

# Unit-2 : Physical Layers Networking Media.

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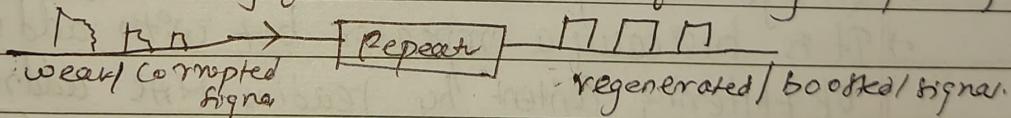
## 7. Network devices.

- Hardware devices that are used to connect computers, printers, fax machines and other electronic devices to a network are called network dev.
- These devices transfer data in a fast, secure and correct way over the same or different networks
- Network devices may be inter-network or intra-netwo.

Some key network device.

### 8) Repeater

- It operates in the physical layer (i.e. hardware)
- Its main job is to regenerate or extend the signal over the same network before the signal becomes too weak or corrupted.
- They do not amplify the signals. So they are not amplifiers.
- When the signal becomes weak, they copy the signal bit by bit & regenerate it at the original strength.
- It is a two port device. & also known as signal boosters.
- It forwards every frame; it has no filtering capacity.



### 9) Hubs

- A hub is used as a central point of connection among multiple ~~not~~ devices in a network.
- Cables from network devices plug into the ports on the hub.
- Hubs cannot filter data, so data packets are sent to all connected devices.
- It ~~classifies~~ operates in physical layer & is a multipoint repeater

→ Two types of hub:

- i) Passive hub Is just a connector. It connects the wires coming from different branches. The signal pass through a passive hub without regeneration or amplification
- ii) Active hubs regenerate or amplify the signal before they are retransmitted.

### Q3) Switch

- Switch operates on data link layer
- It is a multiport device that takes in packets being sent by devices that are connected to its physical ports and sends them out again.
- It performs error checking before forwarding the data packets so that only good packets are forwarded selectively to correct port only.
- It works same as hub but works efficiently & provides better security.
- It has full duplex link & there is no collision of data.

### Q4) Bridge

- Bridge also operates on data link layer as well as physical
- It is basically a repeater but with add on functionality of filtering content by reading MAC address of source and destination. (ie regenerates & forward as well as read MAC address)
- It is also used for interconnecting two LANs working on the same protocol.
- It has single input & single output port thus making it a two port device.

Note: Bridge are used to connect two LANs  
but switch are used to connect any network devices

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c) Two types.

- i) Transparent bridge → Source & destination devices are unaware of bridge between them. It accepts all incoming frames to the bridge. If the frame is unknown, forward the frame to all LANs.
- ii) Source routing → Here, routing operation is performed by source station & frame specifies which route to follow. It is used in Token ring networks.

v) Routers.

- It operates on network layer
- It is a device like switch that routes data packets based on their IP addresses.
- It can be used both in LANs and WANs.
- It shares the available bandwidth with multiple computers in a network.
- Routers are responsible for receiving, analysing & forwarding data packets among connected computer networks. When a data packet arrives, the router inspects the destination address, consults its routing tables to decide the optimal route & then transfers the packet along the route.
- Widely used in home & offices.

vi)

