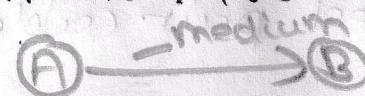


Unit II: Transmission media and Switching (Weightage - 16marks)

A transmission medium can be defined as, "anything that can carry information from a source to a destination".



Need of transmission

- ① Transmission media are needed for interfacing with the device.
- ② Without transmission media transmission can't take place.
- ③ Communication media is intermediate/middle part of Sender and Receiver.
- ④ Transmission media is required for faster communication.
- ⑤ It is needed for reliable delivery of data with efficient method.
- ⑥ Transmission media is needed for secure transmission of data.

Classification of Transmission media

Guided media

Fibre optic Coaxial Twisted

Unguided media

- Radiowaves
- Microwaves
- Infrared
- Satellite

Guided Transmission Media

The transmission media that are wire, also known as wire or bounded transmission media.

It is defined as physical medium through which the signals are transmitted.

It include twisted pair cable, coaxial cable, fibre optic cable.

Advantages of Guided media.

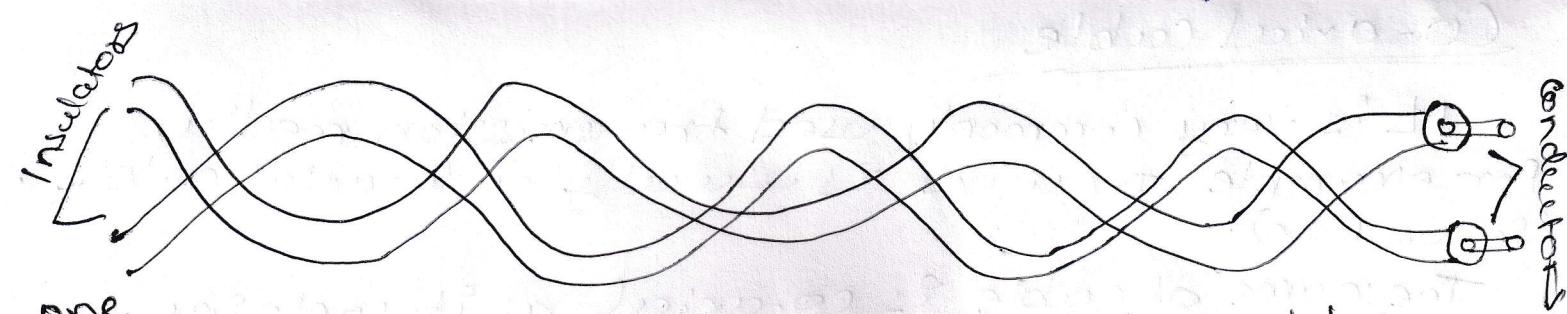
- ① Higher Bandwidth for faster data transfer.
- ② Enhanced physical isolation is there so enhanced security.
- ③ They are cheaper in cost.
- ④ Reliability in data transmission.
- ⑤ They are easier to install & higher data rates.

Disadvantages of Guided media

- ① Higher maintenance and installation cost.
- ② Devices can't be connected wirelessly.
- ③ Cables can be easily damaged or get cut.
- ④ They require storage space so it becomes bulky.

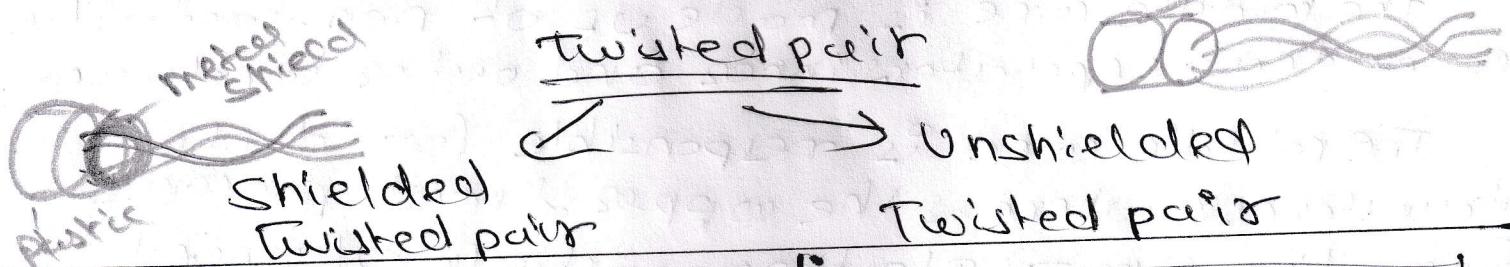
Twisted pair Cable

- Twisted pair cable is most common type of cable used in data communication.
- The least expensive and most widely used guided transmission media is twisted pairs.
- It consist mainly of two conductor (normally copper).
- Frequency range for twisted pair cable is from 0 to 3.5 kHz. A twisted pair consist of two insulated copper wires arranged in regular spiral pattern.
- The degree of reduction in noise interference is determined by numbers of turns per foot.
- Increasing number of per turns per foot decreases noise interface.



one Twisted pair is used to carry signals to the receiver and the other is used as ground reference.

It comprises two separated insulated copper wire which are twisted together and run in parallel.



Unshielded Twisted pair

UTP is set of twisted pairs of cable within a plastic sheet.

Cables without a shield are called as unshielded twisted pair cable.

Advantages

- Easy to install & setup.
- It is cheap cost
- high speed for LAN.

DisAdvantage

- only used for shorter distance.

Shielded Twisted pair

STP is the cable that contain mesh surrounding the wire that allows higher transmission rate. Shielding absorbs radiation and reduce the EMI.

Advantages

- STP Reduces interference
- Faster than UTP
- Better performance at higher data rates.

DisAdvantage

- High cost
- difficult for installation
- High Attenuation rate.

