UNIT-I

CHAPTER-1

COMPUTER NETWORKING

What is Network ?

It is the interconnection of autonomous computers. The autonomous computer means that there is no master and slave relationship between each and every computer system. Master and slave relationship means, if one computer starts or stops the operation of other computer.
In the computer network each and every node is independent. There is no master and slave relationship between them.

Definition: A **computer network** is a collection of interconnected computers and other devices which are able to communicate with each other and share hardware and software resources.

Need of Network:

i) To share data
ii) To share information
iii) To make quick link
iv) To communicate in the form of mail messages and chatting
v) To gain knowledge

Advantages of Network:

i) Resource Sharing
ii) Cost saving
iii) Collaborative user interaction
iv) Time saving
v) Increased storage

Types of Network

On the basis of area covered computer networks are classified as:

i) PAN - Personal Area Network
ii) LAN - Local Area Network
iii) MAN - Metropolitan Area Network
iv) WAN -Wide Area Network

I. PAN (Personal Area Network):

- PAN stands for Personal Area Network whose distance generally ranges from 0 to 10 Meters.
- It spanned in a small area such as a table or a within a room.
- It can cover an area of a few meters radius.
- A PAN can be set up using guided media (USB cable) or unguided media (Bluetooth, Infrared).
- A PAN is a network of Communicating devices (Computer, Phone, MP3/MP4 Player, Camera etc.) in the proximity of an individual.

ii.LAN (Local Area Network)

- LAN stands for Local Area Network whose distance generally ranges from 0 to 10 K.Ms.
- It spanned in a small area such as a building or a group of buildings.
- Each node in the LAN has its own CPU.
- The common transmission speed of LAN is 1 to 100 Mbps.
- LAN has very low error rates and propagation delay.

iii. MAN (Metropolitan Area Network):

- MAN stands for Metropolitan Area Network whose distance generally ranges from 0 to 100 KMs.
- It covered a large area as compared to LANs i.e. these are designed for a City or Town.
- It is the combination of different LANs that may or may not similar.

iv. WAN (Wide Area Network):

- WAN stands for Wide Area Network whose distance generally ranges from 0 to 1000 KMs.
- It covered a large area as compared to LAN and MAN i.e. these are designed for a State or Country.
- It is the combination of different MANs that may or may not similar.
- The transmission speed of WAN measured in gigabits.

Difference among PAN, LAN, MAN& WAN

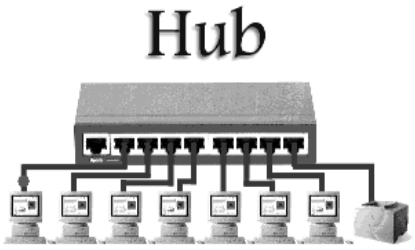
Network → / Parameter ↓	PAN	LAN	MAN	WAN
Stands For	Personal Area Network	Local Area Network	Metropolitan Area Network	Wide Area Network
Area Covered	Within a table or room	Within a building, campus or University etc	Within a Town or City	All over the world
Range	0-10M	0-10 KM	0-100 KM	No range
Error Rates	Lowest	Lowest	Moderate	Highest
Transmission Speed	High Speed	High Speed	Moderate Speed	Low Speed
Networking Cost	Negligible	Inexpensive	Moderately expensive equipment	Expensive

NETWORK DEVICES& THEIR FUNCTIONS:

The devices, which are meant to distribute and channelize the electric signals throughout the network is called Network devices.

(a)Hub:

- A hub is physical network device that connects multiple computers or WS each by a dedicated cable (wires).
- The hub is different types like Active Hub, Passive Hub, Cable Hub, Mail Hub, Managed Hub, Switched Hub and Intelligent Hub.
- Its main responsibility is to Send/Receive signal from Source to Destination which connected to different media types like PC, Printer, Scanner, Speaker etc.



Advantages:

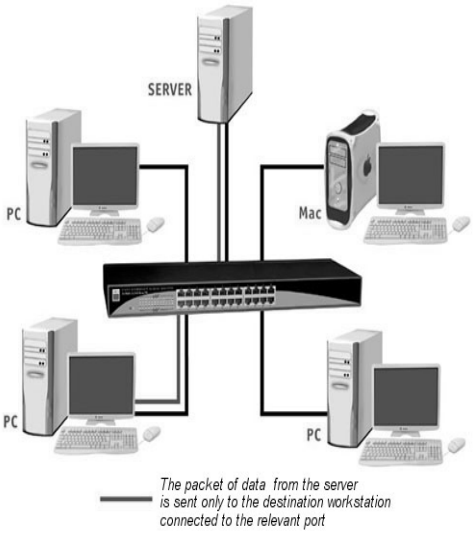
- It is Cheaper.
- It can connect different media type.

