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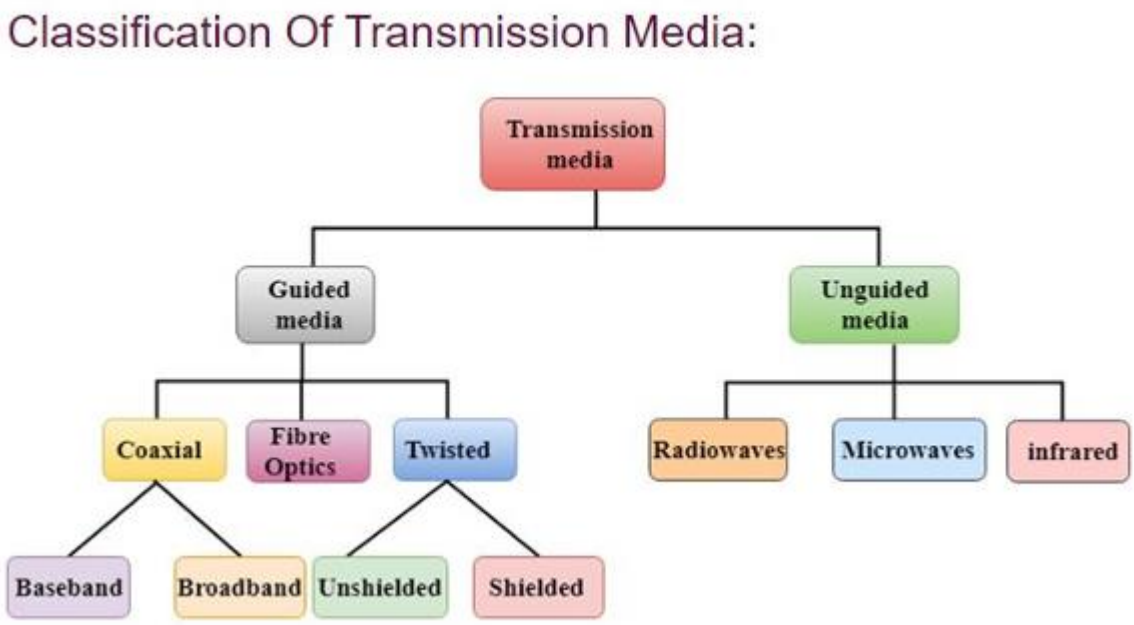
UNIT 1

1) Match the following functions to one or more layers of OSI model. i) Transmission of bit stream across physical medium. ii) Defines Frames. iii) Error correction and retransmission. iv) Reliable Process-to-process message delivery. v) Route selection. vi) Provides user services such as e-mail and file transfer.

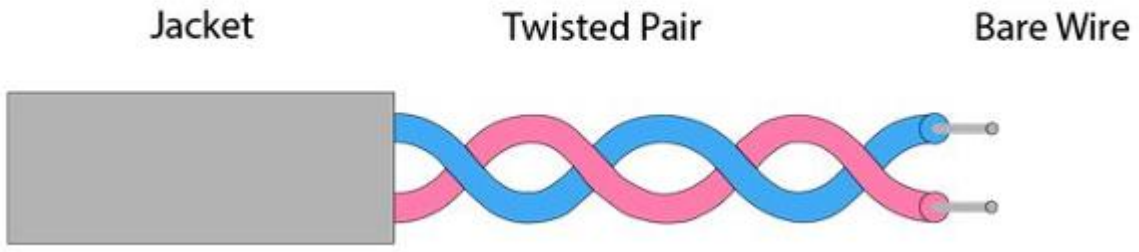
Function	OSI Layer(s)
i) Transmission of bit stream across physical medium	Physical Layer
ii) Defines Frames	Data Link Layer
iii) Error correction and retransmission	**Data Link Layer** & **Transport Layer** (Data Link handles frame-level errors; Transport handles end-to-end retransmission)
iv) Reliable Process-to-process message delivery	Transport Layer
v) Route selection	Network Layer
vi) Provides user services such as e-mail and file transfer	Application Layer

2) Which are the types of guided 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.



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.

Advantages Of Unshielded Twisted Pair:

It is cheap.

Installation of the unshielded twisted pair is easy.

It can be used for high-speed LAN.

Disadvantage:

This cable can only be used for shorter distances because of attenuation.

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

Industrial settings: Factories, plants, or facilities with heavy machinery, motors, and fluorescent lighting.

Hospitals: Where sensitive medical equipment may emit or be affected by EMI

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.

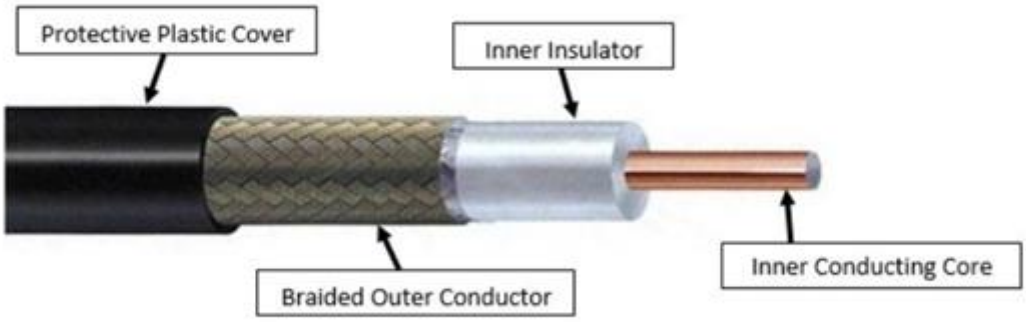
Disadvantages

It is more expensive as compared to UTP and coaxial cable.

It has a higher attenuation 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).

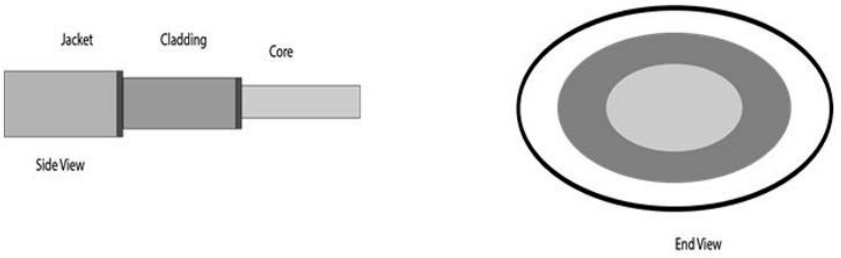


Coaxial cable is of two types

- **Baseband transmission:** It is defined as the process of transmitting a single signal at high speed.
- **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.

Fiber Optic

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



- **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 fiber. The more the area of the core, the more light will be transmitted into the fiber.
- **Cladding:** Reflective layer around the core; keeps light inside the core via **total internal reflection**
- **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.

