CHARACTERISTICS

Physical transmission media are the physical lines or channels through which information (a stream of bits) is transmitted between computers in a network.

Before we discuss each type of transmission medium let us define their characteristics and try to understand the significance of each characteristics because each media is suited to certain types of installation than other. To choose the best type of network media for a network the following factors must be considered:

i) Cost of Media

The cost of the media must be considered first while designing a network. The cost-performance properties are the two major factors. It is decided by the user as per application and standard of the resources.

ii) Implementation Cost

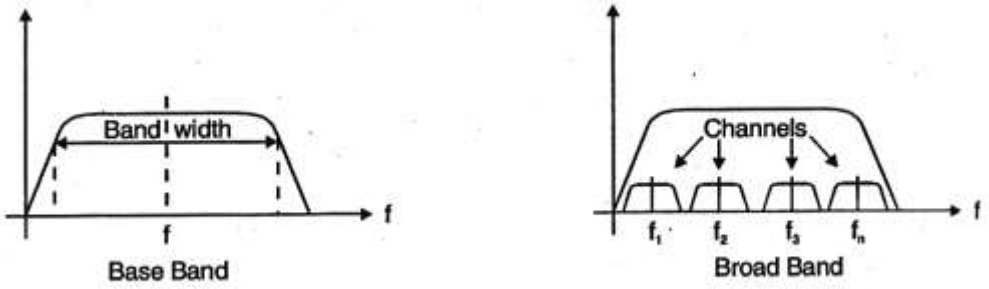
When a media is to be designed for communication purpose one has to estimate the cost of cable or media as well as the cost of installation. For almost all media, the cost of installation exceeds than the cost of the cable itself. For example, for fiber optic cable special tools are to be used and by only trained technical persons can operate these tools. In other media like twisted pair the cost of installation is inexpensive.

iii) Channel Bandwidth

This is more important when media has to carry signals. It is defined as “the range of transmission frequencies that are carried effectively on a media”. A very common example of bandwidth is a telephone line. Its media should have bandwidth of 3 to 4 KHz because the range of voice signals is 300 Hz-3KHz. In computer network the bit

transmission rate depends on bandwidth. When digital or binary data is to be transmitted it is expressed in terms of baud rate it is measured in bits/ sec or "bps." In networking bandwidth is measured in bps.

For analog signal communication like audio/TV signals bandwidth specifies the capacity of carrying varying signals without loss of signal. The larger the bandwidth of a channel the higher is the capacity to carry information. The media can carry many signals at a time in that situation bandwidth will decide how many signals that it can carry. These concepts of carrying signals are known as base band and broad band transmission.



Idea of Base band and Broadband

iv) Band Usage

A channel or bandwidth is an expensive resource. In computer network except for short communication lines, many computers use the bandwidth. The bandwidth is shared so that maximum usage is obtained. The method of dividing bandwidth refer fig. (5.5) into many small channels to transmit a number of signals independently is known as multiplexing and such a bandwidth is known as broad band. On the other hand when it is for only one channel signals like telephone on a twisted wire refer fig. (5.5a) known as base band. More efficient method is broadband transmission by using separate carrier to make it distinct for each channel. Refer fig. (5.5b) fl, f2 are separate carriers allocated for each channel. The signal is modulated and not direct signal.

Comparison

	Baseband	**Broadband**
(1)	Only one channel is transmitted on available bandwidth.	Many channels are transmitted on a available bandwidth.
(2)	Original information is directly sent on line.	Information is modulated & indirectly sent in different form.
(3)	Small band width can be used	Big band width is required to transmit more channels.
(4)	e.g. LAN or a telephone line.	Cable TV channel transmission.
(5)	Twisted wire cable is used	Co-axial cable carries braod band transmission.

v) Electromagnetic Interference (EMI)

It affects the signal which is transmitted through a media. EMI is caused by outside electromagnetic waves and also unwanted noise signals produced by various electrical appliances. EMI is interfering the signals and makes difficult for computers to decode the signal.

vi) Attenuation

Electromagnetic signals tend to weaken during transmission known as attenuation. As signals pass through the medium part of the signal is absorbed and makes the signal weak

MULTIPLEXING

This is the technique of utilizing an available channel effectively. These are three methods of multiplexing. It belongs to broadband communication.

a) Space Division Multiplexing (SDM)

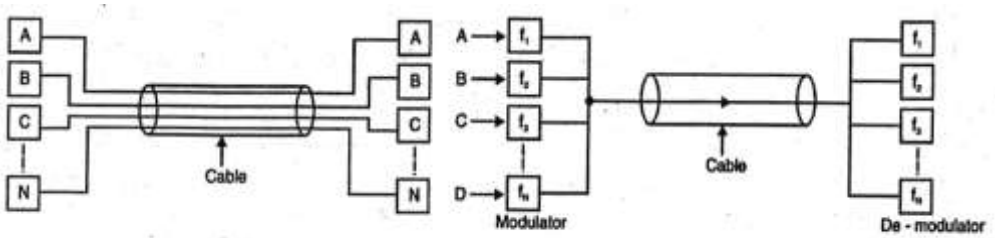
b) Frequency Division Multiplexing (FDM)

c) Time Division Multiplying (TDM)

By means of multiplexing the available channel is divided into many channels to maximize the utilization of the channel capacity.

a) Space Division Multiplexing (SDM)

This is the simplest method of physical multiplexing in which physically individual communication lines are packaged at the source. At the receiving end each line slot is separated to connect each line to individual destination as shown.



(a) Idea of SDM and FDM (b)

The advantage of this method is that it allows individual line to each user & it uses base-band for short distances. Another advantage of SDM is that the system is simple to install and use.