Gateway

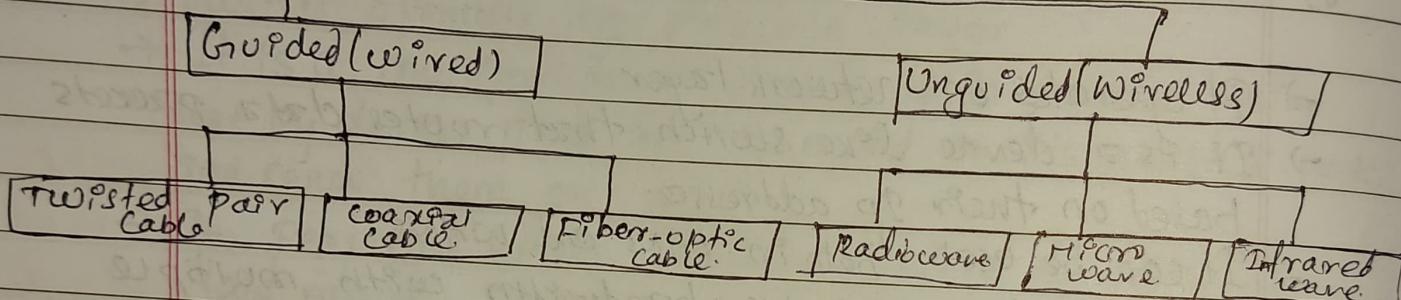
- It is a network point that acts as entry point to other network & translates one data format to another. DHCP service is one of the most common service of gateway. It automatically assigns IP address to a computer from a defined range of address for a ~~given~~ network.

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## \* Transmission media.

- Transmission media are the means by which a communication signal is carried from one system to another.
- It can be defined as a pathway that can transmit information from a sender to a receiver.

### Transmission media.



~~Types:~~

### Wired transmission media (GUIDED)

- Also referred as guided or bounded media.
- A signal travelling along wired media is directed and contained by the physical limits of the medium.
- It has features like high speed and secure, and used for comparatively shorter distances.
- Twisted-pair cable, coaxial cable & Fiber-optic cable are

Note: Bandwidth: Greater the bandwidth of a signal, higher the data rate can be achieved

Transmission impairment: Attenuation: Loss of signal strength in network cables or connections

**classmate** Interference: Overlapping of frequencies. PAGE     
 In guided, it occurs due to poor shielding  
 Unguided, due to other frequencies.

## 9) Twisted-Pair cable:

- This cable is the most commonly used and is cheaper than others.
- It is light weight, cheap, can be installed easily, & they support many types of network.
- Its frequency is 0 to 3.5 kHz & Repeater spacing is 2km
- It consists of two conductors (normally copper), each with its own plastic insulation, twisted together. One of these wires is used to carry signals to the receiver, and the other is used only as ground reference.

Two types:

### o Unshielded Twisted Pair (UTP)

- It is most commonly used in telecommunication.
- It consists of two conductors usually copper, each with its own color plastic insulator.
- It consists of 2 or 4 pairs of twisted cable where 2 pair use RJ-41 connector & 4 pair cable use RJ-45 connector.
- Advantages: Least expensive, Easy to install, high speed capable.
- Disadvantages: Lower capacity & performance compare to STP.
  - Short distance transmission due to attenuation.
  - Bandwidth is low compared to coaxial cable.
  - External interference.

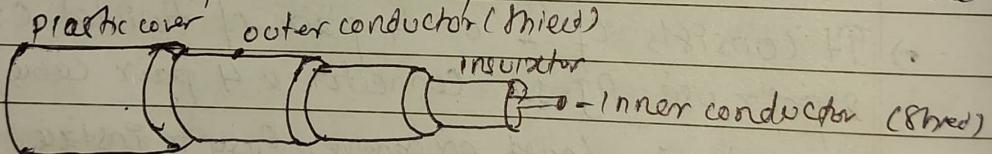
### o Shielded Twisted Pair (STP)

- This type of cable consists of a special jacket to block external interference.
- It has a metal foil which prevents Electromagnetic noise penetration.
- It also eliminates crosstalk.

- It has same attenuation as unshielded twisted pair but faster and more expensive than coaxial and UTP.
- Advantage: Easy to install, increases the signalling rate, higher capacity than UTP & can be used for analog and digital transmission.
- Disadvantage: Comparatively difficult to install & manufacture, more expensive & bulky.

### ii) Coaxial cable

- Mostly used in old analog cable TVs & LANs.
- Coaxial is called by this name because it contains two conductors that are parallel to each other.
- Copper is used in this as centre conductor which can be a solid wire or a standard one.
- Outer metallic wrapping is used as a shield against noise & the second conductor which completes the circuit.
- The outermost plastic cover protects the whole cable.