- **Following are the advantages of fiber optic cable over copper:**
- **Greater Bandwidth:** The fibre optic cable provides more bandwidth as compared copper. Therefore, the fiber optic carries more data as compared to copper cable.
- **Faster speed:** Fiber optic cable carries the data in the form of light. This allows the fiber optic cable to carry the signals at a higher speed.
- **Longer distances:** The fiber optic cable carries the data at a longer distance as compared to copper cable.
- **Better reliability:** The fiber optic cable is more reliable than the copper cable as it is immune to any temperature changes while it can cause obstruct in the connectivity of copper cable.
- **Thinner and Sturdier:** Fiber optic cable is thinner and lighter in weight so it can withstand more pull pressure than copper cable.

3) What is the difference between port address, logical address & Physical address?

Point	Physical Address	Logical Address	Port Address
1. Definition	Hardware address used to identify a device on a local network segment.	Software-assigned address used to identify a device's location in a network for routing.	Identifies a specific process or service within a device.
2. OSI Layer	Data Link Layer	Network Layer	Transport Layer
3. Example	MAC Address – `00:1A:2B:3C:4D:5E`	IP Address – `192.168.1.5`	Port Number – HTTP `80`, FTP `21`
4. Scope	Unique within a local area network (LAN).	Unique across the whole internetwork (global or private).	Unique for each active process/service on a device.
5. Permanence	Usually fixed by the manufacturer (burned into NIC).	Can be changed by user or assigned dynamically (e.g., DHCP).	Assigned temporarily for active communication sessions.
6. Purpose	Enables delivery of frames within the same network segment.	Enables delivery of packets between different networks.	Enables delivery of data to the correct application/process.
7. Representation	Hexadecimal format.	Decimal (IPv4) or hexadecimal (IPv6) format.	Integer values (0–65535).

4) Explain various networking Devices - Bridge, switch, Router, gateway & Access point.

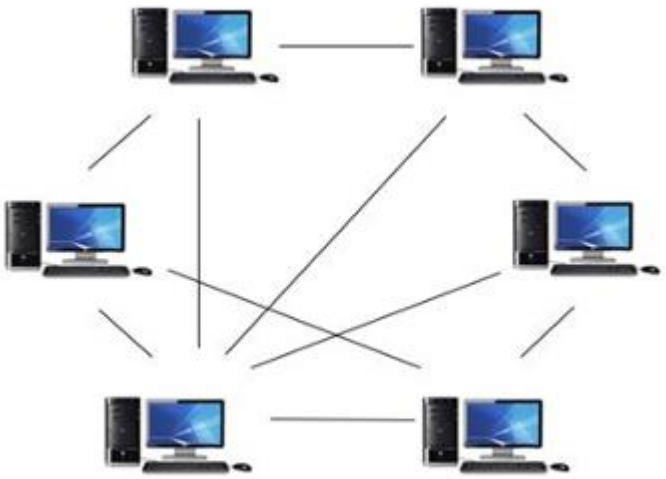
Difference Table

Device	OSI Layer	Primary Function	Address Used	Network Type	Key Feature
Bridge	Data Link (2)	Connects & filters between LAN segments	MAC Address	LAN	Reduces traffic by segmentation
Switch	Data Link (2)	Connects devices within a LAN	MAC Address	LAN	Dedicated path for each device
Router	Network (3)	Routes packets between networks	IP Address	LAN & WAN	Chooses best path for delivery
Gateway	All layers	Protocol conversion between different networks	Depends on protocol	LAN/WAN	Connects dissimilar networks
Access Point	Data Link (2)	Wireless to wired network connection	MAC Address	WLAN	Extends network wirelessly

5) Explain peer to peer and client/server network architecture with diagram

Peer-To-Peer network

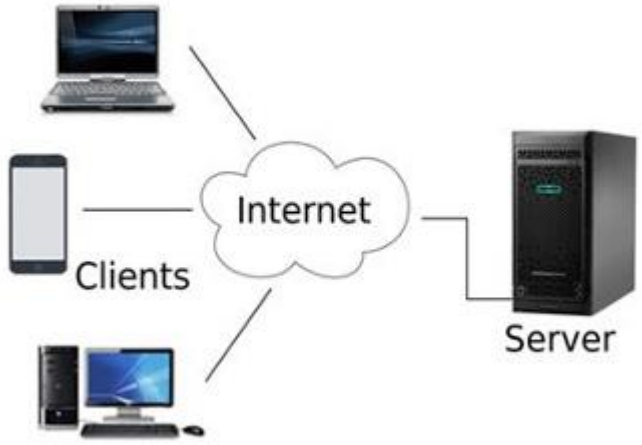
- Peer-To-Peer network is a network in which all the computers are linked together with equal privilege and responsibilities for processing the data.
- Peer-To-Peer network is useful for small environments, usually up to 10 computers.
- Peer-To-Peer network has no dedicated server.
- Special permissions are assigned to each computer for sharing the resources, but this can lead to a problem if the computer with the resource is down.



- Advantages Of Peer-To-Peer Network:
- It is less costly as it does not contain any dedicated server.
- If one computer stops working but, other computers will not stop working.
- It is easy to set up and maintain as each computer manages itself.
- Disadvantages Of Peer-To-Peer Network:
- In the case of Peer-To-Peer network, it does not contain the centralized system . Therefore, it cannot back up the data as the data is different in different locations.
- It has a security issue as the device is managed itself.

Client/Server Network

- Client/Server network is a network model designed for the end users called clients, to access the resources such as songs, video, etc. from a central computer known as Server.
- The central controller is known as a **server** while all other computers in the network are called **clients**.
- A server performs all the major operations such as security and network management.
- A server is responsible for managing all the resources such as files, directories, printer, etc.
- All the clients communicate with each other through a server. For example, if client1 wants to send some data to client 2, then it first sends the request to the server for the permission. The server sends the response to the client 1 to initiate its communication with the client 2.



Advantages Of Client/Server network

- A Client/Server network contains the centralized system. Therefore we can back up the data easily.
- A Client/Server network has a dedicated server that improves the overall performance of the whole system.
- Security is better in Client/Server network as a single server administers the shared resources.
- It also increases the speed of the sharing resources.
- Disadvantages Of Client/Server network:
- Client/Server network is expensive as it requires the server with large memory.
- A server has a Network Operating System(NOS) to provide the resources to the clients, but the cost of NOS is very high.
- It requires a dedicated network administrator to manage all the resources.

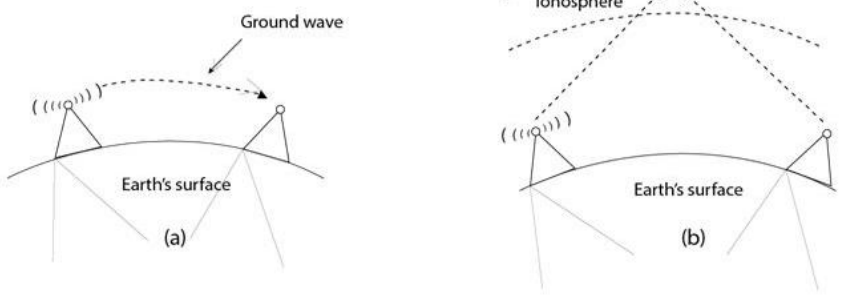
6) Which are the different types of transmission medium?