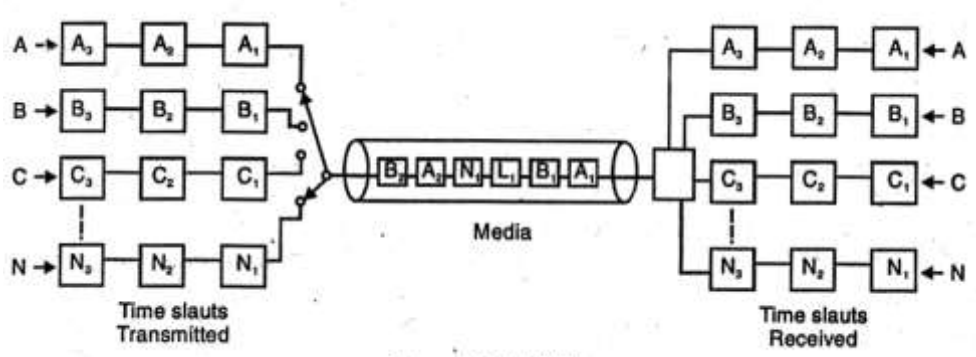
b) Frequency Division Multiplexing (FDM)

This is the method of multiplexing where the medium is carrying multiple individual channels instead of using separate Physical wire for each channel. It means that in FDM physical channel carries a number of small logical channels on a common cable. In fact each channel is transmitted by means of modulation & at the receiving end it is demodulated for this purpose it requires modem. In FDM each channel sends information by using a separate carrier frequency as shown in the figure f1, f2, ……. fn.

Since each carrier frequency is different, they run simultaneously through the cable. At the receiving end they are separated by means of demodulator.

c) Time Division Multiplexing (TDM)

TDM is a very popular modern technique of utilizing the capacity of a physical channel effectively. As name suggests in TDM each user of the channel is allowed to transmit for a small time interval after every periodic time. So that user can utilize full bandwidth in allocated time slice. As shown in the figure the physical channel carries information sequentially such as A3, A2, A1 and received in sequence as Al, A2, A3.



Concept of TDM

STUDY OF TRANSMISSION MEDIA

What is Transmission media?

- Transmission media is a communication channel that carries the information from the sender to the receiver. Data is transmitted through the electromagnetic signals.
- The main functionality of the transmission media is to carry the information in the form of bits through LAN(Local Area Network).
- It is a physical path between transmitter and receiver in data communication.
- In a copper-based network, the bits in the form of electrical signals.
- In a fibre based network, the bits in the form of light pulses.
- The electrical signals can be sent through the copper wire, fibre optics, atmosphere, water, and vacuum.
- The characteristics and quality of data transmission are determined by the characteristics of medium and signal.
- Transmission media is of two types are wired media and wireless media. In wired media, medium characteristics are more important whereas, in wireless media, signal characteristics are more important.
- Different transmission media have different properties such as bandwidth, delay, cost and ease of installation and maintenance.
- The transmission media is available in the lowest layer of the OSI reference model, i.e., Physical layer.

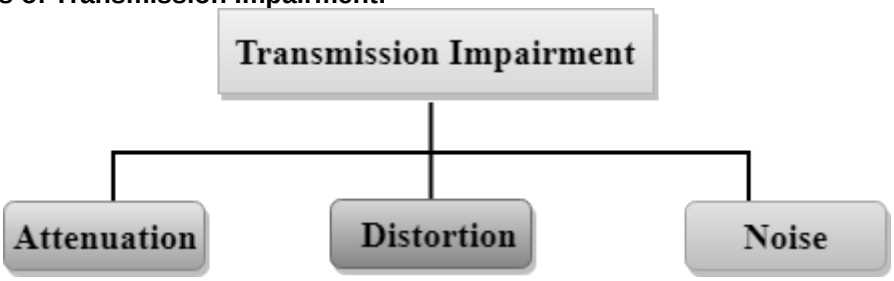
Some factors need to be considered for designing the transmission media:

- Bandwidth: All the factors are remaining constant, the greater the bandwidth of a medium, the higher the data transmission rate of a signal.
- Transmission impairment: When the received signal is not identical to the transmitted

one due to the transmission impairment. The quality of the signals will get destroyed due to transmission impairment.

- Interference: An interference is defined as the process of disrupting a signal when it travels over a communication medium on the addition of some unwanted signal.

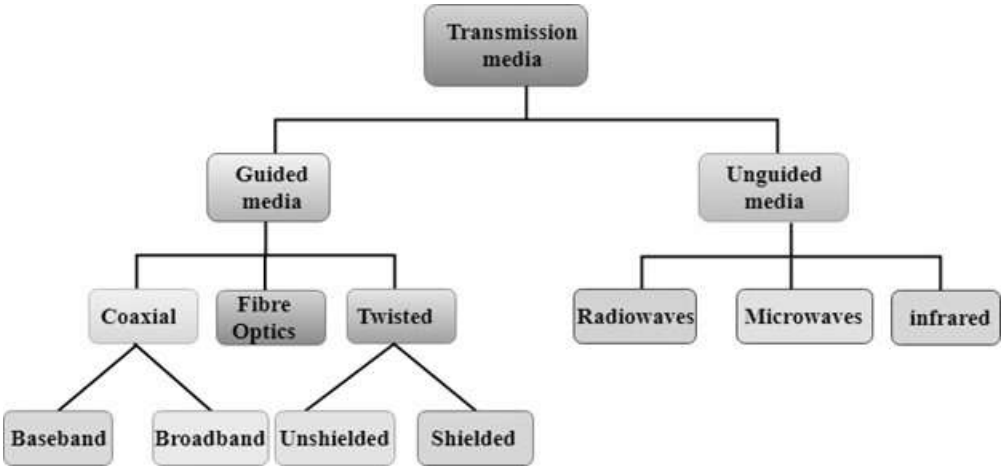
Causes of Transmission Impairment:



Attenuation: Attenuation means the loss of energy, i.e., the strength of the signal decreases with increasing the distance which causes the loss of energy.

- **Distortion:** Distortion occurs when there is a change in the shape of the signal. This type of distortion is examined from different signals having different frequencies. Each frequency component has its own propagation speed, so they reach at a different time which leads to the delay distortion.
- **Noise:** When data is travelled over a transmission medium, some unwanted signal is added to it which creates the noise.

Classification of Transmission Media:



- **Guided Transmission Media**
- **UnGuided Transmission Media**

GUIDED MEDIA

It is defined as the physical medium through which the signals are transmitted. It is also known as Bounded media.