Disadvantages:

- It can't filter the information.
- It passes packets to all connected segments.

b) Switch:

- A switch is a physical network device that can connects multiple computer or WS each by a dedicated cable (wires).
- The switch provides 3 types of Switching techniques such as: Circuit switching, Packet switching and Message switching.
- Its main responsibilities are: 1. Get data packet, 2. Read destination address, 3. Determine port number, 4. Establish a temporary connection, 5. Send data packets, 6. Terminates the connection.
- It is an Intelligent than hub that maintains a bridging table and MAC address to keep tracks of which hardware address are located in which network segments.



Advantages:

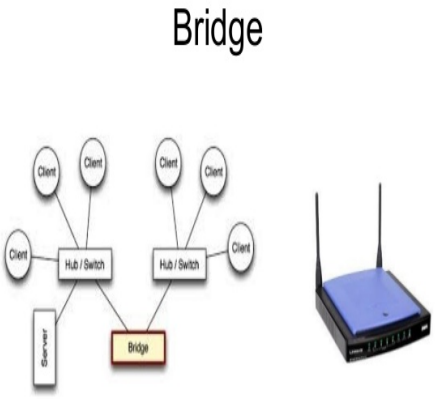
- It limits the collision domain.
- It provides more privacy when sending and receiving data.
- We can send data to a single or multiple device.

Disadvantages:

- It is more expensive than Hub and Bridge.
- Configuration of additional functions on switch becomes more complex.

c) Bridge:

- A bridge is a physical network device that is used to connect to similar networks (Ex: LAN to LAN) by using same protocols.
- It is used for large network so that it can breaks large network into smaller segments (networks) in order limit the number of collisions.
- It uses MAC address to make decisions for its destination path by building its Bridging table which keeps tracks of all its devices connected. So bridge is also known as decider.



Advantages:

- It limits the collision domain.
- It can extend network distances.
- It can connect different types of media or architecture.

Disadvantages:

- It is more expensive and slower than a Repeater.
- The broadcast packets cannot be filtered.

(d)Router:

- A router is a physical network/Internet device or software that is used to connect to similar or dissimilar networks.
- It is used for large network so that it can breaks large network into smaller segments (networks) in order limit the number of collisions.
- Its prime functions are:
  1. Decides Best Path to its destination device, and
  2. It shares Details of Routes to other routers.
- It can be of 2 types such as: 1. Static Router and
  2. Dynamic Router.

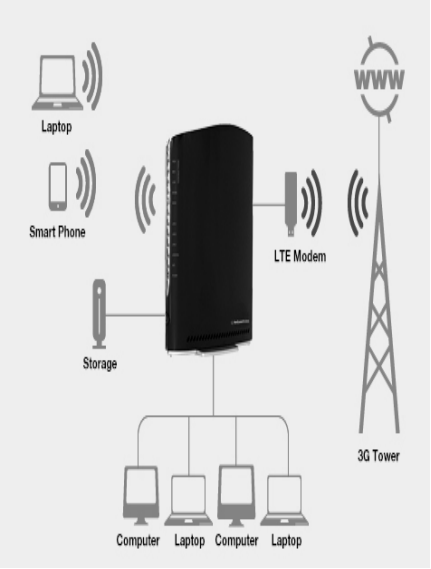
Advantages:

- It limits the collision domain.
- It can work on any environment i.e. LAN, MAN and WAN.
- It can determine the best route with filtering each packet.
- It can connect different types of media or architecture.

Disadvantages:

- It is more expensive and slower than a Bridge
- Due to use of Routable Protocol it can be difficult to configure Static Routing.

