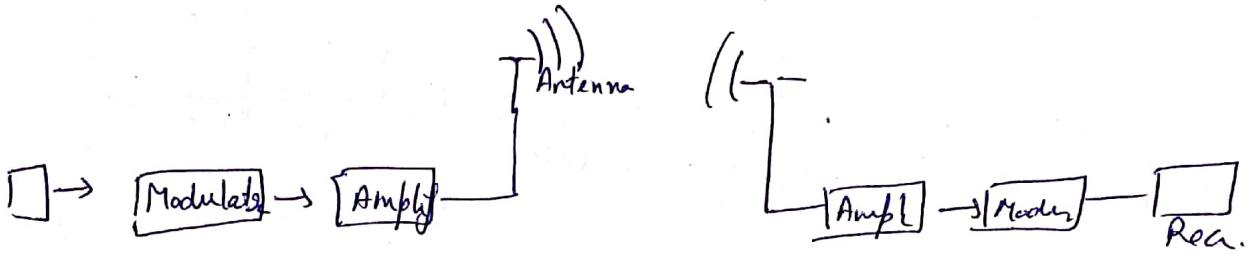
Modulation of Analog. Signal.

Analog 1

Need:

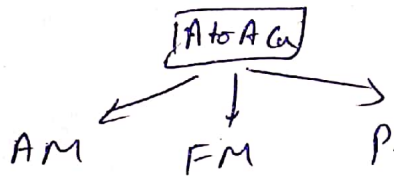
→ To increase the energy of signal
→ Attena height → $\frac{\lambda}{2}$.
→ Interference.
→ To decrease Power loss.

→ energy loss + Power loss.



Home → very low freq. → 30 to 3000 kHz.

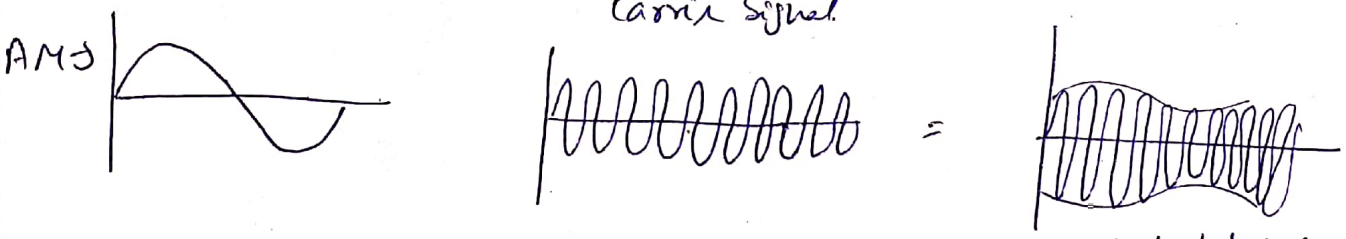
Wht we do, we use an add. freq. on which we impose our signal to transmit.



Base band Signal.

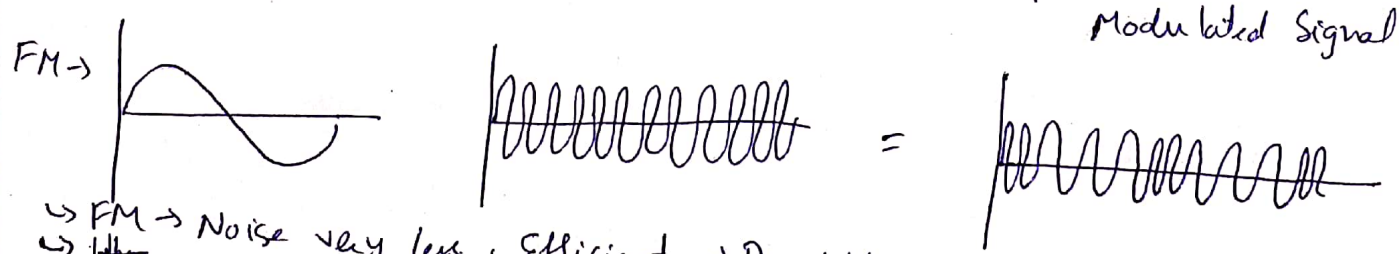
Carrier Signal

AM→



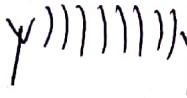
Modulated Signal.

FM→



↳ FM → Noise very less ; Efficient → Demodulate ; Side band are More - stereo sound transmission.
↳ ~~When~~
AM → Noise is high ; less efficient.
↳ Broadcasting. Area of coverage is more.
↳ Modu/Demodu → less complex circuit.

→ Disadv.
↳ directional Quality high.



Propagation is limited.