REFER Q.2 for guided medium

UnGuided Transmission

- An unguided transmission transmits the electromagnetic waves without using any physical medium. Therefore it is also known as **wireless transmission**.
- In unguided media, air is the media through which the electromagnetic energy can flow easily.
- Unguided transmission is broadly classified into three categories:
- Radio waves
- Radio waves are the electromagnetic waves that are transmitted in all the directions of free space.
- Radio waves are omnidirectional, i.e., the signals are propagated in all the directions.
- The range in frequencies of radio waves is from 3Khz to 1 khz.
- In the case of radio waves, the sending and receiving antenna are not aligned, i.e., the wave sent by the sending antenna can be received by any receiving antenna.
- An example of the radio wave is **FM radio**.

- **Applications Of Radio waves:**
- A Radio wave is useful for multicasting when there is one sender and many receivers.
- An FM radio, television, cordless phones are examples of a radio wave.
- **Advantages Of Radio transmission:**
- Radio transmission is mainly used for wide area networks and mobile cellular phones.
- Radio waves cover a large area, and they can penetrate the walls.
- Radio transmission provides a higher transmission rate.



Microwaves are of two types

Terrestrial microwave

Satellite microwave communication.

Terrestrial Microwave Transmission

- Terrestrial Microwave transmission is a technology that transmits the focused beam of a radio signal from one ground-based microwave transmission antenna to another.
- Microwaves are the electromagnetic waves having the frequency in the range from 1GHz to 1000 GHz.
- Microwaves are unidirectional as the sending and receiving antenna is to be aligned, i.e., the waves sent by the sending antenna are narrowly focussed.
- In this case, antennas are mounted on the towers to send a beam to another antenna which is km away.
- It works on the line of sight transmission, i.e., the antennas mounted on the towers are the direct sight of each other.

Characteristics of Microwave

- **Frequency range:** The frequency range of terrestrial microwave is from 4-6 GHz to 21-23 GHz.
- **Bandwidth:** It supports the bandwidth from 1 to 10 Mbps.
- **Short distance:** It is inexpensive for short distance.
- **Long distance:** It is expensive as it requires a higher tower for a longer distance.
- **Attenuation:** Attenuation means loss of signal. It is affected by environmental conditions and antenna size.

Satellite Microwave Communication

- A satellite is a physical object that revolves around the earth at a known height.
- Satellite communication is more reliable nowadays as it offers more flexibility than cable and fibre optic systems.
- We can communicate with any point on the globe by using satellite communication.
- **How Does Satellite work?**
- The satellite accepts the signal that is transmitted from the earth station, and it amplifies the signal. The amplified signal is retransmitted to another earth station.

Infrared

An infrared transmission is a wireless technology used for communication over short ranges.

The frequency of the infrared in the range from 300 GHz to 400 THz.

It is used for short-range communication such as data transfer between two cell phones, TV remote operation, data transfer between a computer and cell phone resides in the same closed area.

Characteristics Of Infrared:

It supports high bandwidth, and hence the data rate will be very high.

Infrared waves cannot penetrate the walls. Therefore, the infrared communication in one room cannot be interrupted by the nearby rooms.

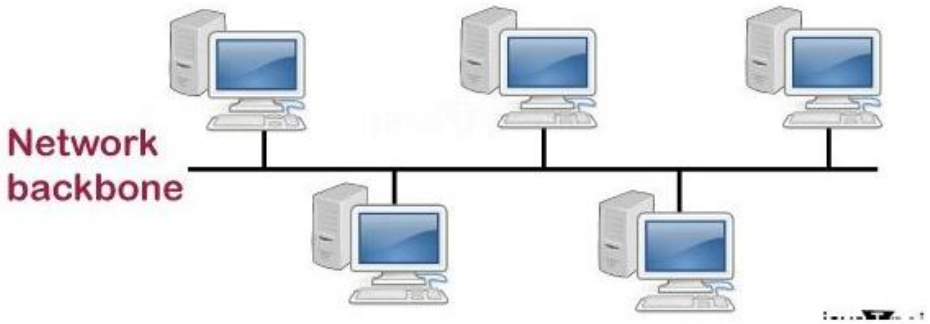
An infrared communication provides better security with minimum interference.

Infrared communication is unreliable outside the building because the sun rays will interfere with the infrared waves.

7) Explain the following topologies with diagram : i) Bus ii) Star iii) Ring iv) Mesh v) Tree

1. Bus Topology

- **Structure:** All devices share a single communication line (backbone cable).
- **Data Flow:** One device sends data to the bus, all others check the address; only the intended device accepts it.
- **Advantages:**
  - Easy to install.
  - Cost-effective for small networks.
- **Disadvantages:**
  - Failure of backbone stops entire network.
  - Limited cable length and number of nodes.



2. Star Topology

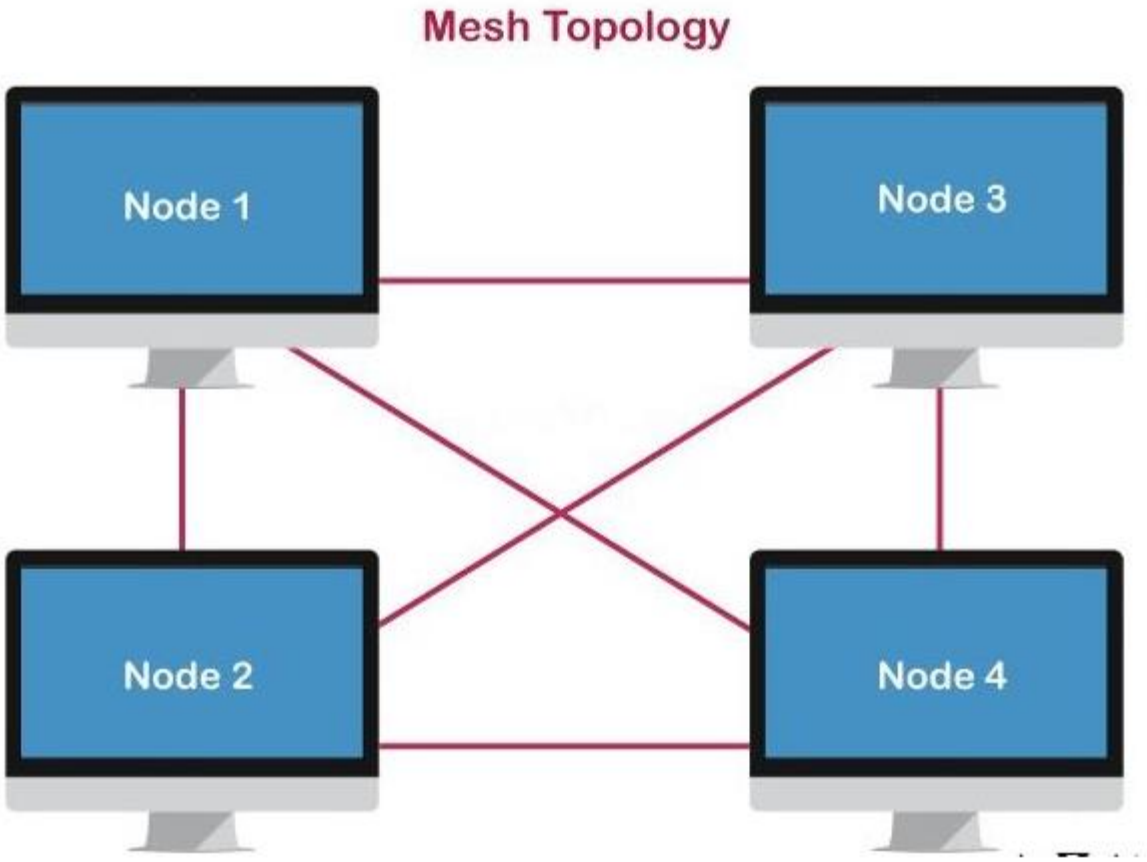
- **Structure:** All devices are connected to a central hub/switch.
- **Data Flow:** Device sends data to hub → hub forwards to the destination.
- **Advantages:**
  - Easy to manage and troubleshoot.
  - Failure of one node doesn't affect others.
- **Disadvantages:**
  - Failure of central hub stops the network.
  - Requires more cable length than bus.