(e) Gateway:



- A gateway is an Entrance point (Network point) to another network i.e. it is a node (stopping/host/end point) on the Internet.
- It can connect two or more dissimilar networks by using same or different protocols i.e. it can works for any environment (LAN, MAN or WAN).So Gateway is also known as protocol converter.
- It uses Address Gateway, Protocol Gateway, Application Gateway

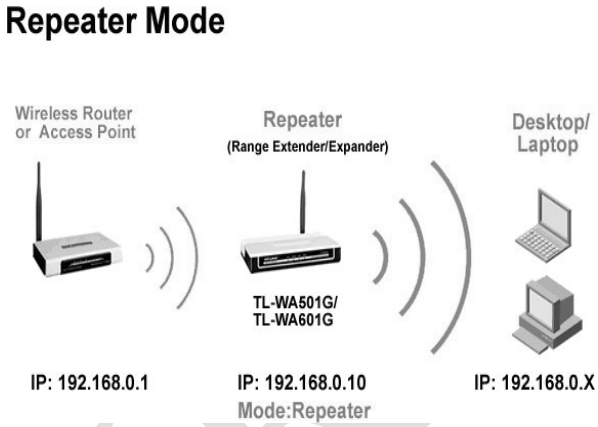
Advantages:

- It can connect backbone network to form a large regional network.
- It doesn't increase network traffic.
- It can connect different type of media.

Disadvantages:

- It cannot filter outgoing and incoming data.

(f)Repeater:



- It is a physical network device that connects two stretches of cable to increases the power of signals, reduce the noise and errors.
- It can extend the network beyond the maximum length to form a single segment. So Repeater is also known as regenerator.
- It has basic three functions such as: 1. Receives the signal, 2. Re-times the signal, 3. Transmits the signal.

Advantages:

- It can extend a network in terms of distance.
- It doesn't increase network traffic.
- It can connect different type of media.

Disadvantages:

- It extends the collision domain.
- It cannot filter data and cannot connect different network architecture.
- Limited number of repeaters can be used in the network.

(g)Network Interface Card (NIC) : -

- An **NIC** (Network Interface Card) is a device that enables a computer to connect toa network and communicate.
- A computer communicates with other computers on a network with the help of an NIC only.
- Now a days, in most of the PCs and the laptops, NIC is an integral part of the motherboard.

Difference between Hub and Switch : -

	HUB	SWITCH
Performance	Low	High
Intelligent Device	No	Yes
Data Packet	Does not read the data packet	Read the data packet
Data Sent	Data is sended through broadcast (one - many)	Data is sended through unicast (one –one)
Band width	Bandwidth is distributed among all the nodes connected to Hub	Bandwidth is no distributed
Port	Does not monitor the port	Monitor the port

Difference between Bridge and Gateway: -

BRIDGE	GATEWAY
(i)It is a device used to connect two similar networks (LAN to LAN) by using same protocols.	(i) It is a device used to connect two or more dissimilar networks (LAN, MAN or WAN) by using different protocols.
(ii)It is used for large network so that it can breaks large network to smaller segments (networks).	(ii) It is an Entrance point (Network point) to another network.
(iii) Bridge is a decider.	(iii) Gateway is also known as protocol converter.
(iv) It works on Physical and Data link layer of OSI model.	(iv) It works on all the layers of OSI model.

Difference between Router and Repeater: -

ROUTER	REPEATER
(i) It is a device which connects two networks which are logically same but physically separate.	(i) A repeater is a device used to amplify the signal being transmitted on a network.It is used in long network lines.
(ii) It is used for large network so that it can breaks large network into smaller segments.	(ii) It can extend the network beyond the maximum length to form a single segment.
(iii) It limits the collision domain.	(iii) It extends the collision domain.
(iv) It works on Network layer of OSI model.	(iv) It works on physical layer of OSI model.

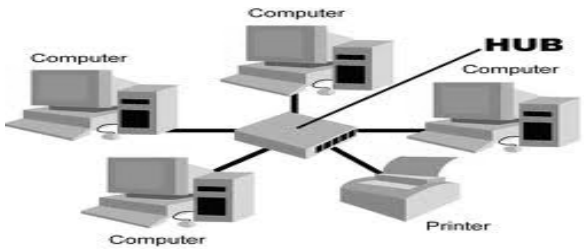
Network Topologies: -

The term topology means the way a network is laid out, either physically or logically.

Briefly, topology defines the physical or logical arrangement of links in a network.

Types of Network Topologies : -

(i) Star Topology : -In star topology each node is directly connected to a hub/switch. If any node has to send some information to any other node; it sends the signal to the hub/switch. This signal is then broadcast (in case of a hub) to all the nodes but is accepted by the intended node(s). In the case of a switch the signal is sent only to the intended node(s).



Advantages

i) Easy to install and wire.

ii) No disruptions to the network when connecting or removing devices.