↳ Bandwidth high. Needs the channel which deals with that much Bandwidth
↳ Modulator/Demodu. → Complex circuit

Analog to Analog Conversion

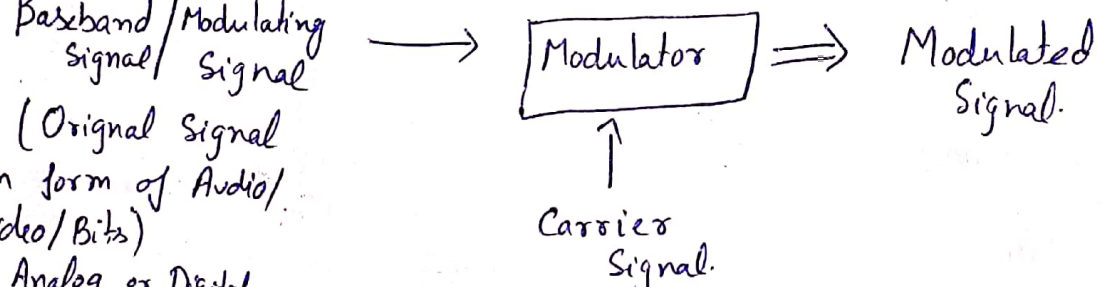
We modulate the signal so that it can be transmitted over long distance appropriately.

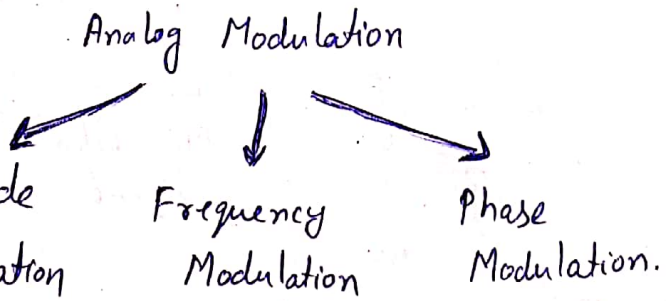
→ The Process of varying any of the three characteristics as the Amplitude, Frequency or Phase of a carrier signal is called as Modulation.

Need of Modulation

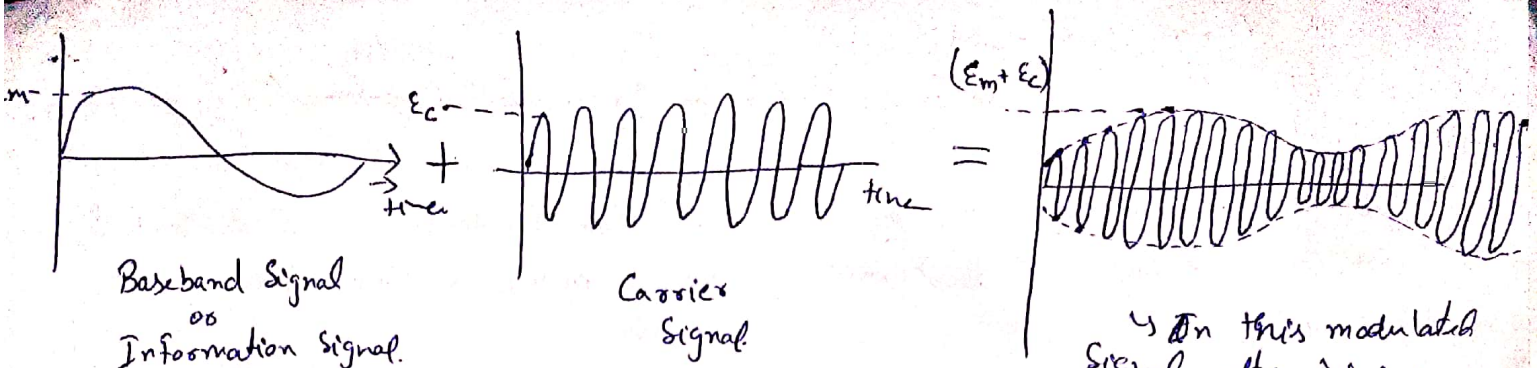
- Reduction in height of an antenna.
- Avoids the mixing of signals (interference)
- Makes multiplexing Possible.
- Increases the range of communication.

=> Modulation can be done on the actual signal by imposing it on an additional signal called carrier signal which will carry our signal from one place to another.





1) Amplitude Modulation — Process of changing the amplitude of the high frequency carrier signal w.r.t to the instantaneous value of the modulating signal



Baseband Signal
or
Information Signal
or
Modulating Signal

Carrier Signal

↳ On this modulated Signal after joining every peak of this signal we will get the Information Signal.

→ Amplitude varies.
Phase & Freq. remains Same.

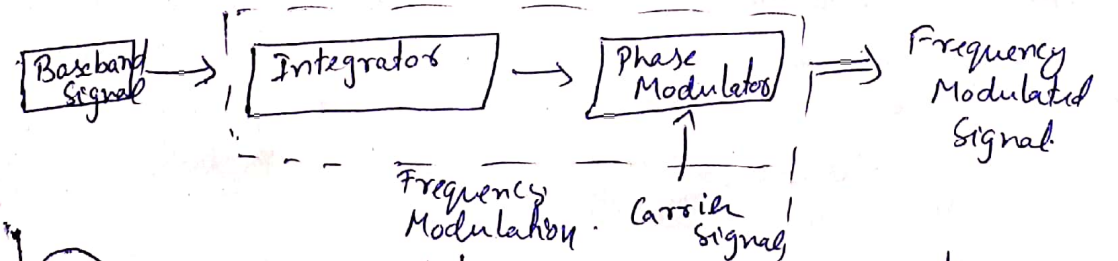
⇒ Advantages of AM →
- ↳ less Complex.
- ↳ AM receivers are simple, detection is easy.
- ↳ AM waves can travel long distance.
- ↳ Low Bandwidth.