Types of Guided media:

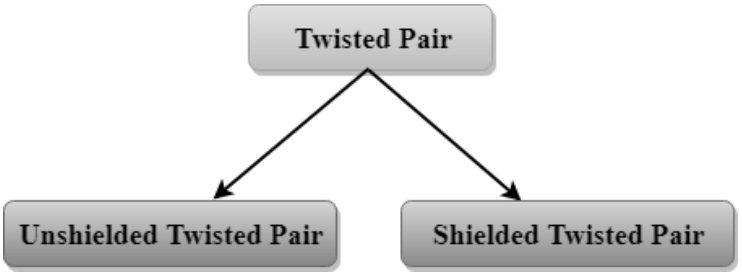
TWISTED PAIR:

Twisted pair is a physical media made up of a pair of cables twisted with each other. A twisted pair cable is cheap as compared to other transmission media. Installation of the twisted pair cable is easy, and it is a lightweight cable. The frequency range for twisted pair cable is from 0 to 3.5KHz.

A twisted pair consists of two insulated copper wires arranged in a regular spiral pattern.

The degree of reduction in noise interference is determined by the number of turns per foot. Increasing the number of turns per foot decreases noise interference.

Types of Twisted pair:



Unshielded Twisted Pair:

An unshielded twisted pair is widely used in telecommunication. Following are the categories of the unshielded twisted pair cable:

- Category 1: Category 1 is used for telephone lines that have low-speed data.
- Category 2: It can support upto 4Mbps.
- Category 3: It can support upto 16Mbps.
- Category 4: It can support upto 20Mbps. Therefore, it can be used for long-distance communication.
- Category 5: It can support upto 200Mbps.

Shielded Twisted Pair

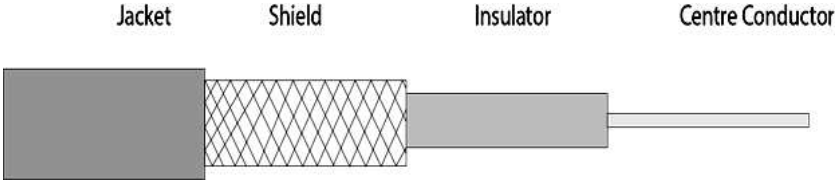
A shielded twisted pair is a cable that contains the mesh surrounding the wire that allows the higher transmission rate.

Characteristics of Shielded Twisted Pair:

- The cost of the shielded twisted pair cable is not very high and not very low.
- An installation of STP is easy.
- It has higher capacity as compared to unshielded twisted pair cable.
- It has a higher attenuation.
- It is shielded that provides the higher data transmission rate.

COAXIAL CABLE

- Coaxial cable is very commonly used transmission media, for example, TV wire is usually a coaxial cable.
- The name of the cable is coaxial as it contains two conductors parallel to each other.
- It has a higher frequency as compared to Twisted pair cable.
- The inner conductor of the coaxial cable is made up of copper, and the outer conductor is made up of copper mesh. The middle core is made up of non-conductive cover that separates the inner conductor from the outer conductor.
- The middle core is responsible for the data transferring whereas the copper mesh prevents from the EMI(Electromagnetic interference).



Coaxial cable is of two types:

1. Baseband transmission: It is defined as the process of transmitting a single signal at high speed.
2. Broadband transmission: It is defined as the process of transmitting multiple signals simultaneously.

Advantages of Coaxial cable:

- The data can be transmitted at high speed.
- It has better shielding as compared to twisted pair cable.
- It provides higher bandwidth.

Disadvantages of Coaxial cable:

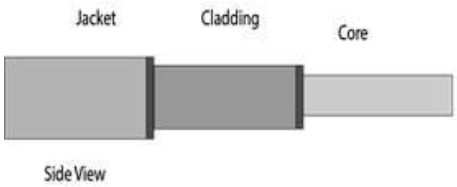
- It is more expensive as compared to twisted pair cable.
- If any fault occurs in the cable causes the failure in the entire network.

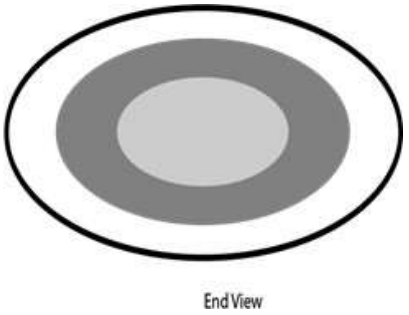
FIBRE OPTIC

- Fibre optic cable is a cable that uses electrical signals for communication.

- Fibre optic is a cable that holds the optical fibres coated in plastic that are used to send the data by pulses of light.
- The plastic coating protects the optical fibres from heat, cold, electromagnetic interference from other types of wiring.
- Fibre optics provide faster data transmission than copper wires.

Diagrammatic representation of fibre optic cable:





Basic elements of Fibre optic cable:

- **Core:** The optical fibre consists of a narrow strand of glass or plastic known as a core. A core is a light transmission area of the fibre. The more the area of the core, the more light will be transmitted into the fibre.
- **Cladding:** The concentric layer of glass is known as cladding. The main functionality of the cladding is to provide the lower refractive index at the core interface as to cause the reflection within the core so that the light waves are transmitted through the fibre.
- **Jacket:** The protective coating consisting of plastic is known as a jacket. The main purpose of a jacket is to preserve the fibre strength, absorb shock and extra fibre protection.

THE SYSTEM OF FIBRE OPTIC COMMUNICATION

Fiber optic communication is a light wave communication. A light signal is passed through a fiber optic cable known as light pipe or light guide. The light signal propagates through fiber cable by multiple reflections in zigzag path. Some part of the signal is lost due to internal absorption. Light is a signal it is an electromagnetic wave like radio wave. The light pipe carries many signals like many telephone channels through the cable without any interference.

Comparison of Bounded Cables

	Properties	Twisted pair	Co–axial cable	Fiber optic cable
(a)	Cost	Inexpensive	Twice or thrice than twisted pair	Expensive
(b)	Installation	Easy	Easy	Difficult
(c)	Attenuation	More	More	Very less
(d)	EMI effect	Maximum	Minimum	No effect
(e)	Band width	1 to 100 mbps/100 mtr.	500 mbps/100 mtr.	Gega bps/km.
(f)	Signal type	Electrical	Electrical	Light signals.

UNGUIDED MEDIA

In this group of wireless media radio waves in the very high frequency (VHF) band which are not used for any other communication may be used for communication between computers.

Advantages:

1) The advantage of wireless media is high data rates by using large bandwidth which can give transmission speed around 24 Kbps.
2) By this media the communication can reach rural and hilly areas.
3) Bandwidth for digital data 1 to 10 Mbps.