3. Ring Topology

- **Structure:** Each device is connected to two other devices, forming a closed loop.
- **Data Flow:** Data travels in one direction (unidirectional) or both directions (bidirectional).
- **Advantages:**
  - Predictable performance under heavy load.
  - No collisions in unidirectional ring.
- **Disadvantages:**
  - Failure of one device can affect the whole network (unless dual ring).

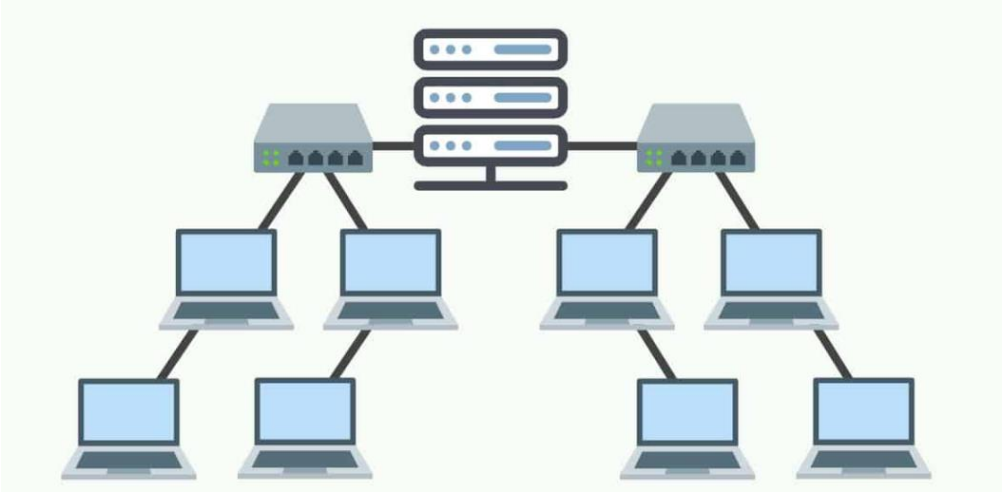
4. Mesh Topology

- **Structure:** Every device has a dedicated point-to-point link to every other device.
- **Data Flow:** Data can take multiple paths to reach the destination.
- **Advantages:**
  - Highly reliable and fault-tolerant.
  - Provides high privacy and security.
- **Disadvantages:**
  - Very expensive.
  - Complex installation and maintenance.



5. Tree Topology

- **Structure:** Hierarchical combination of star topologies.
- **Data Flow:** Central hub connects to secondary hubs which connect to nodes.
- **Advantages:**
  - Supports expansion better than bus or star.
  - Easy fault isolation.
- **Disadvantages:**
  - Failure of backbone link can isolate entire sections.



8) List and Explain following types of networks : i) LAN ii) MAN iii) PAN

1. LAN (Local Area Network)

- **Definition:** A network that connects computers within a limited geographical area such as a building, office, or campus.
- **Coverage:** Up to a few kilometers.
- **Data Transfer Speed:** High (typically 100 Mbps to 10 Gbps).
- **Ownership:** Privately owned.
- **Examples:** Office networks, school networks.
- **Advantages:**
  - High speed.
  - Low cost of setup.
  - Easy to maintain and control.

2. MAN (Metropolitan Area Network)

- **Definition:** A network that spans a city or a large campus, connecting multiple LANs.
- **Coverage:** Around 10 to 50 kilometers.
- **Data Transfer Speed:** Medium to high (often up to hundreds of Mbps).
- **Ownership:** Can be public or private.
- **Examples:** Cable TV networks, city-wide Wi-Fi.
- **Advantages:**
  - Covers larger area than LAN.
  - Supports data and voice transmission.

3. PAN (Personal Area Network)

- **Definition:** A network organized around an individual person within a range of a few meters.
- **Coverage:** Up to ~10 meters (can extend to 100m with Bluetooth Class 1).
- **Data Transfer Speed:** Low to medium (Bluetooth ~2 Mbps, USB much higher).
- **Ownership:** Personal/individual.
- **Examples:** Bluetooth connections between phone and headset, USB connections.
- **Advantages:**
  - Very convenient for personal devices.
  - Low cost and simple setup.

9) What is the difference between guided and unguided transmission media?

Difference between Guided and Unguided Transmission Media

Point	Guided Transmission Media	Unguided Transmission Media
Definition	Data signals are transmitted through a physical medium.	Data signals are transmitted through free space without physical medium.
Medium Used	Copper cables (twisted pair, coaxial) or optical fiber.	Air, vacuum, or water (wireless).
Direction & Path	Signals follow a specific, fixed path.	Signals propagate in all directions (depending on antenna design).
Speed & Bandwidth	Usually higher bandwidth and speed.	Bandwidth is generally lower compared to guided media.
Installation Cost	Higher due to cabling and physical setup.	Lower for short-range wireless; may be high for long-range infrastructure.
Interference	Less susceptible to electromagnetic interference.	More susceptible to interference and noise.
Examples	Twisted pair cable, coaxial cable, optical fiber.	Radio waves, microwaves, infrared, satellite links.

10) Enlist different network devices, Explain difference between Switch and Router.