Two types:

- Baseband
- Used digital transmission on standard cable television cabling.
- It is mostly used for LAN's
- Base band transmits a single signal at a time with very high speed.
- Repeaters can be used to deal with attenuation.

## o Broadband

- This uses analog transmission on standard cable television.
- It transmits several simultaneous signal using different frequencies.
- It covers a large area when compared with baseband.
- Compared to the data capacity of twisted pair wire & baseband, each broadband channel can support the equivalent of millions of bits per second.

Coaxial: Advantages	Disadvantages
→ Bandwidth is high.	→ Single cable failure can fail the entire network.
→ Data transmission without distortion.	→ More prone to lightning strike.
→ Transmits signal at very high rate.	→ Difficult to install & expensive.

## iii) Fiber optic cable.

- A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.
- It uses the concept of reflection of light through a core.
- The core is surrounded by a less dense glass or plastic covering called the cladding.
- It is used for transmission of large volume of data.
- The cable can be unidirectional or bidirectional.
- Advantages:

(i) Increased capacity & bandwidth, light weight  
 (ii) Less signal attenuation, & immunity to electromagnetic interference.

- Disadvantages:
- (i) Difficult to install & maintain, high cost & fragile.

## \* Wireless (guided media)

- Also referred to as wireless or unbounded transmission media.
- No physical medium is required for the transmission of electromagnetic signals.
- They are mostly used in modern days.
- Signal is broadcasted through air, less secure and used for large distance.

### Types:-

#### i) Radiowaves.

- They are easy to generate & penetrate through building.
- They are the electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz.
- Radio waves are omnidirectional (all directions) so the sending & receiving antennas do not have to be aligned.
- AM and FM radios & cordless phones use Radio waves for transmission.
- Due to omnidirectional transmission, there is chance of interference of radio waves.

### Advantage

- Cheaper form of communication as wires are not needed.
- Can carry a message simultaneously over a wide area.

### Disadvantage

- Travels in straight line, so repeater stations may be needed.

NOTE: Radiowave used  $\rightarrow$  broadcasting  
Microwave used  $\rightarrow$  communication

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### iii) Microwaves.

- They are the electromagnetic waves having frequencies between 1 and 300 GHz.
- Microwaves are unidirectional (one direction).
- It is a line of sight transmission. i.e. the sending & receiving antennas need to be properly aligned with each other.
- The distance covered by signal is directly proportional to the height of the antennas.
- These are mainly used for mobile phone communication and television distribution.

#### Advantage:

- i) Cheap form of communication as wires are not needed.
- ii) Microwave can be modified to carry many signals at a time, including data, television pictures & voice message.

#### Disadvantage:

- i) Absorbed very easily by nature i.e. rain, concrete, etc.
- ii) Need special ~~area~~ aerials to receive them.
- iii) Travel in straight line, so repeater stations needed.

### iv) Infrared wave.

- They are electromagnetic waves having frequencies from 300 GHz to 400 THz.
- Can be used for short-range communication.
- Infrared waves, with high frequencies, cannot penetrate walls. This prevents interface between systems.
- It is used in TV remotes, wireless mouse, keyboard, printers.
- Advantages: Can detect people inside burning buildings.
  - Used in military for identifying targets.
  - Used in scientific exp. to identify heat of objects.

→ Disadvantage: → Can cause minor burns if exposed to skin.

→ Can cause cataracts in eyes after long exposure.

→ Cannot be used for long distance communication.

# \* Difference between Guided & unguided media

## Guided Media (bounded)

- i) Uses physical path or conductor to transmit the signals.
- ii) Also called wired or bounded communication.
- iii) It provides direction to signal for travel.
- iv) Guided media is mainly used for point to point communication.
- v) The signals propagate in the guided media in the form of voltage, current or photons.
- vi) Examples: twisted pair cables, coaxial cable, optical fiber cables etc.