Disadvantages:

1) VHF waves are corrupted by atmospheric noise and error may introduce in data and affected by EMI.
2) Lack of security, because radio waves may be received by any one.
3) The'installation cost is very high and installation is complex.
4) Attenuation is very high it can be minimised by using repeaters.

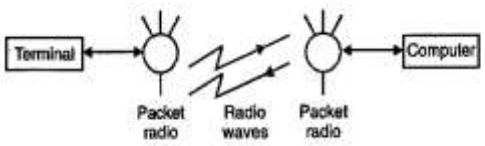
There are three types of unbounded-media communication:

1) Packet radio

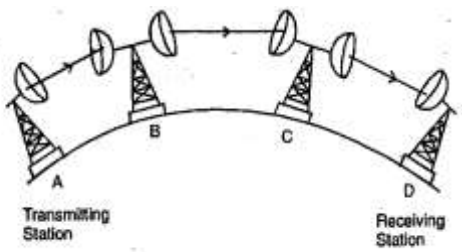
It is a combined packet radio having both transmitter and receiver with different frequencies. A packet radio is attached to each terminal and the computer. The information entered on a terminal is transmitted using the packet radio and received by the computer. Information is processed and results are transmitted back to the terminal by the computer.

2) Microwave Media

Microwave communication use wave guides and repeaters. Microwave is extremely high frequency about 100 Ghz. Since microwave can also bend or pass obstacles like hills. For this purpose repeaters are used between two hills they are placed in a line of sight.



Packet Radio



Microwave Communications

3) Communication Satellite Media

Microwave signals like television; the ionosphere cannot reflect radar signals. Only way to transmit these TV signals to transmit the signals directly from the tower to the receivers. But due to direct transmission of such a high frequency signals they can propagate up to only limited area only in the line of sight area. It happens due to earth's curvature that's why TV towers are located on. top of the hills. As, illustrated

the area can be increased by making multi– trans-reception where signals can be sent from place A to D by making transmission from tower A to B then B. to C and C to D, in this process the cost and signal strength problems become main difficulties. The tower B and C are called repeaters. Even if to transmit these TV signals from one city to another city located about 200Km it becomes essential to place many repeaters if the area is having number of hills and mountains in between the two cities.

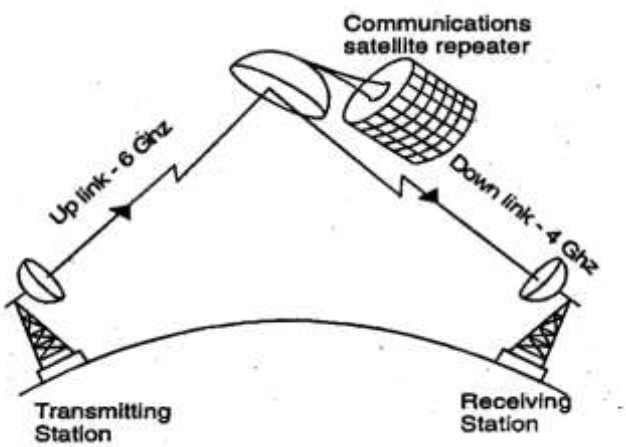
To overcome these difficulties one master repeater can be launched in to the space by making it geostationary. It is a satellite, which can be sent in to the space so that it can cover maximum area of the earth's surface.

In this way a communication satellite is an artificial satellite orbiting round the earth in the same direction as the direction of the earth movement and with the same velocity to make it stationary. In other words "a satellite is an electronic communication system that orbits around the earth". Now the idea is very clear that the TV signals are sent from the tower on the earth to the satellite in the space. The satellite amplifies these signals and re-transmits them back to earth. In satellite communication, the signal communication is in full duplex the earth station and satellite both contains transmitter and receiver.

About the satellite

- A satellite is an artificial revolving object round the earth.
- It contains different communication electronic systems
- It is launched for long distance as well as microwave communications
- The satellite is a full duplex system since it is a two-way communication
- Satellite communications increase the area of coverage
- It can be used for a variety of useful applications like telecommunication, meteorological information, cellular phone etc.

the basic use of communication satellite where the stations on earth are known as earth stations or ground stations and the satellite as a remote station since it is in remote area as space.



Use of communication satellite

The operating steps are:

1. An earth station transmits information to the satellite by using a carrier known as “up link” frequency.
2. The satellite receives the up-link it amplifies it.
3. The satellite transmits the amplified information signals by re-transmitting it on another carrier frequency called as “down link” frequency towards another earth station on the earth.

NETWORK CONNECTIVITY

A small network normally grows but it can not grow beyond certain limit it affects its performance like drop in printing speed, machine's response etc. It needs network expansion. Typically two main types of expansion are needed

- Expansion within a network called network connectivity
- Expansion of two or more networks called internetwork connectivity

To expand a single network without breaking in into new parts or connecting it to other networks some standard connectivity devices are used such as:

1. Hubs
2. Modem
3. Repeaters
4. Routers

1) HUBS

This is the simplest connectivity device used to extend a network. All networks (except those using co-axial cable) requires a central junction are called hubs.

A simple network inter-connected with hub. Hub is a structure with which cables can be connected without soldering wires. There are three types of hubs:

a) Passive hub: It simply combines the signals of network lines. There is no amplification or boosting of signals.

b) Active hub: Since this device not only inter-connects but also amplify and clean-ups signals, it is known as active hub. This hub contains electronics circuits.

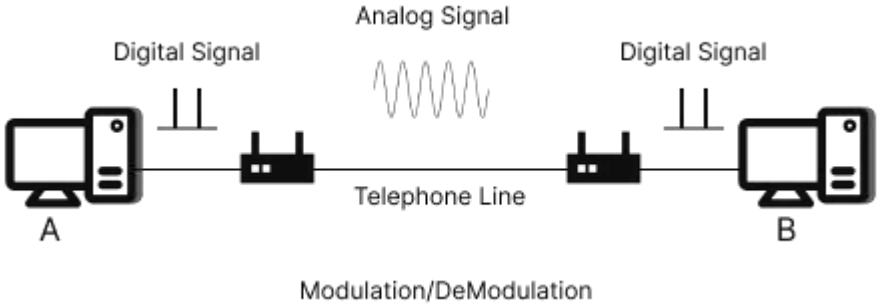
c) Intelligent hub: In addition to signal amplification and regeneration, this type of hub performs intelligent work like network management and intelligent path selection.