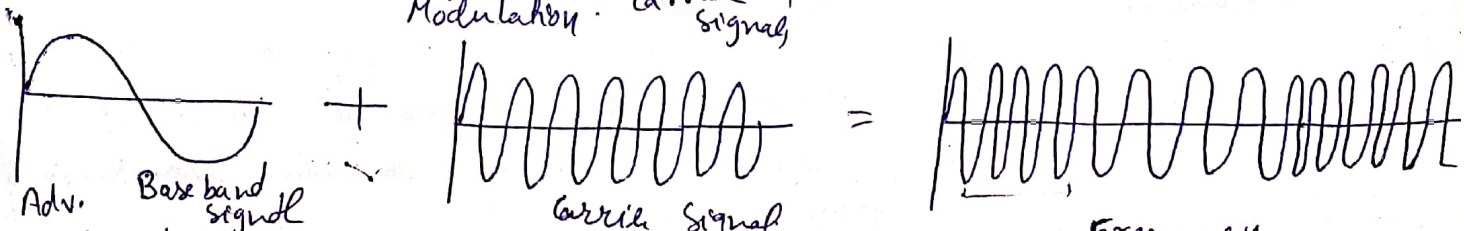
Disadv.
- → Power wastage is ~~more~~ here.
- → AM is less immune to Noise.

App. → Radio transmission
→ Picture transmissions in TV systems

2.) Frequency Modulation.

↳ The frequency of carrier signal varies w.r.t to modulating signal or Base band signal while Phase & Amplitude remains same.





Adv. Base band signal

Carrier Signal

Frequency Modulated Signal

→ improved Noise immunity.
→ Entire transmitted signal is useful.
→ Large area coverage with same amount of transmitted Power.

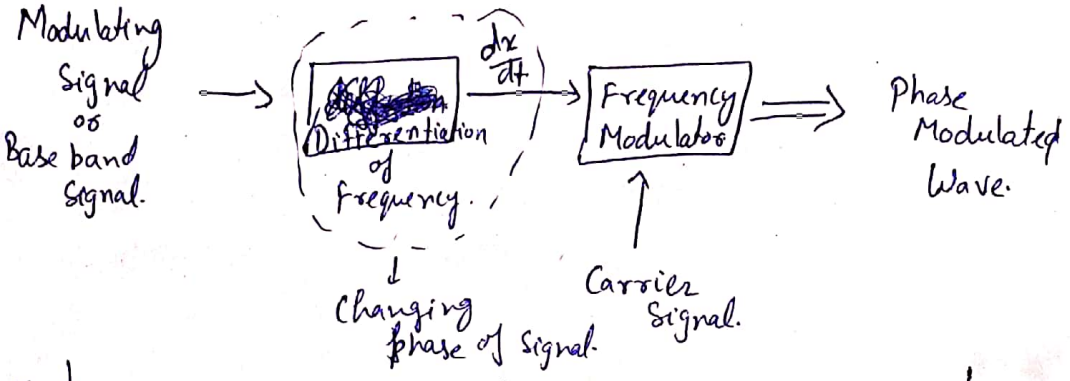
Disadv.
- ↳ large Bandwidth required.
- ↳ FM Transmitters & Receivers are very complex.

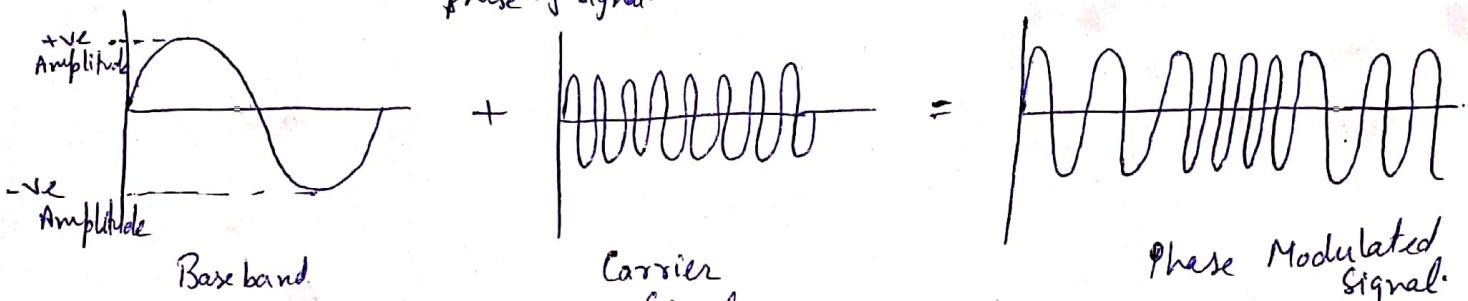
App: of FM

↳ Radio Broadcasting such as Radio mirchi etc.
↳ Sound Broadcasting & TV.
↳ Satellite Communication.

=> Phase Modulation

The Phase of the Signal varies while Amplitude & Frequency Remains Constant.





If Baseband Signal has +ve amplitude, Carrier Signal will lags w.r.t to Baseband signal.

or

Baseband signal will leads w.r.t to carrier signal.