Common Network Devices

1. **Hub** – Basic device that broadcasts incoming data to all connected devices.
2. **Switch** – Connects devices in a LAN and forwards data based on MAC addresses.
3. **Router** – Connects multiple networks and routes packets based on IP addresses.
4. **Bridge** – Connects and filters traffic between two LAN segments.
5. **Gateway** – Connects networks with different protocols and architectures.
6. **Access Point** – Provides wireless connectivity to a wired LAN.
7. **Modem** – Converts digital signals to analog (and vice versa) for transmission over telephone lines.

Difference between Switch and Router

Feature	Switch	Router
OSI Layer	Data Link Layer (Layer 2)	Network Layer (Layer 3)
Primary Function	Connects devices within the same network (LAN)	Connects different networks (LAN to WAN or LAN to LAN)
Address Used	MAC Address	IP Address
Data Forwarding	Forwards frames to the correct device in a LAN	Routes packets to the correct network and device
Network Type	Operates only within a single LAN	Operates across multiple LANs/WANs
Broadcast Domain	One broadcast domain (unless VLANs are configured)	Breaks broadcast domains
Example Use	Connecting computers, printers in an office LAN	Connecting home/office LAN to the internet

11) Compare OSI and TCP/IP Model? Justify how TCP/IP is better than OSI Model now a days.

Comparison between OSI and TCP/IP Models

Point	OSI Model	TCP/IP Model
Full Form	Open Systems Interconnection Model	Transmission Control Protocol / Internet Protocol Model
Layers	7 layers: Physical, Data Link, Network, Transport, Session, Presentation, Application	4 layers: Network Access, Internet, Transport, Application
Layer Functions	Each layer has a specific, well-defined function	Some layers combine functions (Session & Presentation merged into Application)
Development	Developed by ISO for standardizing network communication	Developed by DoD for practical internetworking
Protocol Dependency	Protocol-independent (theoretical reference model)	Protocol-specific (built around TCP/IP protocols)
Use	Used as a reference for learning and design	Used in actual internet communication
Approach	Top-down or bottom-up design possible	Follows practical implementation approach
Example Protocols	Not protocol-specific; examples include Ethernet, IP, TCP, HTTP	Has built-in protocols: IP, TCP, UDP, HTTP, FTP, etc.

Why TCP/IP is Better than OSI Nowadays

1. **Practical Implementation** – TCP/IP is the protocol stack actually used in the Internet, while OSI is mostly theoretical.
2. **Flexibility** – TCP/IP can easily integrate new protocols without redesigning the entire stack.
3. **Proven Performance** – TCP/IP has been tested, optimized, and widely adopted over decades.
4. **Simplicity** – Fewer layers make it simpler to implement and manage.
5. **Interoperability** – Works across all platforms, hardware, and operating systems.
6. **Global Acceptance** – Forms the backbone of modern networking and the Internet.

UNIT 2

12) Explain the following : i) Attenuation ii) Distortion iii) Noise

i) Attenuation

- **Definition**: Gradual loss of signal strength as it travels through a medium.
- **Cause**: Resistance of cables, dispersion, scattering, etc.
- **Example**: In a long Ethernet cable, the signal gets weaker the farther it travels from the source.
- **Effect**: Receiver may get a faint or unreadable signal.
- **Solution**: Use repeaters or amplifiers to boost the signal.

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ii) Distortion

- **Definition**: Change in the shape or form of the signal during transmission.
- **Cause**: Different frequency components of the signal travel at different speeds (delay distortion).
- **Example**: In a telephone line, the voice might sound unclear or muffled because some frequencies arrive earlier than others.
- **Effect**: Alters original data patterns, making interpretation difficult.
- **Solution**: Use equalizers or proper filtering.

iii) Noise

- **Definition**: Unwanted electrical signals that mix with the transmitted signal.
- **Types**:
  1. **Thermal Noise** – Caused by random motion of electrons in conductors.
  2. **Impulse Noise** – Caused by spikes from lightning, switching devices, etc.
  3. **Crosstalk** – Interference from adjacent cables.
  4. **Intermodulation Noise** – Caused when different signals mix to produce unwanted frequencies.
- **Example**: A hiss or static in a phone call.
- **Effect**: Can corrupt bits and cause transmission errors.
- **Solution**: Shielding, better cables, error detection, and correction methods.

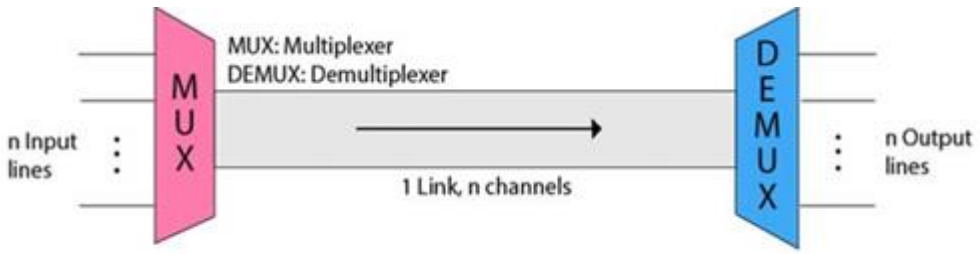
13) Explain multiplexing and its types?

What is Multiplexing?

- Multiplexing is a technique used to combine and send the multiple data streams over a single medium. The process of combining the data streams is known as multiplexing and hardware used for multiplexing is known as a multiplexer.
- Multiplexing is achieved by using a device called Multiplexer (**MUX**) that combines n input lines to generate a single output line. Multiplexing follows many-to-one, i.e., n input lines and one output line.
- Demultiplexing is achieved by using a device called Demultiplexer (**DEMUX**) available at the receiving end. DEMUX separates a signal into its component signals (one input and n outputs). Therefore, we can say that demultiplexing follows the one-to-many approach.

Why Multiplexing?

- The transmission medium is used to send the signal from sender to receiver. The medium can only have one signal at a time.
- If there are multiple signals to share one medium, then the medium must be divided in such a way that each signal is given some portion of the available bandwidth. For example: If there are 10 signals and bandwidth of medium is100 units, then the 10 unit is shared by each signal.
- When multiple signals share the common medium, there is a possibility of collision. Multiplexing concept is used to avoid such collision.
- Transmission services are very expensive.

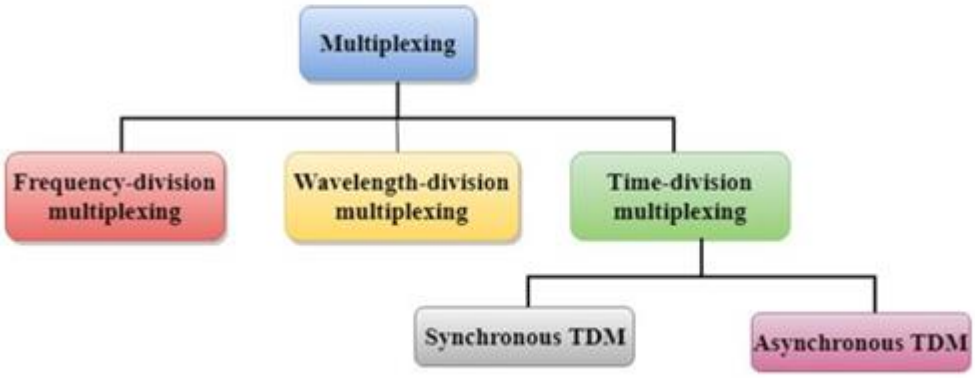


Advantages of Multiplexing:

More than one signal can be sent over a single medium.