Co-axial Cable

It is very commonly used transmission media, for example TV wire is usually a Co-axial cable (Setup Box):

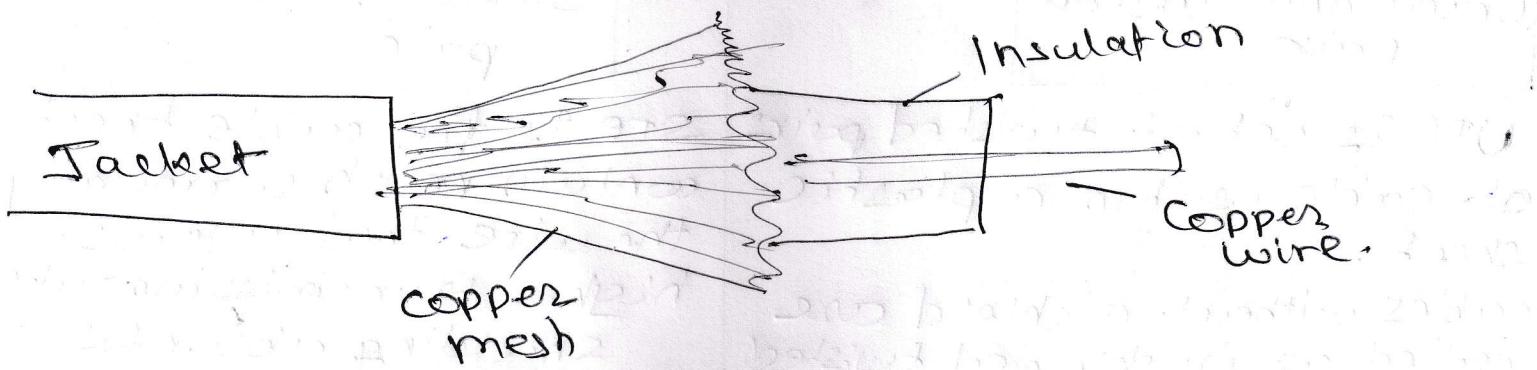
The name of cable is co-axial as it contains two conductors parallel to each other.

It has higher frequency as compared to Twisted pair.

The inner conductor of co-axial cable is made up of copper, outer conductor is made up of mesh.

The middle core is made up of non-conductive cover that separates inner and outer conductor.

The middle core is responsible for data transferring whereas the copper & mesh prevents from the EMI (Electromagnetic Interference).



Advantages

- ↳ Data transmission at higher rate than twisted pair
- ↳ Provides higher bandwidth
- ↳ Can used for both analog & digital signals.
- ↳ Better shielding.

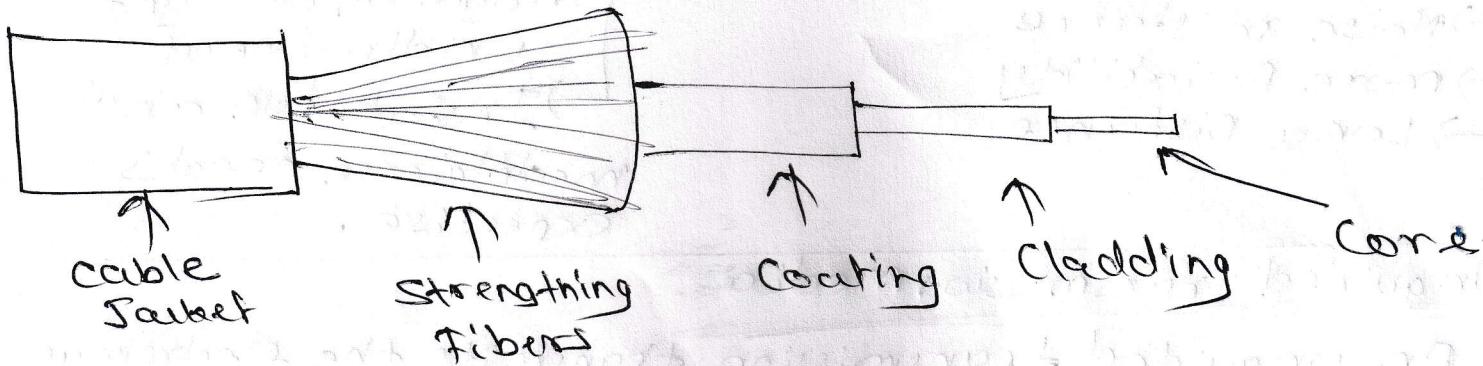
DisAdvantages

- ↳ more expensive than tp.
- ↳ Any fault occurs cable causes the failure in entire network.

Fibre-optic Cable

LIMP

- Fiber optic cable is uses electrical signal for communication. (transfer data in form of light).



- Fibre optic cable is made up of glass or plastic.
- Outer Jacket is made up of PVC or Teflon.
- The Plastic coating protects the optical fibres from heat, cold, electromagnetic interference from other types of wiring..
- Fiber optic provide faster data transmission than copper wires.
- It uses principle of reflection for transmission.

According to Components :

Core: The core of optical fiber is small strand of glass or plastic where light travel. The larger the core area , the more light the fibre can carry.

Cladding: This is a layer of glass around the core of cable. Its job is to make sure light inside core by having a lower refractive index. The density of cladding is less than core.

Coating: It is protective layer. Its main job is to shield the core. It is outer shell keep everything inside safe & secure.

Strengthning Fibres: It is protective layer made of strong materials to prevents the core from getting damage. It is cushion to core.

Jacket: Worked as insulator. made up of plastic.

Advantages

- Higher data rate
- less signal attenuation
- noise resistance
- more reliability
- long distance

DisAdvantages

- more expensive
- propagation of light unidirectional
- Installation and maintenance needs expertise.

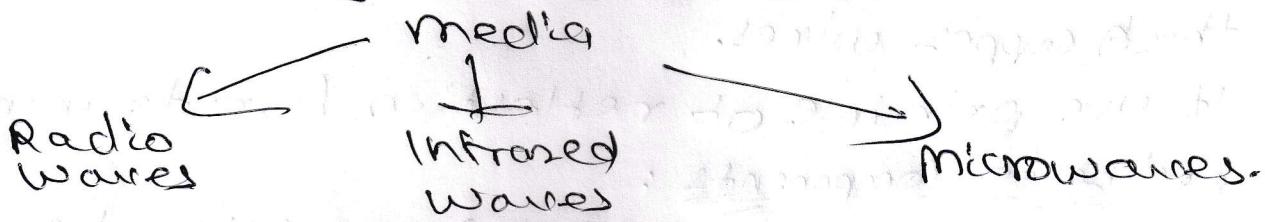
Unguided transmission media

An unguided transmission transmits the electromagnetic waves without using physical medium.