If the modulating Signal or Baseband Signal has -ve magnitude,

→ Baseband signal will lags w.r.t to carrier signal.

or

Carrier leads w.r.t to Baseband Signal

Advantages of PM

↳ ~~Used~~ Improved Immunity towards noise.
↳ Allow communication on high speed

Disadvantages -

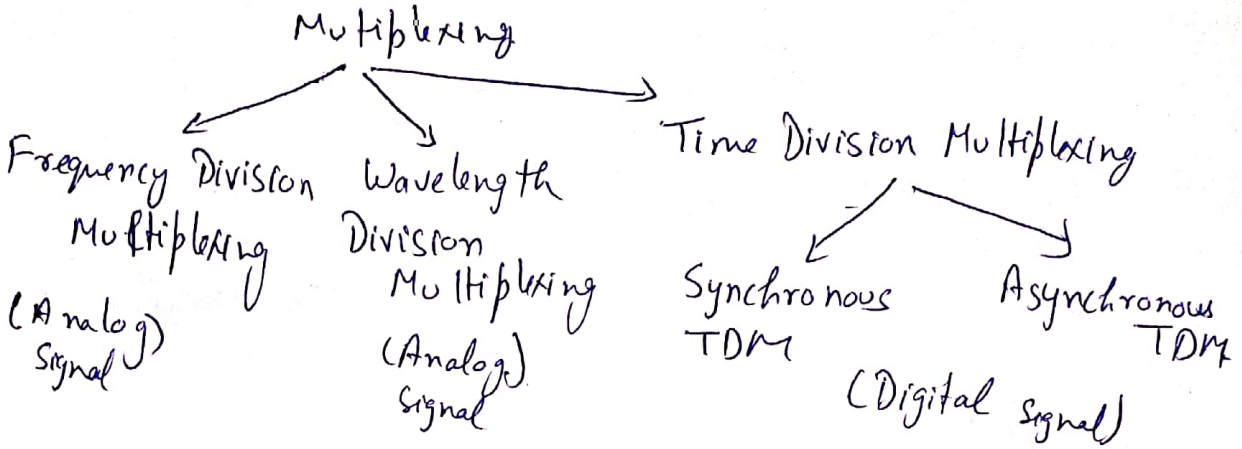
↳ Complex Structure.
↳ Phase ambiguity can be there.
↳ Phase modulation index can be enhanced by employing Frequency multiplier.

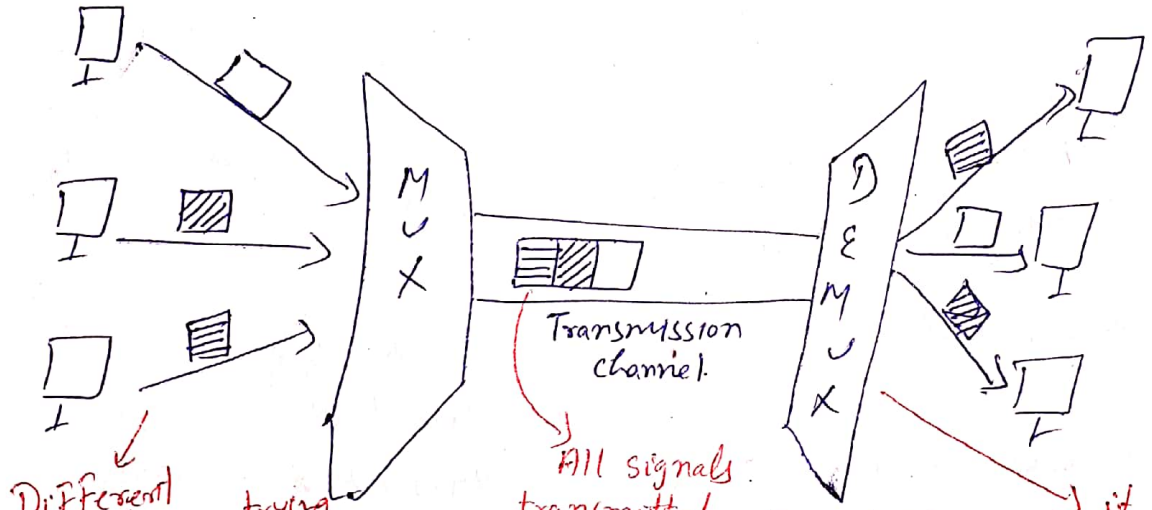
App.

↳ Useful in radio waves transmission
↳ used in wireless technology like GSM, wifi.

Multiplexing

↳ It is a set of techniques that allows the simultaneous transmission of multiple signals across a single data link.





Different devices are trying to transmit data at same time or simultaneously.

Multiplexer

All signals transmitted on same time travelling simultaneously on transmission channel

Demultiplexer.

it will seperate the signals received & transmit the particular signal to the desired destination only

Working of Multiplexer.

Need of Multiplexing

↳ To share the bandwidth b/w all users
↳ To reduce no. of physical connections b/w multiple devices
↳ To increase the capacity of channel
↳ To ↑ the speed of transmission.
↳ To make signal secure
↳ To make communication cost effective.