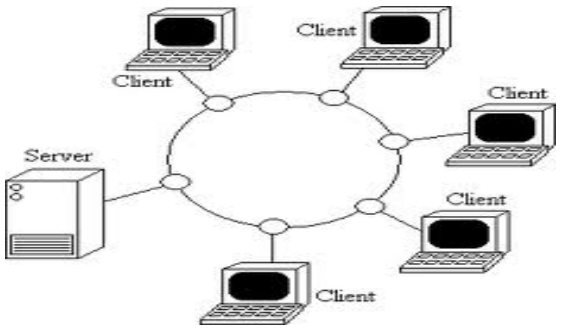
iii) Easy to detect faults and to remove parts.

Disadvantages:

i) It does not allow direct data transfer between the devices.

ii) If the central controller is out of order then the whole network is of out of order.

(ii) Ring Topology: -All computers are linked so as to form a ring. There is no main computer in the network. A node can receive data from one of its adjacent nodes.



Advantages:

i) A ring topology is easy to install and reconfigure.

ii) In ring topology, each node is connected to its neighbor node with short cable. No extra closet space for wiring is required in the building.

iii) Fault isolation is simple.

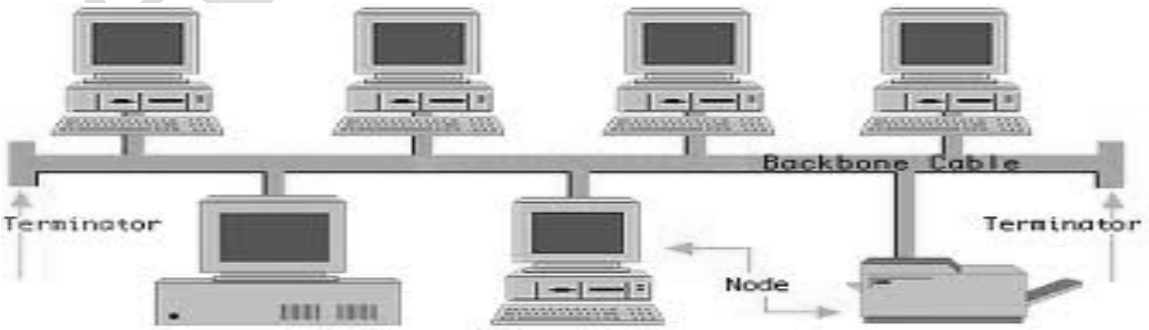
Disadvantages: -

i) Data flow in ring topology is unidirectional.

ii) A break in the ring can disable the entire network.

iii) Fault diagnosis is difficult.

(iii) Bus Topology: - In bus topology all the nodes are connected to a main cable called backbone. If any node has to send some information to any other node, it sends the signal to the backbone. The signal travels through the entire length of the backbone and is received by the node for which it is intended. A small device called terminator is attached at each end of the backbone. When the signal reaches the end of backbone, it is absorbed by the terminator and the backbone gets free to carry another signal.



Advantages: -

i) Easy to connect a computer or peripheral to a linear bus.

ii) Requires less cable length than a star topology.

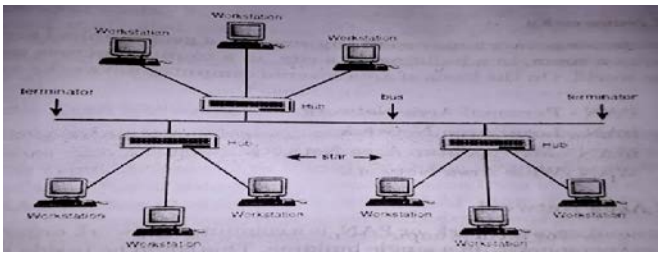
Disadvantages:-

i) Entire network shuts down if there is a break in the main cable.

ii) It is very difficult for reconfiguration and fault isolation.

iii) Adding new devices may require modification or replacement of the backbone.

(iv) Tree Topology: -Tree topology is a combination of bus and star topologies. It is used to combine multiple star topology networks. All the stars are connected together like a bus. This bus-star hybrid approach supports future expandability of the network.



Advantages: -

i) Point-to-point wiring for individual segments.

ii) Supported by several hardware and software venders.

Disadvantages: -

i) Overall length of each segment is limited by the type of cabling used.

ii) If the backbone line breaks, the entire segment goes down.

iii) More difficult to configure and wire than other topologies.

Data Transmission Modes:

Method of data transmission means the direction of data flow between two linked devices. The manner or way in which data is transmitted from one place to another is called data transmission mode.

There are three ways for transmitting data from one location to another.