It is also known as wireless transmission.

In unguided media air is the media through which the electromagnetic energy can flow easily.

Unguided transmission



Advantages

- Use for long distance communication
- High speed data transmission.
- many receivers station can receive signals from same sender station

DisAdvantages

A signal can move out of phase by microwave transmission

A microwave transmission is susceptible to weather condition.

They slow in speed, especially when many people using them.

wireless is easier for hackers to hack, risking data safety.

Radio waves

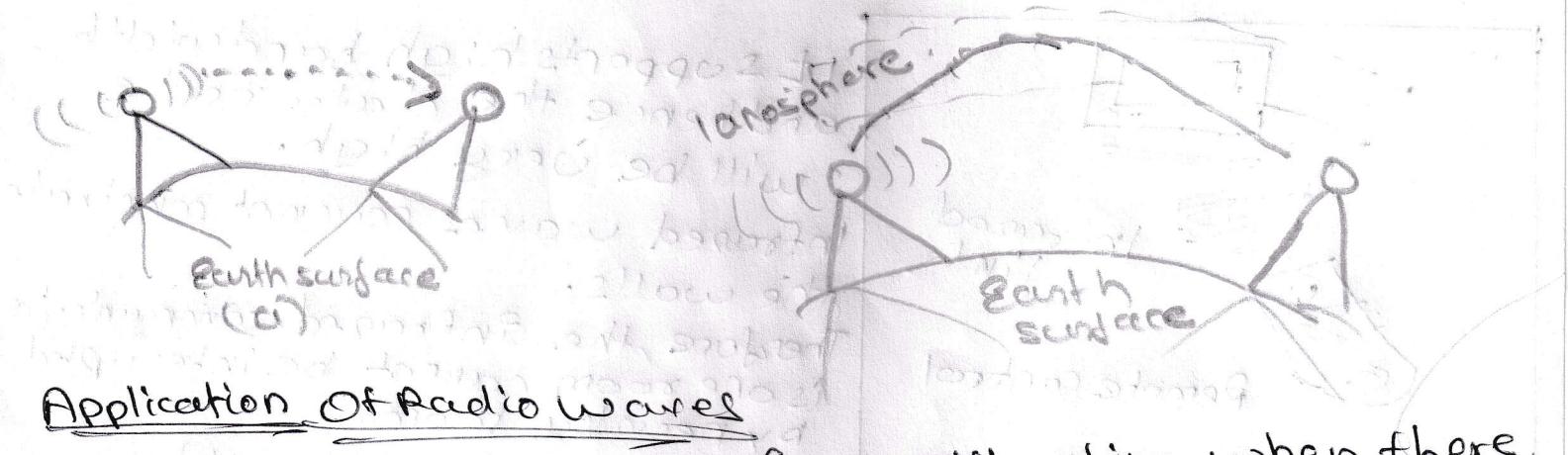
Radio waves are the electromagnetic waves that are transmitted in all directions of free space.

Radio waves are omnidirectional i.e. the signals are propagated in all directions.

The range in frequencies of radio waves is 3 kHz to 11 kHz.

In case of radio waves, the sending and receiving antenna are not aligned; i.e. the wave sent by antenna can be received by receiving antenna.

An example of the radio wave is FM radio.



Application of Radio Waves

- A Radio wave is useful for multicasting when there is one sender and many receivers.
- An FM radio, television, cordless phone are examples of radio waves.

Advantages

- * Mainly used for wide area networks and mobile cellular phones.
- * Radio waves cover large area and they can penetrate walls.
- * Radio transmission provides a higher transmission rate.

Disadvantages

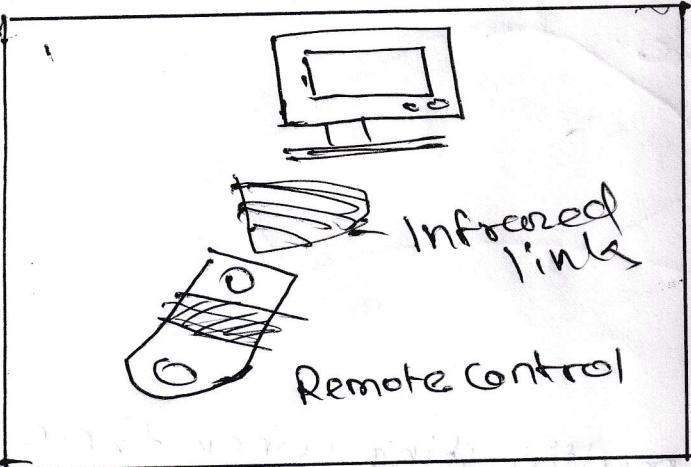
- Great power consumption
- Limited spectrum of frequency
- Travel in straight line, so repeater stations may be needed.

Infrared

An infrared transmission is a wireless technology used for communication over shorter range.

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

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



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

Infrared waves cannot penetrate the walls.

Therefore, the infrared communication is one room cannot be interrupted by nearby rooms.

An infrared communication provides better security with minimum interference.

Sunrays does not cause infrared communication.