## Unguided media

- ii) Transmits the signals wirelessly through air.
- iii) Also called wireless or unbounded communication.
- iv) It does not provide any direction.
- v) Unguided media is mainly used for broadcasting purpose.
- vi) The signals propagate in the unguided media in the form of electro magnetic waves.
- vi) Examples: Microwaves or radio links, Infrared waves etc.

## \* Ethernet cable standards

Ethernet cable is the most popular Local area network (LAN) technology used today. It defines the number of conductors that are required for a connection, the performance thresholds that can be expected, and provides the framework for data transmission.

Category	Shielding	Maximum Transmission speed (at 100m)	Maximum Bandwidth
Cat 3 cable	Unshielded	10 Mbps	16 MHz
Cat 5 cable	Unshielded	10 / 100 Mbps	100 MHz
Cat 5e cable	Unshielded	1000 Mbps / 1 Gbps	100 MHz
Cat 6 cable	Shielded or unshielded	1000 Mbps / 1 Gbps	250 MHz
Cat 6a cable	Shielded	10000 Mbps / 10 Gbps	500 MHz
Cat 7 cable	Shielded	10000 Mbps / 10 Gbps	600 MHz

## \* UTP Fiber cable standards

(Not so important.)

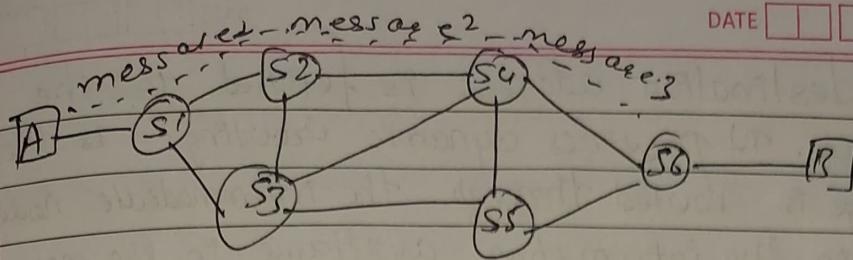
	Multimode Fiber	Single mode fiber
IEC/ISO 11801	OM1, OM2, OM3, OM4	OS1, OS2
IEC 60793-2	-10 <sup>A1b</sup> , -10 <sup>A2a</sup> , -10 <sup>A2.2</sup> , -10 <sup>A2.3</sup>	-50 <sup>B1.1</sup> , -50 <sup>B1.2</sup>
ITU-T	G.651, G.651, G.651, G.651	G.652 G.652D
TIA-492 CLASSMATE	AAA AAB AAC AAD	AAA CAAB PAGE

## Circuit, Message & Packet Switching

- Switching is the technique by which nodes control or switch data to transmit it between specific points on network.
- It is used for transmission of data beyond a local area.
- It is achieved by transmitting data from source to destination through a network of intermediate switching nodes.

### Circuit Switching

- It is a switching technique that establishes a dedicated path between sender & receiver.
- Here, once the connection is established, then the dedicated path will remain to exist until the connection is terminated.
- Circuit switching in a network operates in a similar way as telephone works.
- A complete end-to-end path must exist before the communication takes place.
- In case of circuit switching technique, when any user wants to send the data, voice, video, a request signal is sent to the receiver then the receiver sends back the acknowledgement to ensure the availability of the dedicated path. After receiving the acknowledgement, dedicated path transfers the data.
- It is used in public telephone network.
- Fixed data can be transferred at a time in circuit switching technology.



### Advantages:

- i) In case of circuit switching technique, the communication channel is dedicated, which ensures steady data transmission.
- ii) It has fixed bandwidth.
- iii) Suitable for long continuous transmission.