2) MODEMS

A modem is an electronic device that converts digital signals into analog signals and also vice-versa. It is used to transmit data over communication channels such as telephone lines, cable lines, or wireless networks. The modem is capable of encoding and decoding digital signals so that they can be transmitted through the communication channel. When the analog signal reaches the receiving modem, it decodes it back into digital signals that can be read by the computer or digital device.

Working of Modem in Computer Network

A modem works by converting digital signals into analog signals and vice versa. The modem consists of two main components: the modulator and the demodulator. The modulator is responsible for converting digital signals into analog signals, while the demodulator is responsible for converting analog signals into digital signals.



When a user sends data from the computer, the modem converts the digital signals into analog signals that can be transmitted over the communication channel. The modem sends the analog signal over the telephone line, cable line, or wireless network to the receiving modem. The receiving modem then decodes the analog signal back into digital signals that can be read by the computer or digital device.

Characteristics of Modem in Computer Network

The modem in Computer Network has the following characteristics

- Modems are used to convert digital signals to analog signals.
- They help in the connection of devices to the internet.
- A modem can only connect a limited number of systems to the internet.
- Modems are susceptible to computer hacking, limiting the possibility of secure transmission.
- The cost of a modem is determined by the number of features it provides. Additional features will increase the cost of the modem.
- When a modem is linked to a hub, it slows down.
- They cannot monitor communication between the LAN and the internet.
- To communicate with telephone lines, modems require an RJ11 jack and an RJ45 jack to connect to computers.
- Device drives must be installed in the operating system for modem configuration and communication.

Types of Modem in Computer Network

Modems in Computer Networks can be of different types as described below.

- **External Modem**

  External Modem in Computer System is connected to the computer system with the help of a serial cable. It's also extremely simple to install and has a fast data transfer rate. It is expensive, but it is still used in workplaces due to its high-speed data transfer, mostly to avoid interruptions in network access.

- **Internal Modem**
  As the name implies, The internal modem is installed over the motherboard of a computer. It looks similar to an electronic circuit and it is installed in the motherboard slot. Due to the complexity of the installation process and the slow data transfer speed, it is used for dedicated computers in houses or small spaces.

- **Wireless Modem**
  Wireless modems connect to computer systems without the requirement of a cable, and most people use wireless modems for personal usage.
  These modems use radio frequencies to send data over the air and have a fast transmission speed.

- **Dial-Up Modem**
  Dial-up modems link the computer to the internet by connecting the ISP over a traditional telephone line. It uses the PSTN (Public Switched Telephone Network). The speed is 56kb/sec.

- **Cable Modem**
  The cable modem is referred to as a broadband device as it enables the computer to communicate with the ISP via a landline connection. It is connected to the landline via a coaxial wire and to the computer via an ethernet cable.

- **DSL Modem**
  DSL is an abbreviation for Digital Subscriber Line, which allows data transmission over a standard telephone line. It has a fast data transfer speed and is thus widely used in businesses and residences. It may be used to connect to a computer or router to provide internet access through the ethernet or USB port. There are two kinds of DSL modems, ADSL Modem and SDSL Modem.

- **Satellite Modem**
  Satellite modems are expensive modems that do not require a phone line to connect to the internet. It uses satellite technology to send or receive data. The modem's speed is slower than that of a DSL or cable modem.

3) REPEATERS

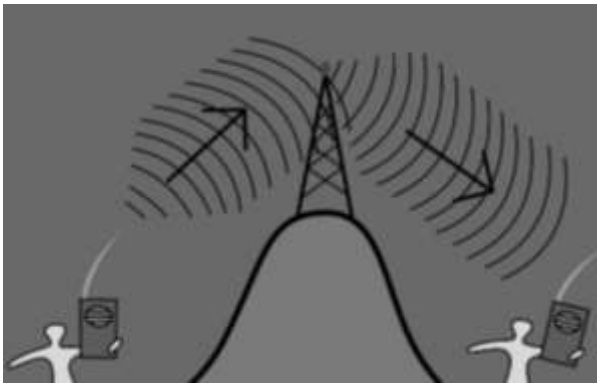
A repeater is a powerful network hardware device that regenerates an incoming signal from the sender before retransmitting it to the receiver. It is also known as a signal booster, and it helps in extending the coverage area of networks. The Incoming data can be in optical, wireless or electrical signals.

When the incoming signals are attenuated, it copies them bit by bit and retransmits them at their original strength. It is used for longer-distance data transmission without compromising data security or quality. Repeaters are two-port devices.

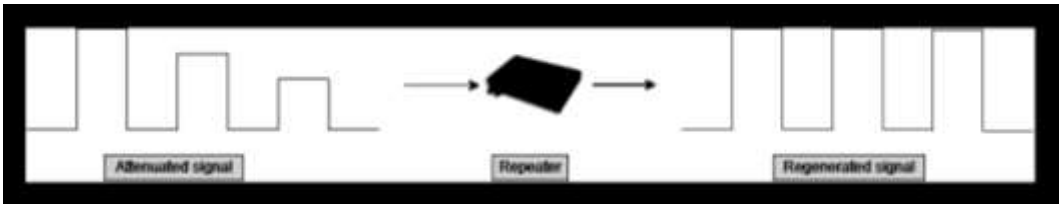
Let's understand about repeaters with an example:

Assume that one person communicates with the other using a one-to-one communication device such as a walkie talkie. If there is a clear path between the two points, the data can be transmitted successfully. If there is a hill or mountain in the way, the data cannot be delivered flawlessly.

As a result, an antenna is placed between the two devices to avoid this situation, as shown below.



This device sends the data back to the receiver and directs the signals to the weak spots. This is referred to as the repeater's primary function.



Features of a Repeater

- It strengthens the system signals by transmitting signals to the weaker locations.
- The Repeaters can continuously monitor the signals generated between the two LANs.
- Repeaters can help with networking flexibility.
- All of the Repeaters are linked together using an IP site connection network. Any problem in the repeater network can be quickly resolved by using that IP network.
- Repeaters do not necessitate any additional processing. The only time they need to be investigated is when performance suffers.
- Signals can be connected using various types of cables by using repeaters.