These are:

a) Simplex mode

b) Half-duplex mode

c) Full-duplex mode

(a) Simplex Mode:

i) In simplex method, the communication can take place in only one direction.

ii) A terminal can only send data and cannot receive it or it can only receive data but cannot send it.

iii) It means that in this method communication is one directional.

iv) Examples of simplex communication method are Radio and T.V. transmissions.

SIMPLEX TRANSMISSION MODE

v) In computer system the keyboard, monitor and printer are examples of simplex devices.

vi) The keyboard can only be used to enter data into computer, while monitor and printer can only accept output.

(b) Half-Duplex Mode:

i) In Half-duplex method, the communication can take place in both directions, but only in one direction in a given time.

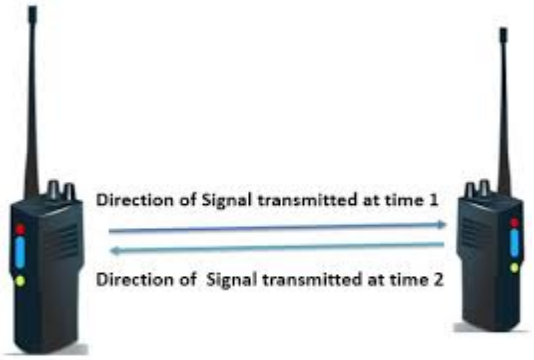
ii) Data is sent and received alternatively.

iii) In half-duplex method, at a time only one end transmits data while other end receives.

iv) Ex : Walkie-Talkie.

v) The Internet browsing is an example of half duplex.

vi) When we issue a request to download a web document, then that document is downloaded and displayed before we issue another.

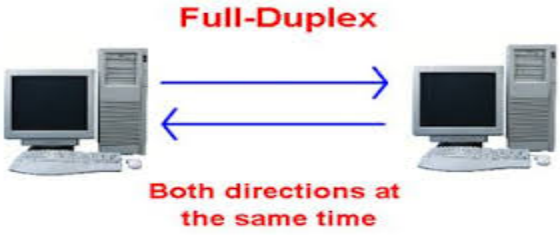


(c) Full-Duplex Mode:

i) In full-duplex method, the communication can take place in both directions at the same time.

ii) It is the fastest directional mode of communication.

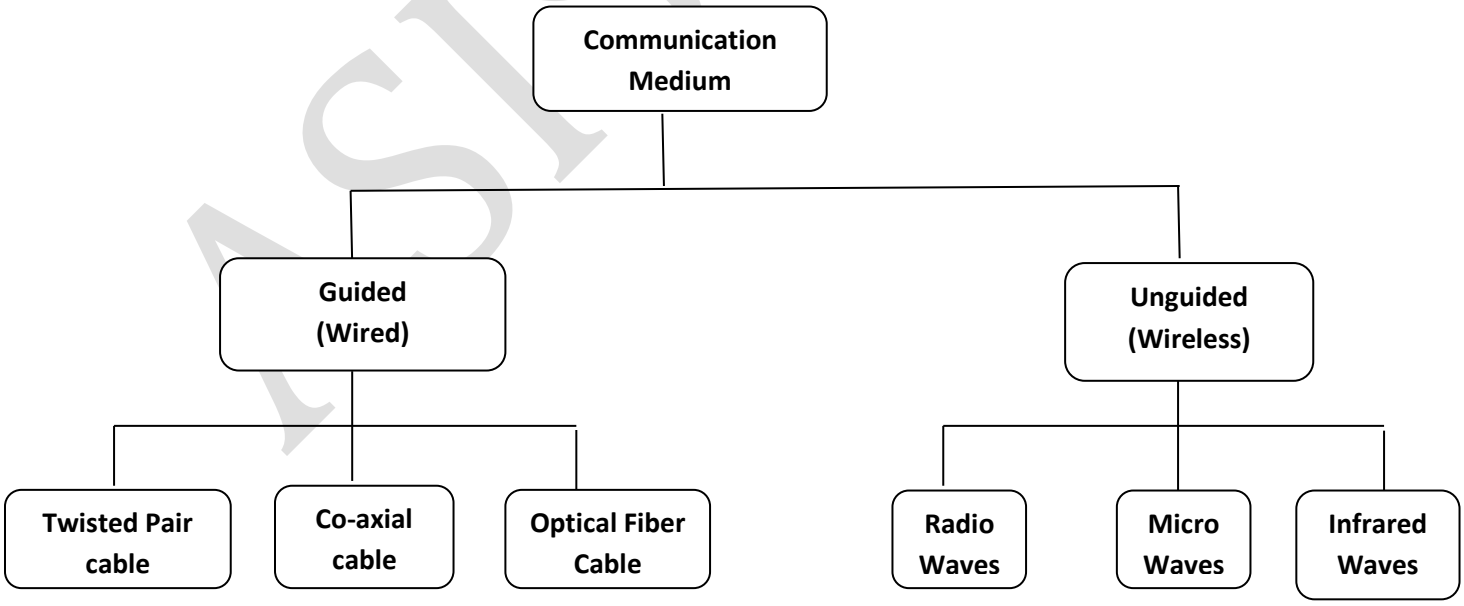
iii) Example of this mode is conversation of the persons through telephone.