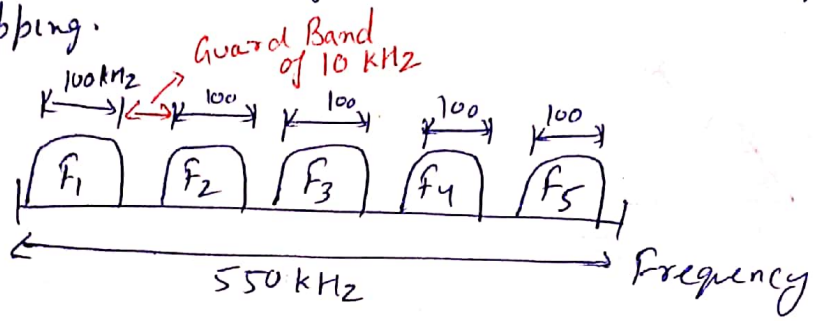
→ Frequency Division Multiplexing

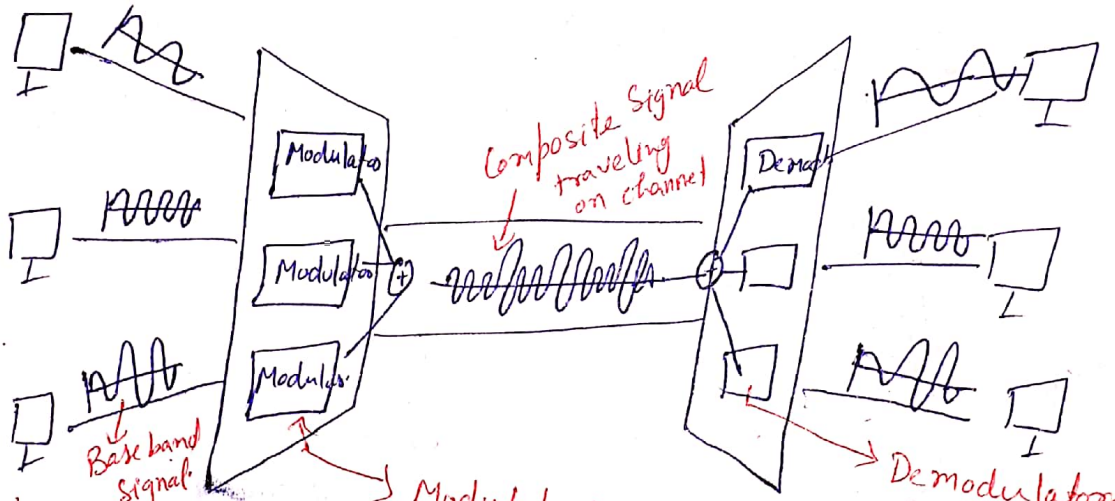
It is an analog technique in which the signals of diff. frequencies are combined for simultaneous transmission.

The total bandwidth is shared by the multiplexed devices at a time. Different frequencies are allocated to the users to avoid any kind of signal interference

→ Guard bands are used to differentiate the frequencies.

↳ These are the strips of unused bandwidth to prevent the signal overlapping.





↳ Nodes transmitting signals on diff. frequencies.

Modulators in Multiplexers modulate the signals, combine the signals & forward/pass it to the transmission medium.

Demodulators in Demultiplexers seperate the signals acc. to their frequencies & transmit to the specific device require the signal of that particular frequency

Advantages

↳ Doesn't need synchronization b/w transmitter & receiver device.
↳ Simple & easy modulation.
↳ Used for analog signals.
↳ large no. of signals can be transmitted simultaneously.

Disadvantages –

↳ Signal Interference is more.
↳ Distortion can be there.

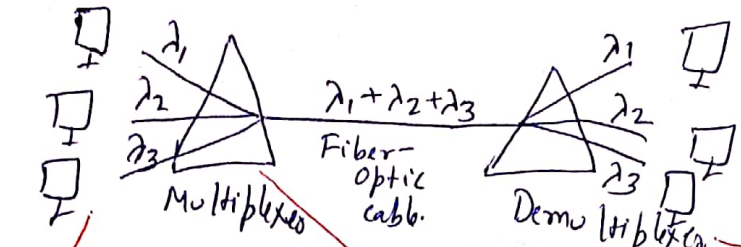
App. → ① AM & FM Broadcasting. ② used for Public telephones & in cable TV systems

(5) Wavelength Division Multiplexing

It is used for high data-rate transmission through fiber-optic cable. It is similar to the FDM except that the multiplexing & demultiplexing involve optical signals transmitted through fiber-optic channels.

→ WDM is an analog multiplexing technique to combine optical signals.

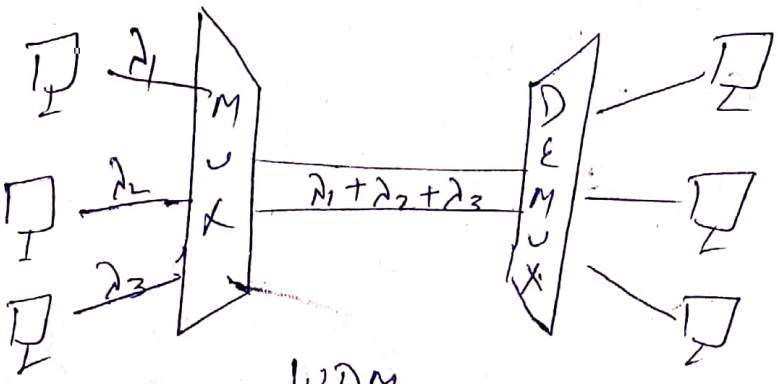
→ WDM technology is very complex but uses the simple idea of combining & scattering of light sources just like prism.