Types of the Repeaters

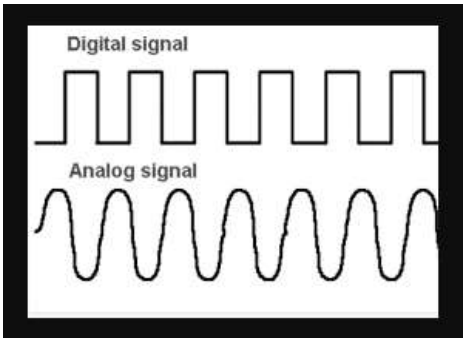
On basis of the types of signals generated

Digital repeaters:

Data is transmitted in the form of binary digits such as 0s and 1s. While transmitting data, 0 and 1 values are generated, and it can transmit data over long distances. This repeater is capable of retiming and resynchronizing.

Analog Repeaters:

Data is transmitted in the form of analog signals to increase the amplitude of the data. These repeaters are used in trunk lines to help broadcast multiple signals using frequency division multiplexing (FDM). It houses the linear amplifier as well as the filters.

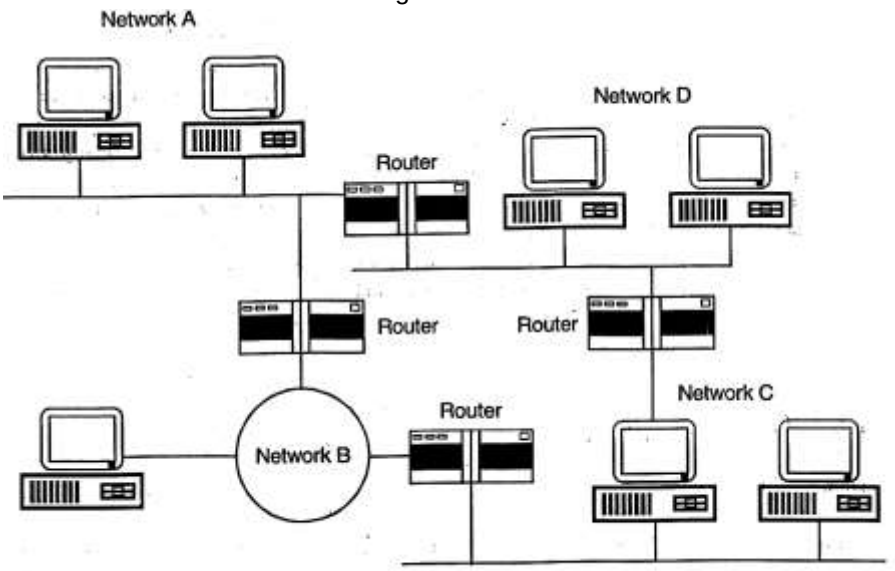


4) ROUTER

This is the inter network connectivity device used to inter-connect two or more independent networks. Router is, a combination of hardware and software. The hardware can be a network server, a separate computer or a special black box device. The software like algorithms are used to determine the best path by which to send a signal packet. It also include operating system.

Figure shows the role of repeaters in an inter network consisting of four networks. Routers use logical and physical addressing to connect two or more logically separate networks. Router are used:

a) to divide a big network into small networks called subnets.
b) to connect a small network to big network like LAN to WAN.



Role of Router

A router maintains a table of available routers and their status. Router use this information along with routing algorithm to determine the best route.

The routers can be static type or dynamic type. The static routers do not route path themselves while dynamic routers determine path themselves.

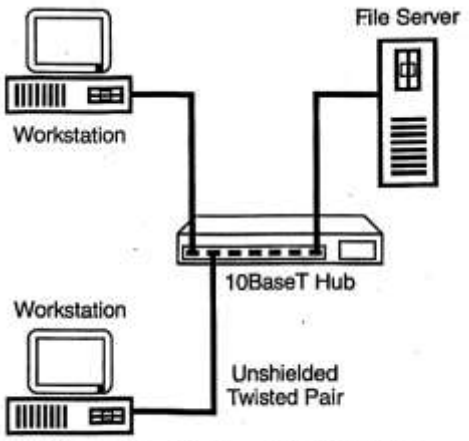
NETWORK ARCHITECTURES

When you work on networks you will come across several network architectures. These architectures are designed to solve specific problems and each has physical layout of connecting devices, cables, network cards and protocols. The two popular architectures are discussed here:

1) Ethernet

Ethernet is a most common physical network architecture in use today. Ethernet is a simple method of connecting many computers together in a LAN. It is a bus or star bus topology using baseband signaling. Ethernet use passive medium like twisted pair, co-axial cable. According to their data transmission speed and physical media type there are standard types of Ethernet such as:

- 10 BASE 5: Speed 10 Mbps(10) and thick co-axial known as thicknet. Maximum cable net 500 mtrs.(5).
- 10 BASE 2: Speed 10 Mbps(10) and thin co-axial cable known as thinnet. Maximum length 200 mtrs.(2)
- 10 BASE T: Speed 10 Mbps(10) and uses UTP twisted pair 100 mtrs.
- 10 BASE FL: Speed 10 Mbps(10) uses (FL)
- 100 BASE VG: Speed 100 Mbps(10) twisted pair.(VG-Voice Grade)



Ethernet Architecture 10BASE T HUB

Role of Ethernet

In case of Ethernet workstations send signals in the form of packets across the network. When a collision takes place it stops transmissions of workstations and allows to re-transmit after random internet of time. Ethernet uses CSMA/CD protocol it is Carrier Sense Multiple Access with Collision Detection Protocol.

2) Token ring

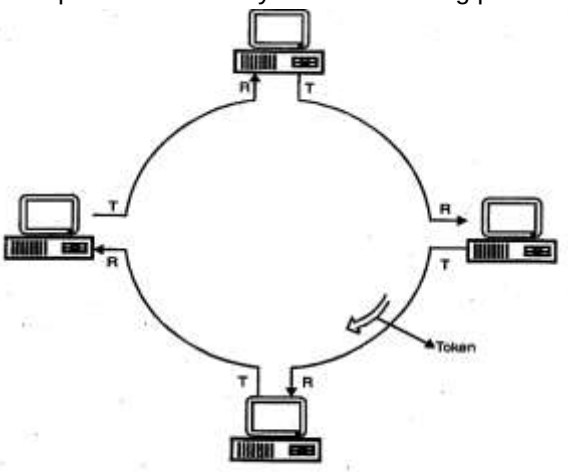
Token ring architecture was developed by IBM as a high reliable network. It is more complex than Ethernet. It uses physically star topology but logically ring topology. It uses physically UTP or STP cables and also can use fiber optic cable to extend a network. There are different types of token ring cabling as per IBM standards.