Communication/Transmission Media: -

A medium of data transmission over a computer network is called a channel or a transmission medium.

A transmission medium is a medium of data transfer over a network. It can be wired or wireless.



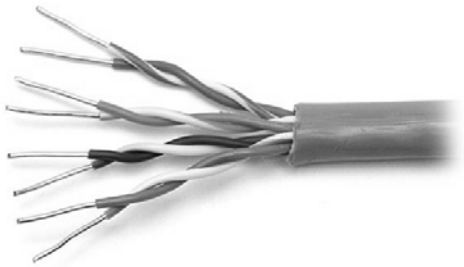
Wired Media: -A number of various types of cables are used to transfer data over computer networks. These are Twisted Pair Cable, Co-axial Cable, and Optical Fiber Cable. Let us know about these in some details.

i) **Twisted pair cable (Ethernet Cable): -** This is probably the most widely used cable for creating small computer networks. It contains four twisted pairs covered in an outer shield. These pairs are colour coded. An RJ-45 connecter is used to connect this cable to a computer.

It is of two types:

UTP (Unshielded Twisted Pair): As the name suggests in UTP cables individual pairs are not shielded.

Characteristics of UTP cable:



i) It is a low-cost cable available for setting up small networks.

ii) It is a thin (External diameter app. 0.43cm) and flexible cable and therefore it offers ease of installation.

iii) It can carry data up to a length of 100m at a stretch.

STP (Shielded Twisted pair):

It is the same cable as the UTP, but with each pair shielded individually. An outer shield then covers all the pairs like in UTP. STP data connectors are used to connect STP cable to the computer. RJ-45 connectors can also be used to connect this cable to a computer.

Characteristics of STP cable:

i) As compared to UTP, STP offers better immunity against internal and external Electro Magnetic Interferences (EMI).

ii) It is expensive than UTP cable.

iii) As compared to UTP cable, STP cable is difficult to install.

Advantages:

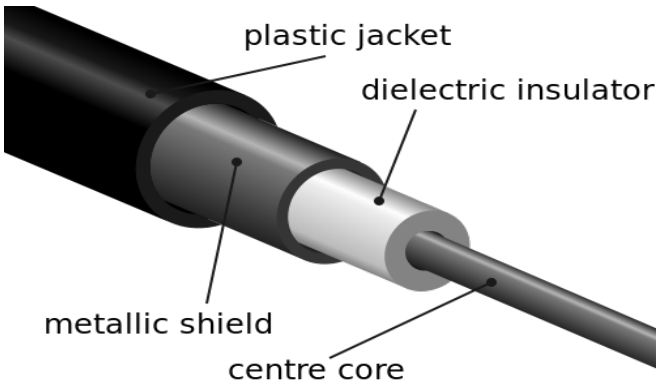
i. It is simple
ii. It is physically flexible.
iii. Easily connected
iv. Easy to install and maintain
v. It is a low weight
vi. Less cost.

Disadvantage:

i. Bandwidth is low.
ii. Provide less protection from interference.

(b) Co-axial cable: -A coaxial cable consists of two conductors that share a common axis. The inner conductor is a straight wire and the outer conductor is a shield that might be braided or a foil.

Characteristics of Co-axial cable:



i) It can carry data for a larger distance (185m - 500m) at a stretch.

ii) Less susceptible to electromagnetic fields.

iii) Bulkier and less flexible than twisted pair.

iv) Due to its thickness (1cm diameter) and less flexibility, it is difficult to install as compared to twisted pair cable.