Devices transmitting Signals of different wavelength.

Combine all the light signals of different wavelengths

It will scatter the received light signal into diff. signals of diff. wavelengths.



WDM.

Advantages —

- Full Duplex transmission Possible.
- Reconfiguration Easy.
- High security
- High Bandwidth.
- less Physical connections.
- Performance is high.

Disadvantages

- Complex technique.
- High Maintenance
- Cost effective.

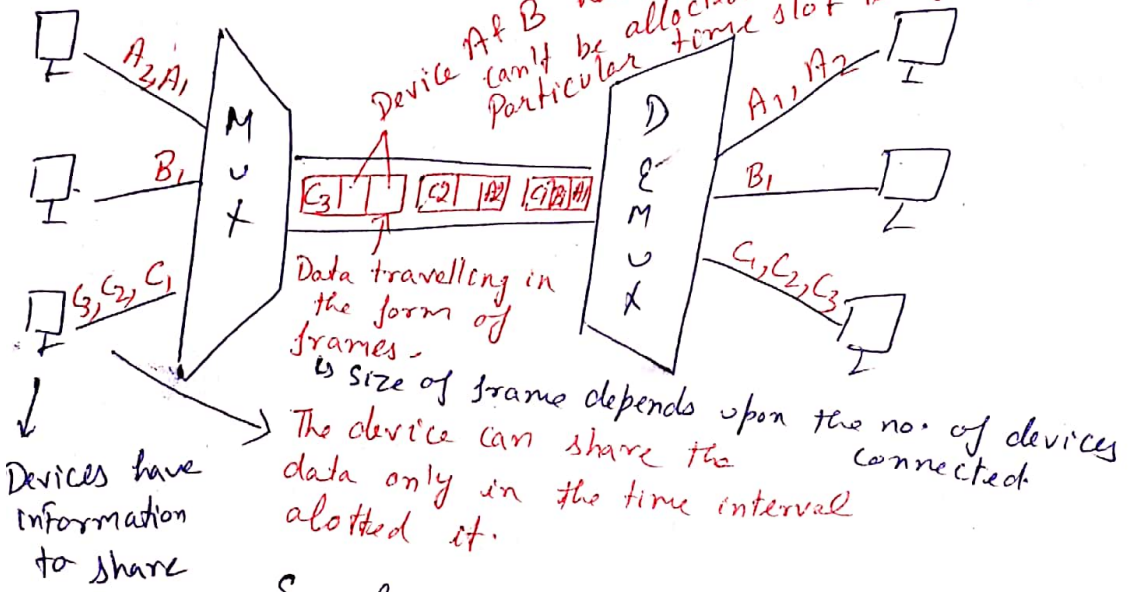
Application

- SONET (Synchronous Optical N/w).

3.) Time Division Multiplexing

It is a digital process that allows several connections to share the high bandwidth of a link.
Each connection occupies a portion of time in the link, i.e. Time is shared or like portion of the bandwidth.

- Each user device is alloted a small time interval during which it can transmit its data.
- Types of TDM
  - Synchronous TDM
  - Asynchronous TDM.



- Size of frame depends upon the no. of devices connected.

Synchronous TDM.

In Synchronous TDM, each device is allotted a specific time interval to transmit the Data.
If the device has any information to transmit during his time interval, it can transmit the information. Otherwise the slot remain unutilized.

⇒ Asynchronous TDM.

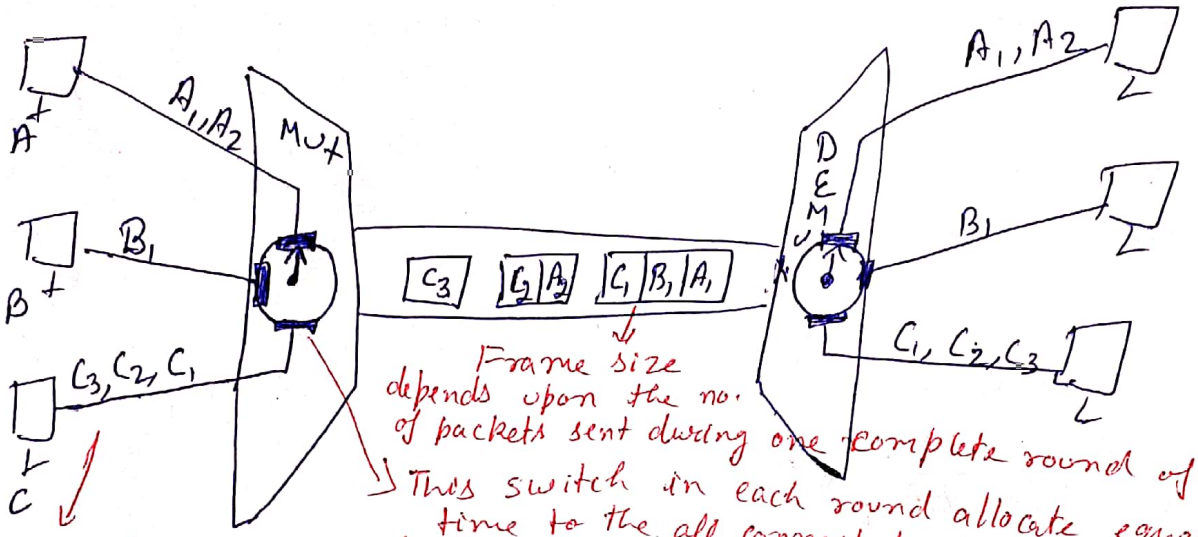
In Asynchronous TDM, the device which has any information to transmit can transmit randomly. The slots are allocated dynamically to improve the bandwidth efficiency.