Advantages

- Simple circuit and cheap in cost.
- Low power consumption.
- Portable
- No license needed.
- High security and simple shielding

Disadvantages

works only a Line of sight mode

Short range

Low Bandwidth

Speed is comparatively low

Microwaves

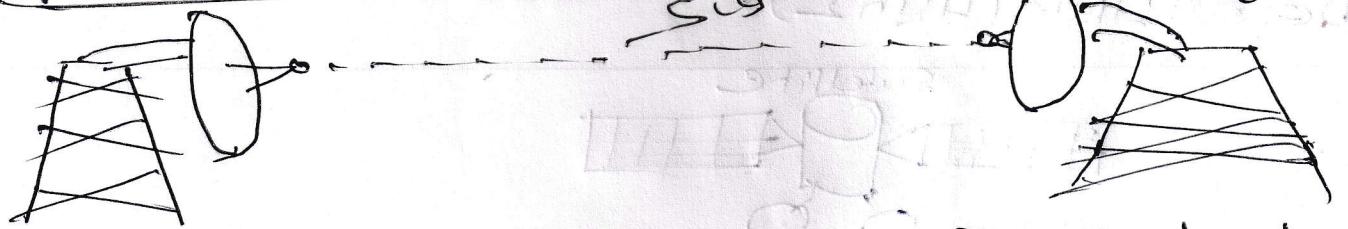
Types of Microwaves

Terrestrial
microwaves

Satellite
microwaves

Micro waves transmission is information by electromagnetic waves with wavelengths in the microwave. frequency range of 300 MHz to 300 GHz (1m-1mm) wavelength of electromagnetic spectrum.

Terrestrial Microwaves



Terrestrial microwave transmission is a technology using focused radio waves between ground antennas.

Frequency range of electromagnetic waves is from 1 GHz to 1000 GHz.

Antennas must be aligned; waves are focused (unidirectional).

Antennas on towers send beams to distant towers in line of sight.

Works on line of sight transmission.

Advantages

- Cheaper than cables.
- Communication over oceans can be achieved.
- Easy communication in terrain as installation of cable is quite difficult task.

DisAdvantages

Eaves dropping: creates insecure communication.

Susceptible to weather conditions.

Bandwidth limited.

Satellite Communication

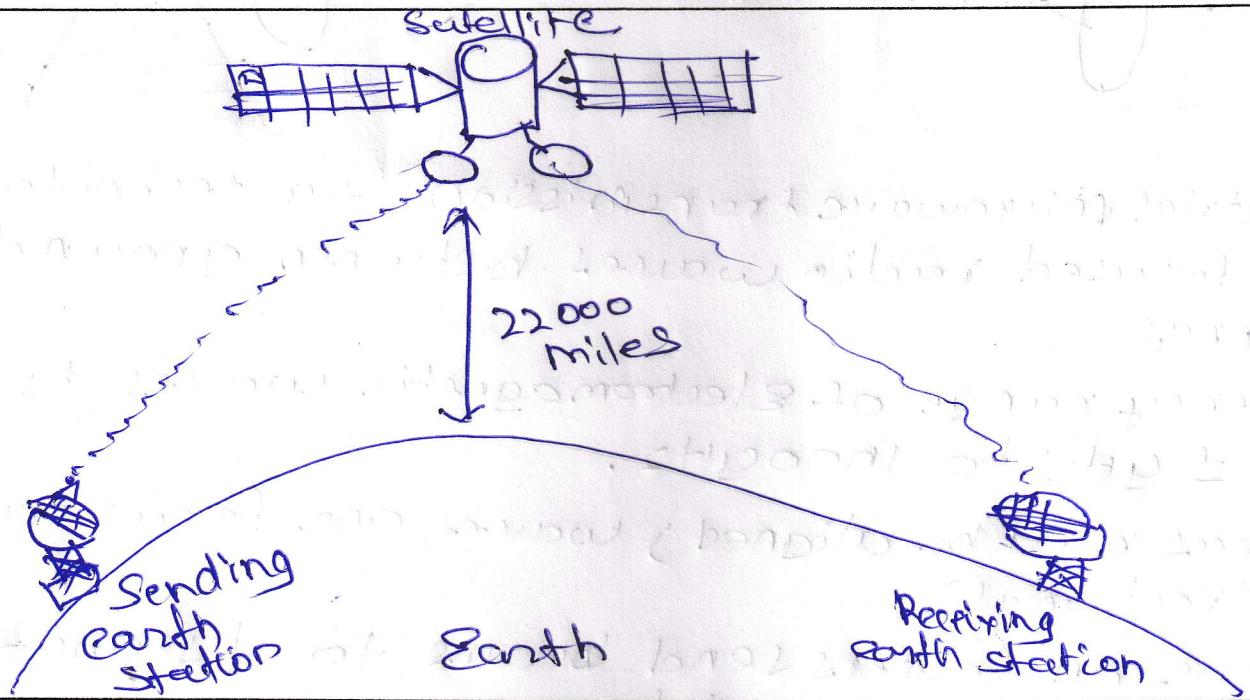
YIMP

A satellite communication, signal transferring between the sender and receiver is done with the help of Satellite.

A satellite is a physical object that revolves around the earth at a known height.

In this process, a beam of modulated microwaves is sent towards satellite called UPLINK (6GHz).

The satellite amplifies the signal and send back to receiver antennas present on earth surface as DOWNLINK (4GHz).



Satellite communication is more reliable nowadays as it offers more flexibility than cable and fibre optic systems.

We can communicate with any point on globe by using satellite communication.

As entire signal transferring is happening in space. Thus this type of communication is known as space communication.

The satellite does the functions of an antenna and repeater together.

If the earth along with its ground stations is revolving and satellite is stationary, the sending and receiving earth stations and satellite can be out sync over time.

However, 3 satellites are needed to cover earth's surface entirely.

Advantages

- * Coverage of area of satellite microwave is more than terrestrial microwave.
- * Easy to install
- * transmission cost of satellite is independent of distance from centre of coverage area.
- * So it is used in mobile and wireless communication applications.

Disadvantages

- * Designing and development of satellite requires more time & higher in cost.
- * The satellite needs to be monitored and controlled on regular periods so that it remains in orbit.
- * Life of satellite is about 12-15 yrs. Due to this reason, another launch of satellite has to be planned before it becomes non-functional.

Applications

Satellite television

Digital cinema

Satellite Radio

Satellite internet access

Switching

Switching is the mechanism by which data/information sent from source towards destination which are not directly connected.

Network have interconnecting devices, which receives data from directly connected sources, stores data, analyses it and then forward to next interconnecting devices closest to destination.