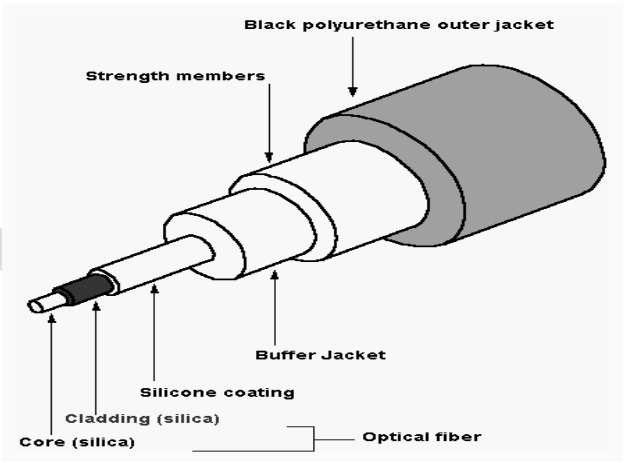
Advantages:

i. The data transfer ratio in better than twisted pair.
ii. It often higher band width up to 400 MBPS.
iii. Used for broad band connection.
iv. Used in cable network
v. Used for it is easy to wire. & expand.
vi. Lens susceptible to noise or interference.

Disadvantages:

i. It is bulky.
ii. It is expensive to install for longer distance.
iii. It must be grounded to prevent interference.
iv. It is easy to tap the co-axial cable.

(c) Optical Fiber cable:-



Optical Fibers are long, thin strands of glass about the thickness of a human hair. They are arranged in bundles called optical fiber cables and used to transmit data through light signals over long distances.

An optical fiber has following parts:

Core - It is the thin glass rod at the center through which the light travels.

Cladding - It is the outer optical material surrounding the core that reflects the light back into the core

Buffer coating - It is the plastic coating that protects the cable from damage and moisture.

These optical fibers are arranged in bundles of hundreds and thousands and are protected by the cable's outer covering, called jacket.

Characteristics of Optical Fiber Cable:

i) It can carry data for a very large distance at a stretch.
ii) Not susceptible to electromagnetic fields
iii) Especially skilled people are required to install optical fiber cables.
iv) Till date it is the most expensive and at the same time the most efficient cable available for computer networks.

Advantages: -

i. It is highly suitable for harsh industrial environment.
ii. It can carry data over a long distance.
iii. High bandwidth.
iv. An optical fiber offers low power loss.
v. It is not affected by any external electromagnetic wave.

Disadvantages:

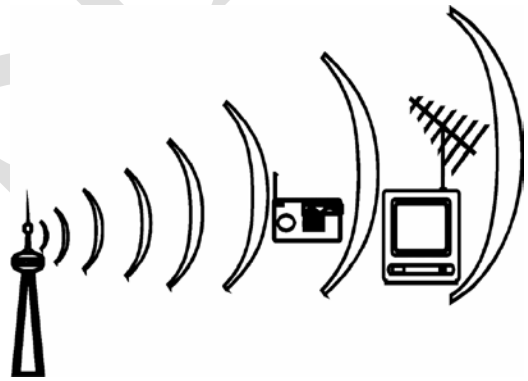
i. Installation problem.
ii. Difficult to solder.
iii. Expensive.
iv. Not Flexible

Comparison of wired media: -

Cable → / Parameter ↓	Twisted Pair Cable	Co-axial Cable	Optical Fiber Cable
Data Transfer Rate	10 Mbps-10Gbps	100 Mbps	More than 100 Gbps
Data Transfer Range	100 m	185 m -500 m	More than 10 K.M.
Interference (EMI) Susceptibility	More	Less than Ethernet cable	NIL
Cost of Cable	Least Cost	More than Ethernet	Very Expensive

Wireless Media: -These technologies do not make use of wires and cables instead they make use of waves and signals for transmission. These categories are radio waves, microwaves, infrared radiation, Bluetooth, satellite link.

(a) Radio Waves: -



i. Radio waves have a frequency range of 3 KHz to 3GHz.

ii. Radio waves are used for communication over distances ranging from a few meters (in walkie-talkies) up to covering an entire city.

iii. These waves are easy to generate, can travel long distances and can penetrate buildings easily.

iv. Cordless phones, AM (Amplitude Modulation) and FM (Frequency Modulation), PM(Phase Modulation),radio broadcast, Garage door openers etc. are examples of radio wave transmission.

Characteristics of Radio Wave Transmission:

i) These waves are Omni-directional, so the transmitting and receiving antennas need not be aligned.