Type 1: Uses STP cables and used within the same building.

Type 2: It uses twisted pairs and allows to use it for both telephone voice signals and computer data. In the same physical area or room.

Type 3: Uses UTP or STP but for limited distance.

Type 5: It uses fiber optic cable but only on the main ring path.



Token ring Cabling

Role of token ring

In this architecture each workstation is attached to a controlled card and all workstations function logically in a ring. Each in the ring acts basically as a repeater. The ring passes a free token (a small frame with a special format) around the ring in one direction. A station in the ring receives the token from its nearest upstream neighbor, when a station receives a free token, it knows it can attach data and send it to nearest down stream neighbor in the ring. If the station has no data it will pass receive data. In token ring, each station is given an equal chance to have the token and take control in order to pass data.

PROTOCOLS

These are the set of rules or standard designs to enables computers to be connected to each other and transfer information through a network. When the network is too big for the communication, a well understood standard method of communication and physical inter connection should be established. When computers in different countries are to be connected together then their must be different standards of different nations. It becomes very complex communication. This problem can be solved by making common rules to inter connect and communicate between

computers are known as protocols, all the entities in the network must agree on these protocols.

In such a network data is transmitted in the form of packets on the network. The packet contains standard format. The format is decided by the type of protocols. The format of packet in a type of protocol specifies the following information such as:

Header	Data	Trailer

a) **Header: (Start of packet)**
   It specifies source and destination address.

b) **Message: (Data)**
   This part of packet contains actual data or information. The information coding also decided by protocol standard, e.g. data, nibbles or in bytes or in ASCII or EBCDIC and so on.

c) **Trailer:**
   In this part of packet, ending information is transmitted like error checking and correction information.
   When this packet is transmitted during the transmission, message may get damaged or loosed due to serious reasons, for this purpose this information is sent in the trailer part.

There are different international standard protocols at different levels.

a) TCP/IP (Transmission control Protocol and Internet Protocol), etc.
b) UDP (User Data Protocols)
c) ARP (Address Resolution Protocols)
d) ICMP (Internet Control Message Protocols)

Internet Protocol:

The Internet protocol was developed by United States Department Of Defense to interconnect educational institute and government installations. The protocol, which has become extremely popular, is known as TCP/IP (Transmission control Protocol and Internet Protocol). This Internet protocol do not belong any one company and the technology is available to everybody. Due to this Internet protocol is supported by the widest variety of vendors.

TCP/IP Protocols:

TCP/IP Internet protocol use three types of addresses for network addressing

1) Hardware or physical address, it is used by the data link and physical layers. It is hard coded into the network cards at each device.
2) Internet protocol address provides logical node identification. This address is unique address assigned by an administrator according to certain guidelines. It is expressed in four parts dotted • notation.
   e.g. 123- 144-131 • 12
3) Logical node names, which an administrator can assign, are easier to remember than an IP address, e.g. BARNEY.COM

IP Internet Protocol

IP works at the network level. It is a connection less data from protocol. IP uses packet switching and performs route selection by using dynamic routing tables that are referenced at each hop. This packet making up a message could be routed differently through the Internet work depending on the state of the network at each hop. e.g. If a link were to go down or become congested, packets could take a different route. Internet Protocol (IP) performs the following functions and uses the methods as follows:

1) For addressing, IP uses the logical network address.
2) For switching purpose, it uses the packet switching method.
3) For route selection, it uses the dynamic method.
4) For connection services IP provides error control.

ACCESS METHODS

As explained earlier when more than one node try to use transmission media it results in collision. To minimise or avoid collisions there are certain methods called access methods. There are three techniques as follows:

i) Contention ii) Polling iii) Token passing

i) Contention:

Contention means to struggle; nodes are struggling for accessing media. This is more useful in LANS. In contention-based network each node is observing media before transmitting. There are two methods known as carrier sensing and carrier detecting. In carrier sensing method, each node listens or sensing the media if media is busy it is waiting till it becomes free and then starts transmitting. On the other hand in carrier detecting method, nodes are continued to listen media and if another carrier is detected then it stops and waits for random amount of time. Applying these methods the number of collisions is reduced.

ii) Polling:

In polling based method the network traffic is controlled by a device called controller, which polls the node that is ready. It is continuously checking that which node is ready to transmit or receive and polls down to media.

iii) Token passing:

As explained in token ring architecture it is forming a ring and circulating token known as frame to each node. If node is ready at the moment when it has token it occupies media to transmit or receive. After finishing its work, it passes token to the next node in the ring.

Exercise

Select the correct alternative and rewrite the following.

1. _____cable type is ideal for connecting between two buildings.
(i) UTP (ii) STP (iii) Co-axial (iv) Fibre optic
1. (iv) Fibre optic

2. In _____topology connections are made from centre point of server or Hub.
(i) Bus (ii) STAR (iii) RING (iv) All of these
2. (ii) STAR

3. The process of modulation and demodulation is done by device namely _____.
(i) Hub (ii) Repeater (iii) Router (iv) Modem
3. (iv) Modem

4. If the network is to be extended beyond predefined cable limit _____is used.
(i) Modem (ii) Repeater (iii) Hub (iv) Router
4. (ii) Repeater

5. All the systems on a network must follow a set of common rules, called as _____
(i) Protocol (ii) Interface (iii) Convensions (iv) None of these
5. (i) Protocol

6. _____ cable has highest sensitivity to EMI.
(i) STP (ii) UTP (iii) Fibre optic (iv) Co-axial
6. (ii) UTP

7. BUS topologies are suited for networks that uses _____ access methods.
(i) contension based (ii) token passing
(iii) polling (iv) None of these
7. (i) Contension based

8. Token ring network was originally developed by _____
(i) AT & T Bell laboratories (ii) IBM
(iii) Polo Alu Research Centre (PARC) (iv) Xerox corporation
8. (ii) IBM

9. The transmission rate for fibre optic cable is typically_____
(i) 10 MBPS (ii) 25 MBPS (iii) 100 MBPS (iv) 500 MBPS
9. (iii) 100 MBPS

10. The conversion from digital to analog and vice-versa is done by_____.
(i) repeater (ii) Hub (iii) Modem (iv) Router
10. (iii) Modem

11. A device used for modulation and demodulation process in network is _____
(i) Hub (ii) Router (iii) Modem (iv) Repeater
11. (iii) Modem

12. _____cable type is ideal for connection of networks which are at a 10 km distance.
(i) UTP (ii) STP (iii) Co-axial (iv) Fibre optic
12. (iii) Co-axial .