Switching techniques

In large networks, there can be multiple paths from sender to receiver. The switching technique will decide the best route for data transmission.

Switching technique is used to connect the systems for making one-to-one communication.

Classification

Switching Techniques

Circuit Switching

Message
Switching

Packet
Switching

Circuit Switching

Circuit Switching technique that establishes a dedicated path between sender and receiver.

In Circuit Switching Technique, once the connection is established then dedicated path will remain to exist until the connection is terminated.

Circuit switching in network operates in 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 receiver sends back the acknowledgement to ensure the availability of dedicated path.

After Receiving Acknowledgement, dedicated path transfer the data.

Circuit switching is used in public telephone network.

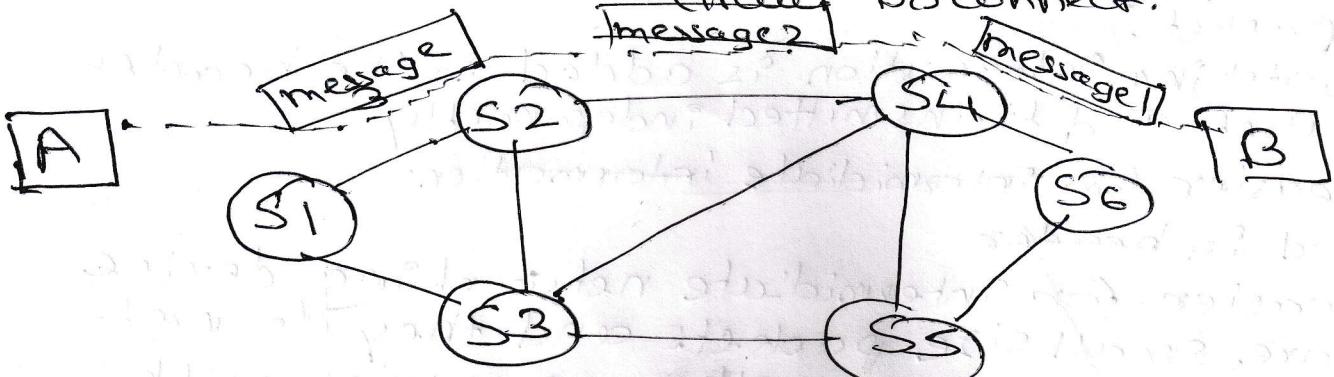
It is used for voice transmission. Fixed data can be transferred at time in this.

It has three phases →

Circuit establishment

Data transfer

Circuit disconnect.



Advantages

- In case of Circuit Switching technique, communication channel is dedicated.
- It has fix Bandwidth.

Disadvantages

- Once the dedicated path is established, the only delay occurs in the speed of data transmission
- It takes a long time to establish a connection approx 10 seconds during which no data can be transmitted
- It is more expensive than other switching techniques as a dedicated path is required for each connections
- It is inefficient to use because once the path is established and no data is transferred, then the capacity of the pair is wasted.
- In this case, the connection is dedicated therefore no other data can be transferred even if the channel is free.

Switch

like phone call
Before sending data, the sender checks the path
If available, confirmed, data is sent.

Packet Switching

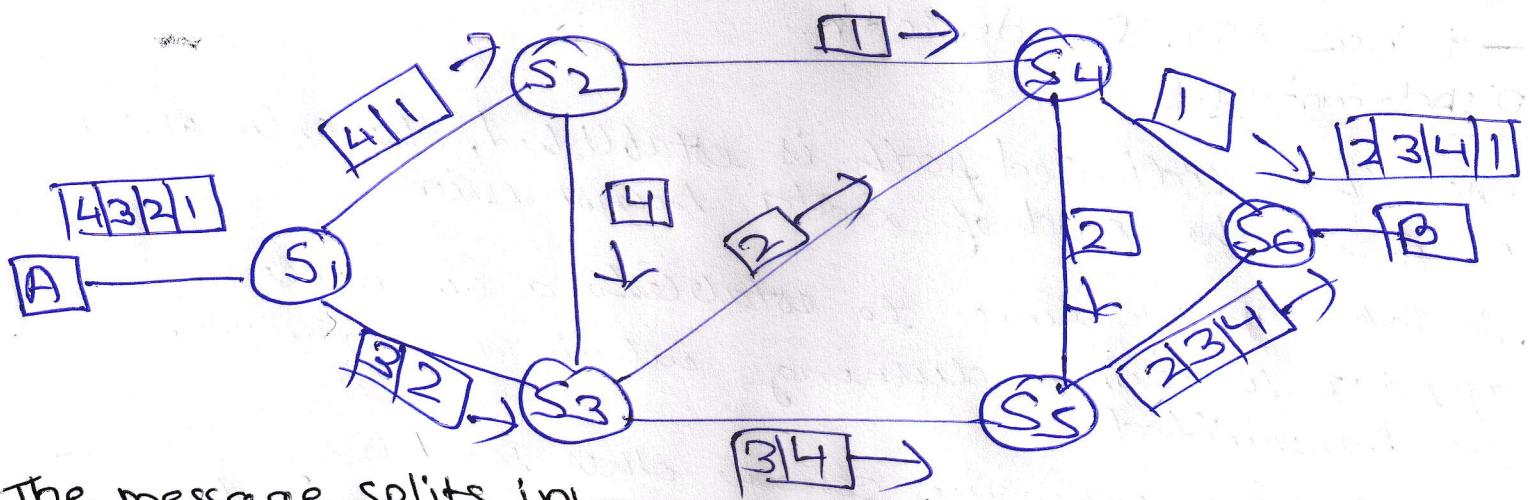
The entire message is broken down into smaller chunks called packet.

The switching information is added in the header of packet and transmitted independently.

~~it is easier for intermediate information~~

~~is added in header~~

It is easier for intermediate networking device to store small size packets and they do not take much resource either on carrier path or in internal memory of switches.



The message splits into smaller pieces known as packets and packets are given a unique number to identify their order at the receiving end.