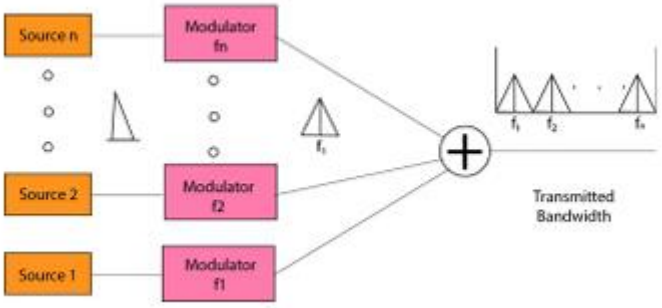
The bandwidth of a medium can be utilized effectively.

- Multiplexing techniques can be classified as:



Frequency-division Multiplexing (FDM)

- It is an analog technique.
- **Frequency Division Multiplexing** is a technique in which the available bandwidth of a single transmission medium is subdivided into several channels.
- In the above diagram, a single transmission medium is subdivided into several frequency channels, and each frequency channel is given to different devices. Device 1 has a frequency channel of range from 1 to 5.
- The input signals are translated into frequency bands by using modulation techniques, and they are combined by a multiplexer to form a composite signal.
- The main aim of the FDM is to subdivide the available bandwidth into different frequency channels and allocate them to different devices.
- Using the modulation technique, the input signals are transmitted into frequency bands and then combined to form a composite signal.
- The carriers which are used for modulating the signals are known as **sub-carriers**. They are represented as f1,f2..fn.
- **FDM** is mainly used in radio broadcasts and TV networks.



Advantages Of FDM:

FDM is used for analog signals.

FDM process is very simple and easy modulation.

A Large number of signals can be sent through an FDM simultaneously.

It does not require any synchronization between sender and receiver.

Disadvantages Of FDM:

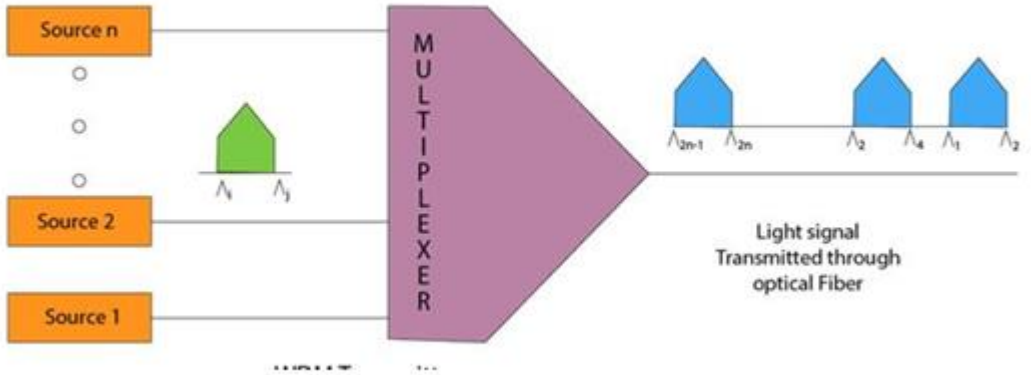
FDM technique is used only when low-speed channels are required.

It suffers the problem of crosstalk.

A Large number of modulators are required.

It requires a high bandwidth channel.

Wavelength Division Multiplexing (WDM)



Wavelength Division Multiplexing is same as FDM except that the optical signals are transmitted through the fibre optic cable.

WDM is used on fibre optics to increase the capacity of a single fibre.

It is used to utilize the high data rate capability of fibre optic cable.

It is an analog multiplexing technique.

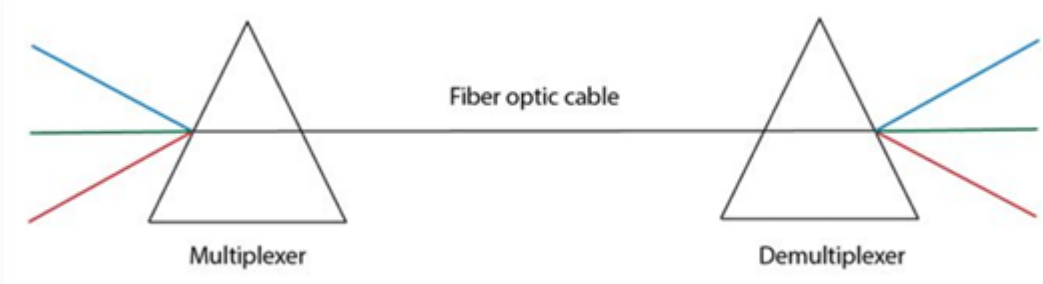
Optical signals from different source are combined to form a wider band of light with the help of multiplexer.

At the receiving end, demultiplexer separates the signals to transmit them to their respective destinations.

Multiplexing and Demultiplexing can be achieved by using a prism.

Prism can perform a role of multiplexer by combining the various optical signals to form a composite signal, and the composite signal is transmitted through a fibre optical cable.

Prism also performs a reverse operation, i.e., demultiplexing the signal.



Time Division Multiplexing

- It is a digital technique.
- In Frequency Division Multiplexing Technique, all signals operate at the same time with different frequency, but in case of Time Division Multiplexing technique, all signals operate at the same frequency with different time.
- In **Time Division Multiplexing technique**, the total time available in the channel is distributed among different users. Therefore, each user is allocated with different time interval known as a Time slot at which data is to be transmitted by the sender.
- A user takes control of the channel for a fixed amount of time.
- In Time Division Multiplexing technique, data is not transmitted simultaneously rather the data is transmitted one-by-one.
- In TDM, the signal is transmitted in the form of frames. Frames contain a cycle of time slots in which each frame contains one or more slots dedicated to each user.
- It can be used to multiplex both digital and analog signals but mainly used to multiplex digital signals.

There are two types of TDM:

Synchronous TDM

Asynchronous TDM

Synchronous TDM

A Synchronous TDM is a technique in which time slot is preassigned to every device.