13. The cellphone or mobile phone uses_____ transmission technology.
(i) Radio (ii) Microwave (iii) Infrared (iv) Satelite
13. (ii) Microwave

14. _____ does not regenerate the computer signal in networks.
(i) Passive Hub (ii) Active Hub (iii) Repeater (iv) All the three
14. (i) Passive Hub

15. ____ cable type support the greatest cable length for computer networking.
(i) UTP (ii) STP (iii) Co-axial (iv) Thicknet co-axial
15. (iv) Thicknet co-axial

16. The transmission rate of is typical for fibre optic cables.
(i) 10 Mbps (ii) 25 Mbps (iii) 100 Mbps (iv) 500 Mbps
16. (iii) 100 Mbps

17. A device used for modulation and demodulation process in network is _____
(i) Hub (ii) Router (iii) Modem (iv) Repeater
17. (iii) Modem

18. _____ cable type is ideal for connection of networks which are at a 10 km distance.
(i) UTP (ii) STP (iii) Co-axial (iv) Fiber optic
18. (iii) Co-axial

19. The transmission rate of _____ is typical for the fibre optic cable.
(i) 10 mbps (ii) 25 mbps (iii) 100 mbps (iv) 500 mbps
19. (iii) 100 mbps

20. The cellphone or mobile phone uses transmission technology.
(i) Radio (ii) Microwave (iii) Infrared (iv) Satellite
20. (ii) Microwave

21. ____does not regenerate the computer signal in networks.
(i) Passive Hub (ii) Active Hub (iii) Repeater (iv) All the three
21. (i) Passive Hub

22. _____ cable type support the greatest cable length for computer networking.
(i) UTP (ii) STP
(iii) Thicknet Co–axial (iv) Thinnet Co–axial
22. (iii) Thicknet Co-axial

23. Cable has highest bandwidth.
(i) UTP (ii) STP (iii) Co–axial (iv) Fiber Optic
23. (iv) Fiber Optic

24. The Transmission Rate of _____ is typical for fiber optic cables.
(i) 10 Mbps (ii) 25 Mbps (iii) 100 Mbps (iv) 5000 Mbps
24. (iii) 100 Mbps

25. Most widely used and economical cable for network installation is _____
(i) Fiber–Optic (ii) UTP (iii) STP (iv) Co-axial
25. (iv) Co–axial

26. If the network is to be executed beyond predefined cable limit, _____is used.
(i) Modem (ii) Repeater (iii) Hub (iv) Router
26. (ii) Repeater

27. Electromagnetic Interference is minimum in case of_____ cable.
(i) UTP (ii) STP (iii) Fiber Optic (iv) Co-axial
27. (iii) Fiber Optic

28. In TCP/IP is _____protocol.
(i) Connectionless (ii) Connection Oriented
(iii) Address Resolution (iv) Datagram
28. (i) Connectionless

29. _____Cable is most sensitive to EMI.
(i) STP (ii) UTP (iii) Co-axial (iv) Fiber Optic
29. (ii) UTP

30. _____is the type of cable, which does not carry electrical signals.
(i) UTP (ii) Co-axial (iii) STP (iv) Fiber Optic
30. (iv) Fiber Optic

31. Bus Topologies are best suited for networks that use _____Access Methods.
(i) Contention Based (ii) Token Passing
(iii) Polling (iv) None of these
31. (i) Contention Based

32. _____Cable uses light signals to transmit the data
(i) Co-axial (ii) Fiber Optic (iii) STP (iv) UTP
32. (ii) Fiber Optic

33. The Installation Cost of_____ cable is maximum.
(i) STP (ii) UTP (iii) FiberOptic (iv) Co-axial
33. (iii) Fiber Optic

34. A_____ is a set of rules governing the Share of Transmission Medium network.
(i) Frames (ii) Protocol (iii) Assess Method (iv) Topology
34. (ii) Protocol

35. _____cable type is ideal for connecting between two buildings.
(i) UTP (ii) STP (iii) Co-axial (iv)Flat
35. (iii) Co-axial

36. _____is a set of rules and formats for sending and receiving data in a network.
(i) Interface (ii) Frames (iii) Protocols (iv) Access Method
36. (iii) Protocols

37. _____cable has maximum EMI resistance.
(i) Thicknet (ii) Thinnet (iii) UTP (iv) Fiber optic
37. (iv) Fiber optic

38. _____cable is most costly among all.
(i) UTP (ii) STP (iii) Fiber Optic (iv) Co–axial
38. (iii) Fiber Optic

39. The device used is extend cable length of a network is
(i) MODEM (ii) REPEATER (iii) HUB (iv) ROUTER
39. (ii) REPEATER

40. In _____Topology, all devices are connected to a central hub.
(i) Ring (ii) Star (iii) Bus (iv) None of the above
40. (ii) Star

41. If length of cable is very long then_____ is used in between to bring the weakend signal to its original level.
(i) MODEM (ii) HUB (iii) REPEATER (iv) ROUTER
41. (iii) REPEATER

42. Thinnet cable can reliably transmit a signal upto _____meter without connectivity devices.
(i) 500 (ii) 185 (iii) 1000 (iv) 10,000
42. (ii) 185

43. _____cable uses light signals to transmit data.

(i) Fiber Optic (ii) Coaxial (iii) UTP (iv) STP

43. (i) Fiber Optic

44. _____of the following is an example of wireless media.

(i) Optic Fibre (ii) Microwave (iii) UTP (iv) STP

44. (ii) Microwave

45. The mobile phone uses_____ transmission technology.

(i) Radio (ii) Microwave (iii) Infrared (iv) Satellite

45. (ii) Microwave

46. _____cable is insensitive of EMI.

(i) Co-axial (ii) STP (iii) UTP (iv) FiberOptic

46. (iv) Fiber Optic

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