(Recall when you throw a stone in a pond, circular waves are generated and spread outwards. Similarly, radio waves are generated by the transmitter and spread in all the directions.)

ii) Relatively inexpensive than wired media.

iii) It offers ease of communication over difficult terrain.

iv) Less secure mode of transmission.

(b) Micro Waves: -

i. Micro waves have a frequency range of 300MHz to 300 GHz.

ii. Microwaves travel in straight lines and cannot penetrate any solid object.

iii. Therefore, for long distance microwave communication, high towers are built and microwave antennas are put on their tops.

iv. These waves travel in straight lines and therefore the sending and receiving antennas have to be aligned with each other.

Characteristics of Micro Wave Transmission:

i) Free from land acquisition rights.
ii) Relatively inexpensive than wired media.
iii) Offers ease of communication over difficult terrain.
iv) The transmission is in straight lines so the transmitting and receiving antennas need to be properly aligned (line of sight transmission).

(c) Infrared Waves: -

i. Infrared waves have a frequency range of 300 GHz to 400 THz.
ii. These waves are used for short range communication (approx. 5m) in a variety of wireless communications, monitoring, and control applications.
iii. Home-entertainment remote-control devices, Cordless mouse, and Intrusion detectors are some of the devices that utilize infrared communication.

Characteristics of Infrared Wave Transmission:

i) It is a Line Of Sight (LOS) transmission; therefore information passed to one device is not leaked to another device.
ii) No government license is required for their use.
iii) It is a Line Of Sight (LOS) transmission, therefore at a time only two devices can communicate.
iv) The waves do not cross any solid object.
v) Performance drops with longer distances.

(d) Bluetooth: -

i. Bluetooth technology uses radio waves in the frequency range of 2.402 GHz to 2.480 GHz.
ii. This technology is used for short range communication (approx. 10m) in a variety of devices for wireless communication.
iii. Baby monitors, door openers, and cell phones are some of the devices that utilize Bluetooth communication.

Characteristics of Bluetooth Transmission:

i) Line Of Sight (LOS) between communicating devices is not required.
ii) Bluetooth can connect upto eight devices simultaneously.
iii) Slow data transfer rate (upto 1Mbps).

(e) Satellite link: -

i) Satellite links are used for very long-distance wireless communication which may range from intercity to intercontinental.
ii)Transmission from the earth to a satellite is known as **uplink**. Transmission from a satellite to the earth is known as **downlink**.
iii)There are multiple micro wave frequency bands which are used for satellites links.
iv)Frequency used for uplink varies from 1.6 GHz to 30.0 GHz and that for downlink varies from 1.5GHz to 20.0GHz. Downlink frequency is always lower than the uplink frequency.

Characteristics of Transmission using satellite link:

i) Satellites cover large area of earth.
ii) Since communication over very long distances is possible, this becomes a commercially attractive option.
iii) This system is expensive.
iv) Requires legal permissions.

Difference between Guided Media and Unguided media: -

Guided Media	Unguided Media
(i) Cables and wires are used under guided media	(i) Wave transmission is used in unguided media
(ii) Cover small distances	(ii) Cover large distances
(iii) Signal may destroy	(iii) Signal is of high quality
(iv) It is also known as Bound or Wired media	(iv) It is also known as Unbound or Wireless media.
(v) Example: Twisted pair cable, Coaxial Cable, Fiber Optic cable	(v)Example: Radio wave, Microwave, Infrared wave, Bluetooth, Satellite.

Points To Be Remember:

1) **Sender:** - A device or a computer that sends the data.
2) **Receiver:** - A device or a computer that receives the data.
3) **Message: -** Message is the information to be communicated. It may be text, images, audio or video.
4) **Server: -** A given database in a computer of large memory.
5) **Node:** Computers and other peripherals devices connected to a network.
6) **Broadcasting:** - The methods of sending data to all systems regardless of the intended recipient.
7) **Active Hub: -** Amplifies the signal when required and works as a repeater.
8) **Passive Hub:** - It simply passes the signal without any change.
9) **MODEM**: – A MODEM (Modulator–DEModulator) is a device that connect telephone line to computer.

   MODEM converts digital signal into analog (Modulation) and analog to digital (Demodulation). This conversion is required because telephone lines cannot carry digital data.

10) The Satellites are artificial and move around the Earth in different types of Orbits: -

    i. GEO (GEo-stationary Orbit)
    ii. MEO (Medium Earth Orbit)
    iii. LEO (Low Earth Orbit)