- no. of slots in the frame can be less than the no. of input lines
- Multiplexer checks each I/P line in Round robin fashion i.e. each device will have equal time slot; but slot will be allocated only to the device which as some information to send.

↳ In Asynchronous TDM, a slot needs to carry data as well as the address of the destination.

↳ Interleaving is performed on the both side multiplexers.

On multiplexing side, as the switch opens in front of a connection, that connection has the opportunity to send a unit onto the path.



Frame size depends upon the no. of packets sent during one complete round of time.

Thus switch in each round allocate equal amount of time to the all connected devices. If any device Devices has diff. amount of data to transmit during the time interval, allocated to it, has any information to send, can transmit it Asynchronous TDM.

↳ Advantages
- ↳ Proper Channel Utilization
- ↳ No time slot wastage.
- ↳ Throughput is high.
- ↳ Distortion is absent.

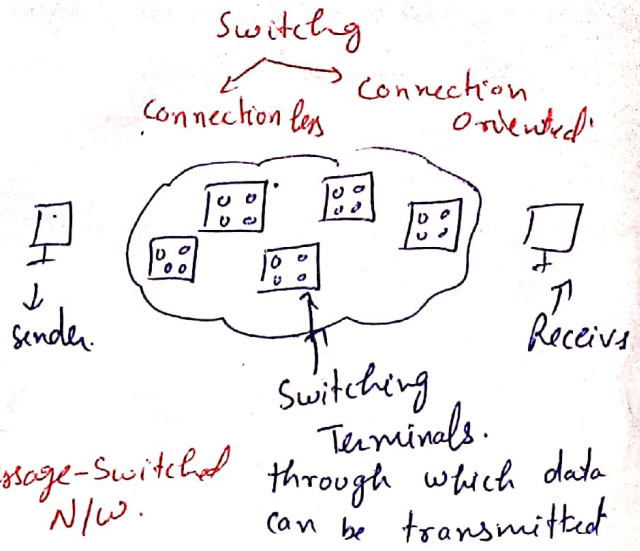
↳ Disadvantages
- ↳ Initial cost is high.
- ↳ Complexity is more.
- ↳ Probability of Bit Error.

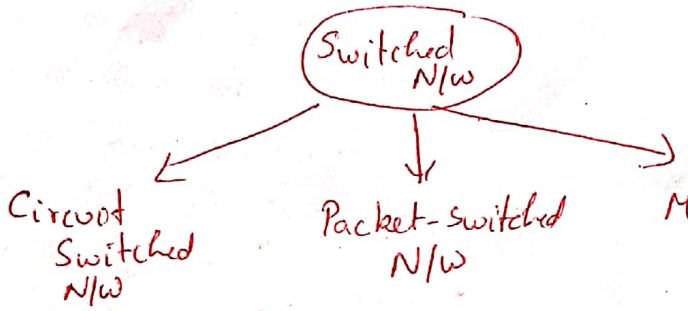
Application
- ↳ Used for long-Distance Communication.
- ↳ Used in telephone lines.

Switching -

A switched N/w consists of series of interlinked nodes, called switches. Switches are devices capable of creating temporary connections b/w two or more devices linked to the switch.

Three methods of switching are used
→ Circuit switching.
→ Packet Switching
→ Message Switching.