Every packet contains some information in header such as source address, destination address, and sequence number.

Packets will travel across the network, taking shortest path as possible.

All the packets are reassembled at receiving end in correct order.

If any packet is ~~message~~ missing or corrupted, then the message will send to resend the message.

If correct order of packets are received, then the acknowledgement message will be sent.

Advantages

- ① Efficiency: Shares network resources among multiple users data packets, maximize usage.
- ② Reliability: Ensures continues communication, because can find alternative routes.
- ③ Scalability: Easily expands to accomodates more users and data without changes.
- ④ Saves money, Versatility, Quality control, traffic control in networking.

Disadvantages

- It can't be implemented in those applications that require low delay and high-quality services.
- Protocols used in packet switching technique are very complex and requires high implementation cost.
- If network is overloaded or corrupted, then it requires retransmission of lost packets. It can create loss of information.

Circuit switching is preferred over packet switching in voice communication.

- In circuit switching, a dedicated path is established between sender and receiver, which is maintained for entire duration of connection.
- It provides continuous delivery of data guaranteed.
- No addressing required, during data transfer phase.
- Delays are small.
- It uses connection oriented service.
- Message received in order to the destination.

Circuit Switching

In circuit switched network, a dedicated path is created between two points by setting the switches.

Circuit switching requires simple protocols for delivery. Initial cost is low.

Telephone or modem is used as end terminal.

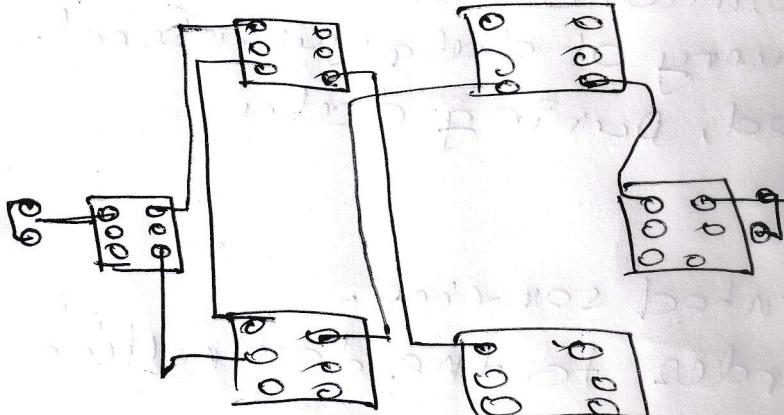
In circuit switching, there is no concept of storing and forwarding transmission.

All packets use same path.

Waste of Bandwidth is possible.

Physical connection b/w sender and receiver.

Continuous transmission
ex phone calls



Packet switching

In packet switched network, no dedicated path is created between two points. Only virtual circuit exists.

Packet switching requires complex protocols for delivery. High installation cost.

In this computer is used as end terminal.

Here, each node may store incoming packets and forward them after use.

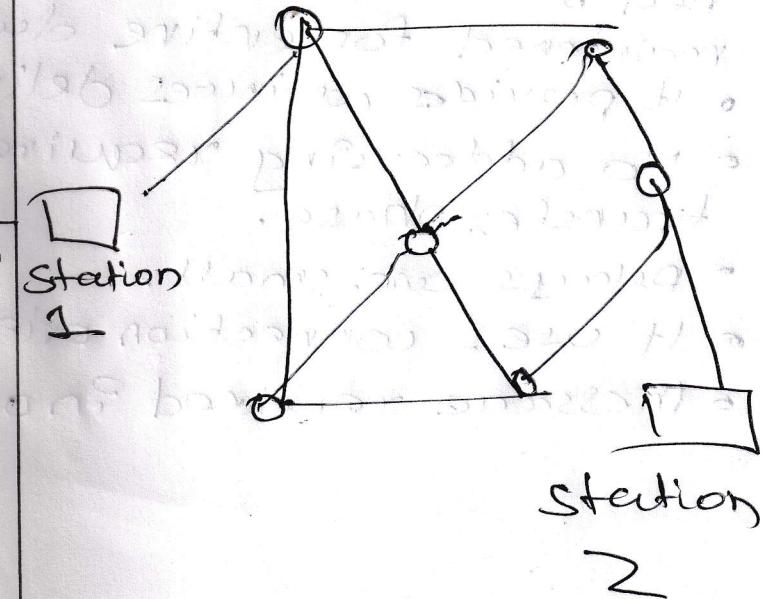
Packets travel independently.

No waste of bandwidth.

No physical path.

packet transmission

ex Internet



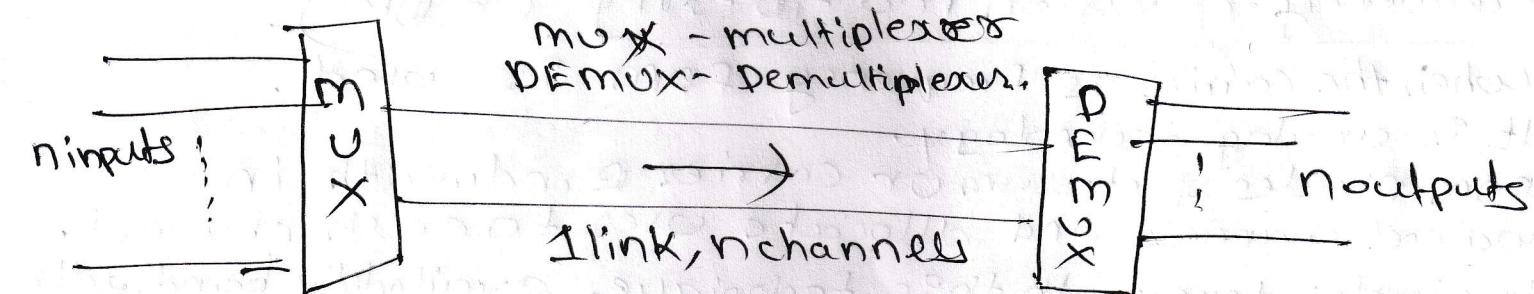
Multiplexing

Multiplexing is the process of simultaneously transmitting two or more individual signals over common communication channel.