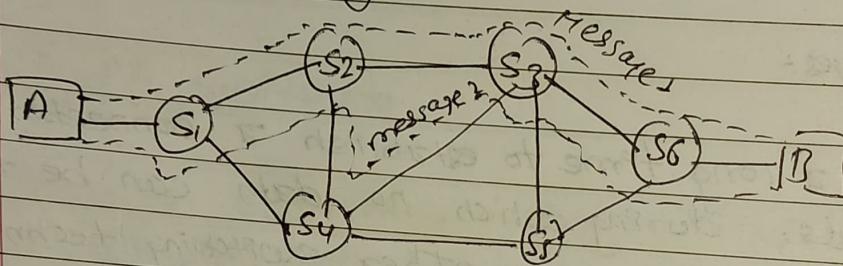
### Disadvantages:

- i) It takes a long time to establish a connection approx 10 seconds, during which no data can be transmitted.
- ii) More expensive than any other switching technique, as dedicated path is required.
- iii) It is inefficient to use because once the path is established & no data is transferred, then the capacity of the path is wasted.

## 2. Message switching

- o It is a switching technique in which a message is transferred as a complete unit & routed through intermediate nodes at which it is stored and forwarded.
- o In message switching, there is no establishment of a dedicated path between the sender & the receiver.

- o The destination address is fetched to the message. It provides dynamic routing as the message is routed through the intermediate nodes based on the information available in the message.
- o Message switches are programmed in such a way so that they can provide the most efficient routes.
- o Each and every node stores the entire message & then forward it to the next node. This type of network is known as store & forward network.
- o Message switching treats each message as an independent entity.



### Advantages:

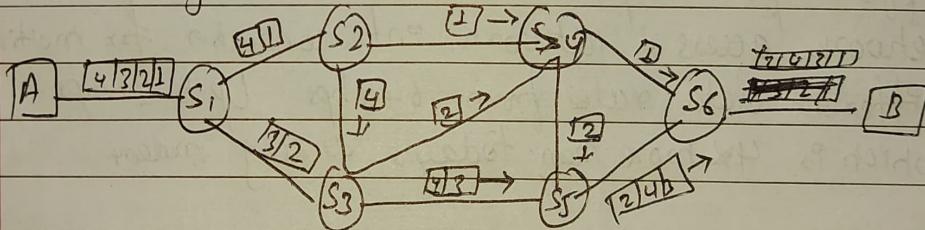
- o Sharing of communication channels ensures better bandwidth usage.
- o Reduces network congestion due to store & forward method.
- o Broadcasting messages requires less bandwidth than circuit switching.
- o Messages of unlimited sizes can be sent.
- o Message priority can be used to manage the network.

### Disadvantage

- o In order to store many messages of unlimited sizes each intermediate switching node requires large storage capacity.
- o Long delay can occur due to store & forward method.

### 3. Packet switching

- It is a switching technique in which the message is sent in one go, but it is divided into smaller pieces/packets and they are sent individually.
- The smaller pieces also known as packets are given a unique number to identify their order at the receiving end.
- Every packet contains some information in its headers such as source address, destination address & sequence number.
- Packets will travel across the network taking the shortest path as possible & all the packets are reassembled at the receiving end in correct order.
- If any packet is missing or corrupted, then the message will be sent to resend the message.
- If the correct order of packets is reached, then the acknowledgement will be sent.



Two types :- Datagram & Virtual circuit with Packet switching.

#### Advantages :

- Cost-effective:** Switching devices don't require massive secondary storage, so cost is minimized to some extent.
- Reliable:** If any node is busy, the packets can be re-routed.
- Efficient:** Doesn't require any established path, & many users can use the same communication channel simultaneously.

#### Disadvantages:

- Can't be implemented in those applications that require low delay & high quality services.
- Packets may arrive in wrong order.
- Protocols used are very complex & required high cost.

## \* TSDN [Interface & Standards]

- Integrated Services Digital Network (ISDN) is a telephone system network. It is a wide area network becoming widely available.
- ISDN is a Circuit switched telephone network system that also provides access to packet switched networks, designed to allow digital transmission of voice & data over ordinary telephone copper wires, resulting in better voice quality than an analog phone.
- It also provides Internet access at a maximum of 128 kbps in both upstream & downstream directions.

### Features:

- Offers point-to-point delivery
- Network access & network interconnection for multimedia
- Different data rates from 64 kbps Up to 2 Mbps which is 4\* more than today's analog modems.