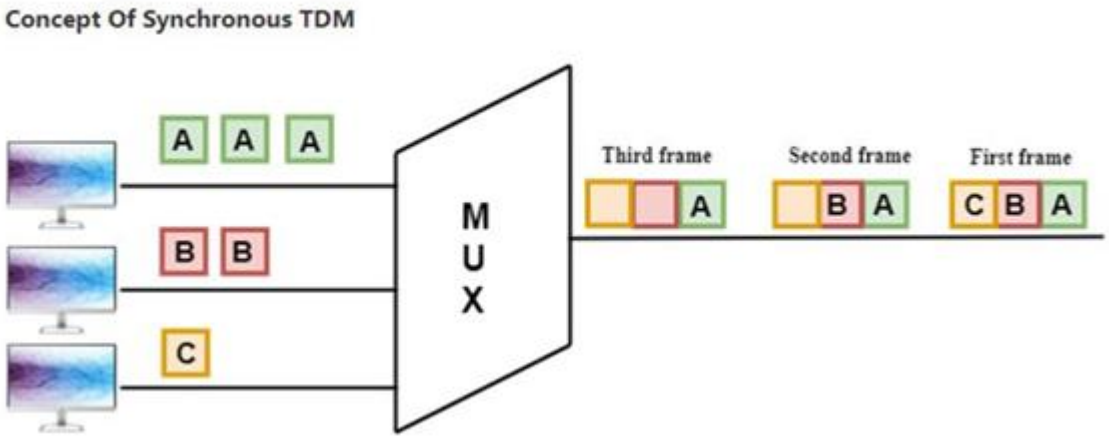
In Synchronous TDM, each device is given some time slot irrespective of the fact that the device contains the data or not.

If the device does not have any data, then the slot will remain empty.

In Synchronous TDM, signals are sent in the form of frames. Time slots are organized in the form of frames. If a device does not have data for a particular time slot, then the empty slot will be transmitted.

The most popular Synchronous TDM are T-1 multiplexing, ISDN multiplexing, and SONET multiplexing.

If there are n devices, then there are n slots.



Asynchronous TDM

An asynchronous TDM is also known as Statistical TDM.

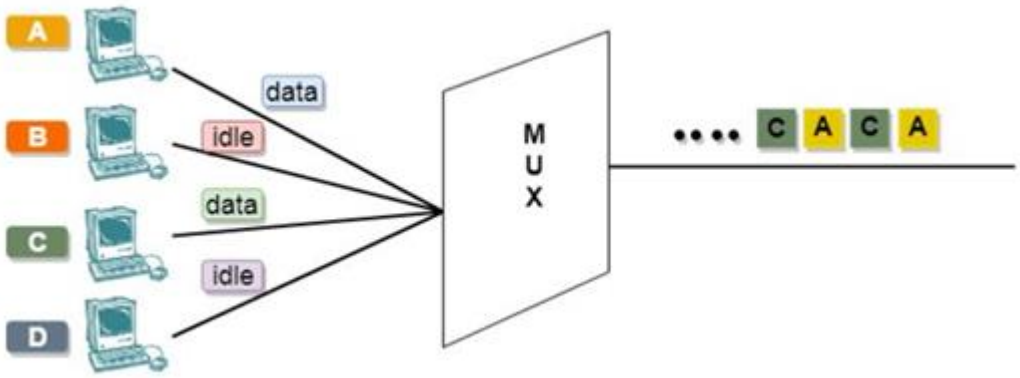
An asynchronous TDM is a technique in which time slots are not fixed as in the case of Synchronous TDM. Time slots are allocated to only those devices which have the data to send. Therefore, we can say that Asynchronous Time Division multiplexor transmits only the data from active workstations.

An asynchronous TDM technique dynamically allocates the time slots to the devices.

In Asynchronous TDM, total speed of the input lines can be greater than the capacity of the channel.

Asynchronous Time Division multiplexor accepts the incoming data streams and creates a frame that contains only data with no empty slots.

In Asynchronous TDM, each slot contains an address part that identifies the source of the data.



14) Compare Message Switching and Packet Switching

Aspect	Message Switching	Packet Switching
Basic Idea	Entire message is treated as a single unit and sent from source to destination.	Message is divided into smaller units called *packets*, sent individually.
Storage Requirement	Each intermediate node stores the **entire message** before forwarding (*Store-and-Forward*).	Each node stores only **one packet at a time** before forwarding.
Transmission Delay	Higher, because the next hop waits until the whole message is received before forwarding.	Lower, because packets are forwarded as soon as they arrive.
Bandwidth Utilization	Less efficient for long messages due to large storage needs at each node.	More efficient, as packets can take different routes and share bandwidth.
Error Handling	If error occurs, the **entire message** must be resent.	If error occurs, only the affected **packets** are resent.
Path	Single path is usually used for the whole message.	Different packets can take **different paths** to the destination.
Example Usage	Early telegraph networks, Telex.	Internet data transfer (TCP/IP).

15) Explain types of cable connection?

1. Straight-Through Connection

- **Definition**: A network cable where both ends follow the **same wiring standard** (either T568A → T568A or T568B → T568B).
- **Purpose**: Used to connect **different types** of networking devices.
- **Use Cases**:
  - Computer → Switch
  - Computer → Hub
  - Router → Switch
- **Wiring**: Pin 1 on one end connects to Pin 1 on the other, Pin 2 to Pin 2, and so on.
- **Diagram**:

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```
End A: (T568B)          End B: (T568B)
1 → 1  (Orange/White)   1 → 1
2 → 2  (Orange)         2 → 2
3 → 3  (Green/White)    3 → 3
4 → 4  (Blue)           4 → 4
5 → 5  (Blue/White)     5 → 5
6 → 6  (Green)          6 → 6
7 → 7  (Brown/White)    7 → 7
8 → 8  (Brown)          8 → 8
```

2. Cross-Over Connection

- **Definition**: A network cable where the transmit (TX) and receive (RX) wires are **swapped** at one end.
- **Purpose**: Used to connect **same types** of networking devices directly without a switch or hub.
- **Use Cases**:
  - Computer → Computer
  - Switch → Switch
  - Router → Router
- **Wiring**:
  - Pin 1 (TX+) ↔ Pin 3 (RX+)
  - Pin 2 (TX–) ↔ Pin 6 (RX–)
- **Diagram**:

mathematica

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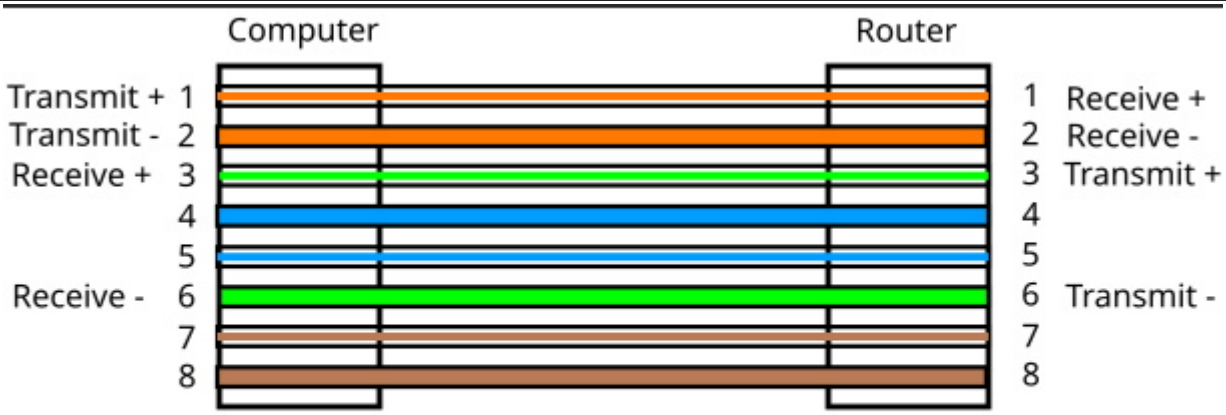
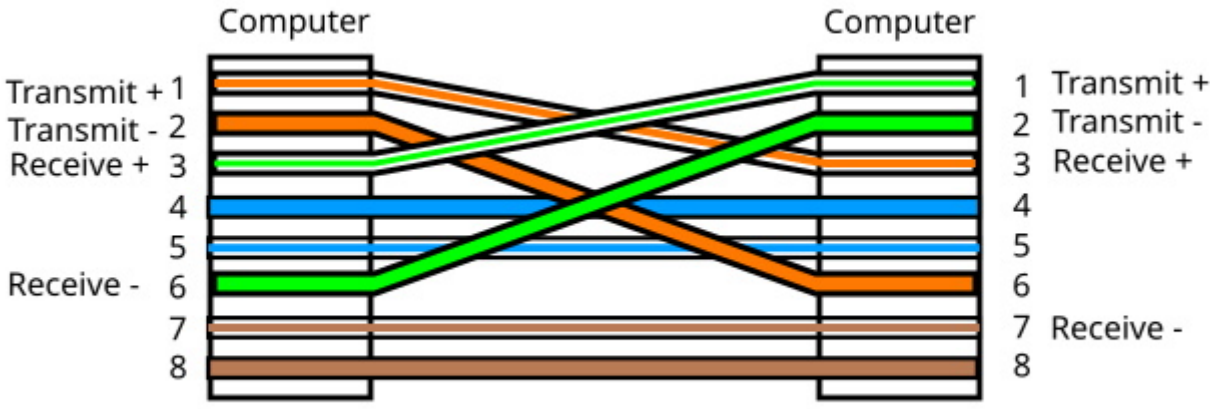
```
End A: (T568B)          End B: (T568A)
1 → 3  (Orange/White)   3 → 1
2 → 6  (Orange)         6 → 2
3 → 1  (Green/White)    1 → 3
4 → 4  (Blue)           4 → 4
5 → 5  (Blue/White)     5 → 5
6 → 2  (Green)          2 → 6
7 → 7  (Brown/White)    7 → 7
8 → 8  (Brown)          8 → 8
```

Key Difference Table

Feature	Straight-Through Cable	Cross-Over Cable
Wiring	Same standard at both ends (T568A-A / B-B)	Different standard at each end (A-B)
Use Case	Different devices	Same devices
Common Example	PC → Switch	PC → PC
TX/RX Wires	Not swapped	Swapped
Auto-MDIX Support	Not needed	Needed only if device doesn't auto-detect



Straight Through Cable



Crossover Cable

16) Explain in brief FHSS and DSSS

FHSS (Frequency Hopping Spread Spectrum)

- **Definition:** The signal is transmitted over a series of different frequencies, hopping from one to another in a sequence known to both transmitter and receiver.
- **How it works:**
  1. The available bandwidth is divided into many channels.
  2. The transmitter changes ("hops") its carrier frequency according to a predefined hopping pattern.
  3. The receiver follows the same pattern to reassemble the message.
- **Advantages:**
  - Resistant to interference.
  - Harder to intercept.
  - Works well in noisy environments.
- **Example use:** Bluetooth.

DSSS (Direct Sequence Spread Spectrum)

- **Definition:** Each bit of data is multiplied by a sequence of bits called a *chip code* (spreading code) before transmission.
- **How it works:**
  1. The original data signal is combined with a higher-rate *pseudo-random noise* code.
  2. This spreads the signal across a wider frequency band.
  3. The receiver uses the same code to extract the original data.
- **Advantages:**
  - Very robust against interference.
  - High security due to spreading code.
- **Example use:** GPS, Wi-Fi (802.11b).

17) Difference between Analog and Digital Signals

Feature	Analog Signal	Digital Signal
Definition	Continuous signal that varies smoothly over time.	Discrete signal represented by binary values (0s and 1s).
Nature	Smooth and continuous waveform.	Step-like waveform.
Values	Infinite possible values within a range.	Limited set of values (mostly two: HIGH = 1, LOW = 0).
Representation	Represented by sine waves.	Represented by square waves.
Examples	Sound waves, light intensity, temperature.	Computer data, digital audio, images.
Noise effect	More affected by noise, causing distortion.	Less affected by noise due to discrete nature.
Accuracy	Can be more precise in theory but degrades with noise.	Maintains quality over long distances but depends on sampling rate.

18) Explain Manchester Encoding Differential Manchester Encoding

a) Manchester Encoding

- **Definition:**
  A line coding scheme where each bit has a transition in the middle:
  - **0** → High to Low transition in the middle.
  - **1** → Low to High transition in the middle.
- **Purpose:** Provides **self-clocking** (no separate clock signal needed).
- **Advantage:** Synchronization is maintained; DC component is eliminated.
- **Example Waveform:** Each bit has a mid-bit transition regardless of value.

---

b) Differential Manchester Encoding

- **Definition:**
  A variation of Manchester encoding where:
  - Mid-bit transition always occurs (for synchronization).
  - **0** → Transition at the start of the bit.
  - **1** → No transition at the start of the bit.
- **Purpose:** Data is represented by presence/absence of transition at the **start** of bit period rather than by voltage level.
- **Advantage:** Less sensitive to polarity inversion.

✅ Key Difference Table:

Feature	Manchester Encoding	Differential Manchester Encoding
Mid-bit transition	Always present (indicates bit value)	Always present (for clock)
Bit value representation	By direction of mid-bit transition	By presence/absence of transition at start
Polarity sensitivity	Sensitive to polarity inversion	Not sensitive
Synchronization	Good	Good
Usage	Ethernet (IEEE 802.3)	Token Ring

19) Differentiate between Circuit Switching and Packet Switching.

Aspect	Circuit Switching	Packet Switching
Definition	A dedicated communication path is established between sender and receiver before data transfer.	Data is divided into packets, each sent independently over the network without a fixed path.
Connection Type	Connection-oriented.	Connectionless (can be connection-oriented in some protocols like TCP).
Path	Same path is used for the entire communication session.	Different packets can take different paths to reach the destination.
Resource Utilization	Resources remain reserved for the entire session, even if no data is being sent.	Network resources are used only when packets are transmitted.
Delay	Low delay once the circuit is established.	Can have variable delay (latency) due to different paths and network congestion.
Efficiency	Less efficient due to idle time during the session.	More efficient because bandwidth is shared among multiple users.
Example	Traditional telephone networks.	Internet data transfer (IP networks, emails, web browsing).

All the Best!!

- Karan Salunkhe