Multiplexing is achieved or accomplished by an electronic circuit known as multiplexer.

Technique to separate a combined signal into its individual component signals is known as Demultiplexer.

Demultiplexer is used for demultiplexing, separate a signal into its component signals.



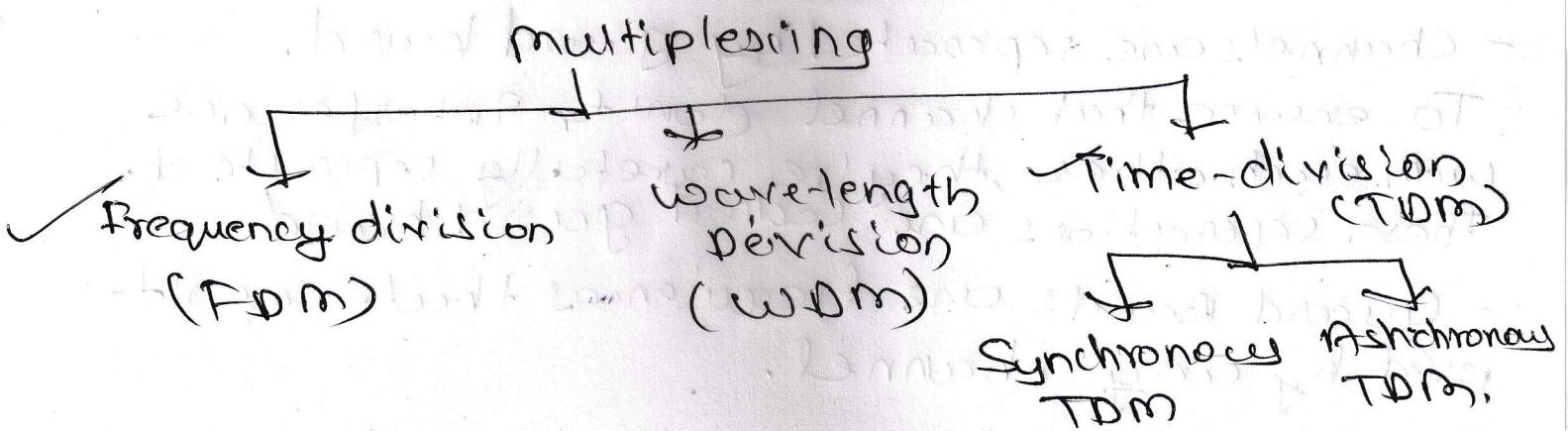
Multiplexing is a technique by which different analog and digital streams of transmission can be performed/processed over a shared link.

Multiplexing divides the high capacity medium into low capacity logical medium which is then shared by different stream.

Communication is possible over the air (radio frequency), using physical media (cable), and light (optical fiber). All mediums are capable of multiplexing.

When multiple senders try to send over a single medium, a device called multiplexer divides the physical channel and allocates one to each.

On the other hand at end of communication, a demultiplexer receives a data from single medium, identifies each and sends to different receivers.



Advantages of multiplexing

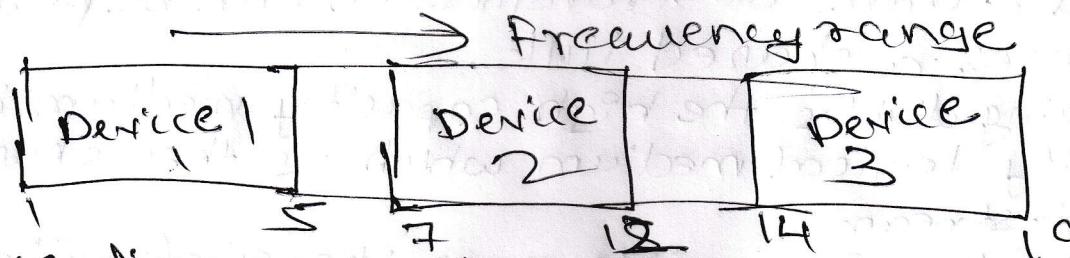
- ① Simple and Easy
- ② Reduces no. of wires.
- ③ In expensive and signals may have varying speed.
- ④ Reduces Circuit complexity and cost.

Disadvantages

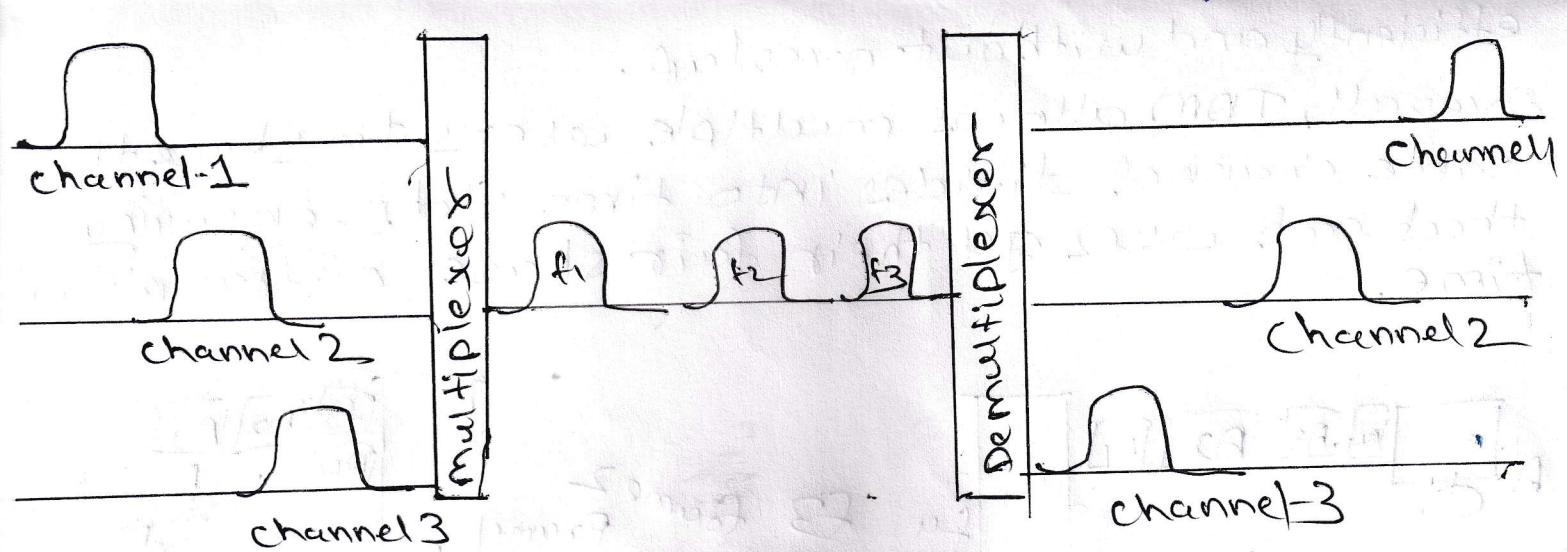
- ① Complexity
- ② Extra I/O ports required to control multiplexer.