### Advantages

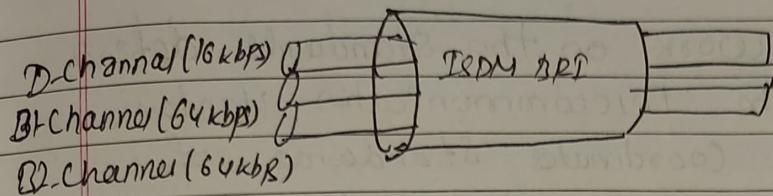
- Quality: ISDN connections are low error rate digital pipe
- Flexibility: connection can be established at any time.
- Economy: usage costs are very effective.
- Availability: Widely available in most of the countries.

### ISDN User Interfaces

- Basic Rate Interface (BRI)
- Primary Rate Interface (PRI)

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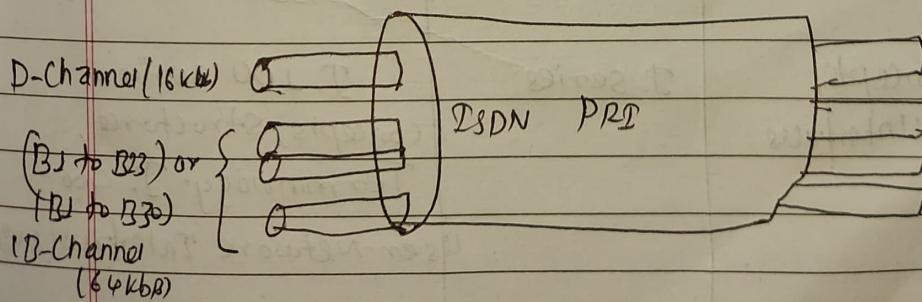
## \* Basic Rate Interface (BRI)



It specifies a digital pipe consisting of two 64 kbps B channels & one 16 kbps D-channel. Conceptually, BRI service is like a large pipe that contains three smaller pipes two for B channels & one for the D channel. It is designed to meet the needs of home users & small businesses. The existing twisted pair local loop can be used to carry digital transmission.

## \* Primary Rate Interface (PRI)

It is intended for users with higher data rate requirements, such as large business establishments, offices with LAN. The US, Canada & Japan make use of a transmission structure based on 1.544 Mbps; this corresponds to the T-1 transmission facility of AT&T. In Europe, 2.048 Mbps is the standard rate. Both of these data rates are provided as a PRI.



## \* ISDN Standards

The ISDN works on the standards defined by ITU-T. The Telecommunication Standardization Sector (ITU-T) coordinates standards for telecommunications on behalf of International Telecommunication Union (ITU). It is based on Geneva, Switzerland.

The various principles of ISDN as per ITU-T recommendation are:

- To support switched & non-switched applications
- To support voice & non-voice applications
- Reliance on 64-kbps connectors
- Intelligence in the network
- Layered protocol architecture
- Variety of configurations

The various standards of ISDN are:

Issue	Protocol	Key Examples
Telephone Network & ISDN	E-series	E-164 - International Telephone Numbering Plan
ISDN Concepts, Aspects & Interfaces	T-series	T-100 series - concepts, structures, Terminology. T-400 - User-Network Interface (UNI)
Switching & Signaling	Q-series	Q.931 - LAPD

# Questions asked from this Chapter in board exam

MCQs - ITP

- Q. What is transmission media? How do guided media differ from unguided media? Explain different types of guided media in detail. (2078-10 marks) (2076-10 marks)  
 (2091-10 marks) (2072-10 marks) (2075-10 marks)
- Q. Write short note on: ISDN. (2.5 marks - 2078)
- Q. What is circuit-switching? How is it different from packet switching? (2076 - 10 marks) (2075-10 marks)
- Q. What is switching? Compare & contrast a circuit-switched network & packet-switched network. (2076-5 marks)
- Q. What is virtual circuit network? How is it different from datagram network? (2075-5 marks)
- Q. Differentiate between broadband & base band services. (2070-5 marks)