Frequency division multiplexing (FDM)

- When the carrier is Frequency FDM is used.
- It is analog technology.
- FDM divides spectrum or carrier Bandwidth in logical channels and allocate user to each channel.
- In simpler terms, In this technique available bandwidth of single transmission is divided into several channels.



- In above diagram, a single transmission medium is divided into several frequency channels, and each frequency has given to different devices. Device 1 has 1 to 5 channels.
- Each user can use channel frequency independently and has exclusive access of it.
- All channels are divided in such a way they do not overlap on or with each other.
- To send signals we use modulation. After modulation all signals are combined into one Stream.
- Channels are separated by guard band.
- To ensure that channel don't interfere with each other, they're carefully separated. These separations are called guard band.
- Guard bands are frequencies that can't be used by any channel.



They are mainly used in radio broadcasts and TV networks transmitted in air.

Advantages

- FDM is used for analog signals.
- Process is very simple and easy modulation.
- Large numbers of signals can be sent through an FDM simultaneously.
- It does not require synchronisation between sender and receiver.

Disadvantages

- low-speed channels are required.
- It suffered problem of cross talk.
- Large numbers of modulator required.
- It requires a high bandwidth channel.

Time-Division multiplexing (TDM)

TDM primarily applied on digital signals but can be applied on analog signals as well.

Each user or signals gets its own time slot to transmit data and within that time slot only user can transmit.

In TDM, the shared channel is divided into time slots and they can transmit data during allocated time.

For Digital signals these time slots are organized into frames, which are packets of data that fit into a single time slot.

This ensures that data from each user is transmitted

efficiently and without overlap.

Overall, TDM allows multiple users to share the same channel divides into time slots, ensuring that each user get their fair share of transmission time.



when A transmits data its frame at one end, the demultiplex provides media to channel A at other end.

As soon as A expires, the side switches to B. On other hand, Demultiplexes works in a synchronized manner and provides media to B.

Advantages

- TDM efficiently uses available bandwidth by dividing into fixed time slots, ensuring fair transmission.
- It's easy and cost-effective to setup.
- Suitable for various communication systems.
- Provides low latency, ideal for real-time app.
- It's scalable, allowing for easy expansion.

DisAdvantages

- Relies on synchronization and errors can lead to data loss.
- Not flexible for enough applications.
- There is risk of disruption if central timing source fail.
- TDM introduces overhead, reducing the effective data rate for each channel.

1.1MP

FDM

FDM stands for frequency-division multiplexing.

Frequency is shared.

Used with Analog signals.

Interference is high.

Utilization is ineffective inefficient.

Guard Band is necessary.

It has high conflict.

Complex wiring.

TDM

TDM stands for Time-Division multiplexing.

Time scale is shared.

Used with both Analog and Digital signals.

Interference is low or negligible.

Efficiently used.

Synchronization pulse is necessary.

It has low conflict.

Easy/simple wiring.

Communication

Synchronous Communication

In Synchronous communication, data is sent from in form of blocks or frames.

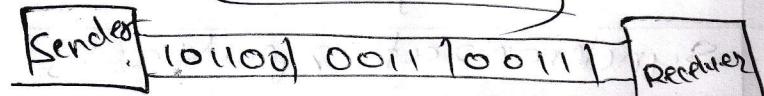
Sender and receiver use same clock signal.

It is fast transmission

Time interval is constant of transmission

Efficient as compared to frames (larger data).

flow of data



Asynchronous Communication

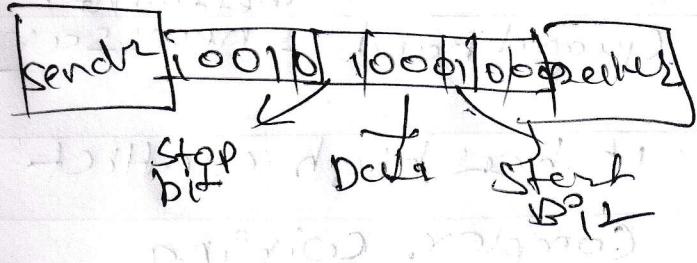
In Asynchronous communication, data is sent in form of byte or character.

Does not need clock signal between sender and receiver.

It is slow transmission

time interval is not constant, random.

In transmission start bits and stop bits are added with data



Disadvantages

- Relies on synchronization and errors can lead to data loss.
- Not flexible for enough applications.
- There is risk of disruption if central timing source fails.
- TDM introduces overhead, reducing the effective data rate for each channel.

1.1MP

<u>FDM</u>	<u>TDM</u>
FDM stands for frequency-division multiplexing.	TDM stands for Time-Division multiplexing
Frequency is shared.	Time scale is shared.
Used with Analog signals.	Used with both Analog and Digital signals.
Interference is high.	Interference is low or negligible.
Utilization is ineffective <i>(inefficient)</i> .	Efficiently used
Guard Band is necessary	Synchronization pulse is necessary
It has high conflict	It has low conflict
Complex wiring	Easy/simple wiring