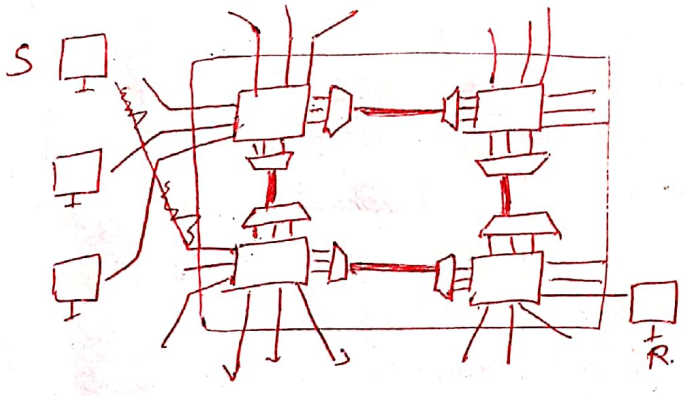


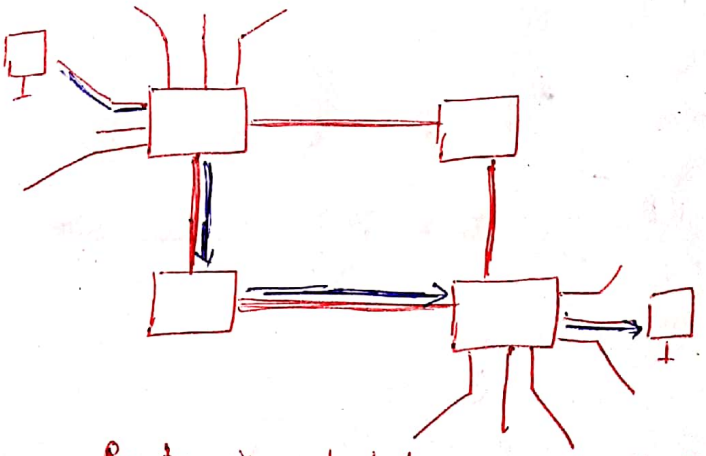


1) Circuit Switched N/w -

When two nodes communicate with each other over a dedicated comm. path. It is called circuit switching. There is a need of pre-specified route from which data will travels & no other data is permitted.

→ It works with Connection-oriented method.
  ↳ To transfer data, circuit must be established.
→ Circuits can be temporary & permanent.
→ The channel is divided by using FDM or TDM.
→ The resources need to be reserved for data communication until the connection ends.



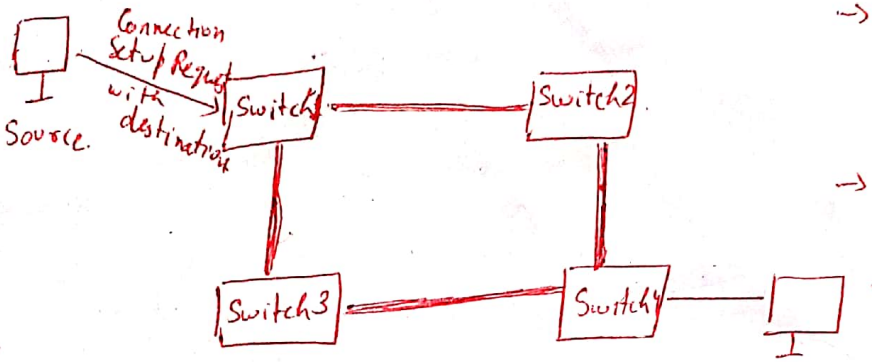


→ The communication in circuit-switched N/w requires 3 phases:
  1) Setup Phase
  2) Data Transfer Phase
  3) Teardown Phase.

Route is selected in the setup Phase for communication.

1) Setup Phase-

For communication, a dedicated circuit needs to be established. A setup request is sent from the source for communicating with destination to the connected switch. Then switch further send the request to the connected switches and so on until the request reaches to the destination.



→ Switch 1 finds the channel b/w itself & Switch 3. It sends the setup request to Switch 3.

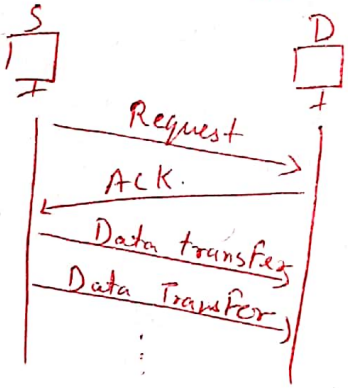
→ Switch 3 finds the channel b/w switch 4 & itself.

→ Switch 4 sends the setup request to Destination device destination on the behalf of source.

→ IF Destination accepts the request. ACK will be sent back to the source from that dedicated path & Connection is setup for Data transfer.

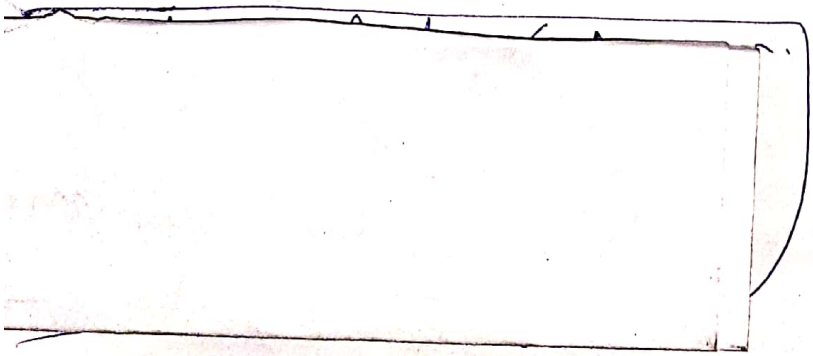
2) Data Transfer Phase

After establishing the dedicated circuit, the two devices can transfer data.



3) Tear Down Phase.

When One of the Parties needs to disconnect, a signal is sent to each switch to release the resources.



Eg - In telephone comm. system, normal voice call is the e.g. of Circuit Switching in which the service provide maintain an unbroken link for each telephone call.

→ Establish the circuit
→ Transfer data
→ Disconnect the circuit.

Adv. of Circuit Switching.

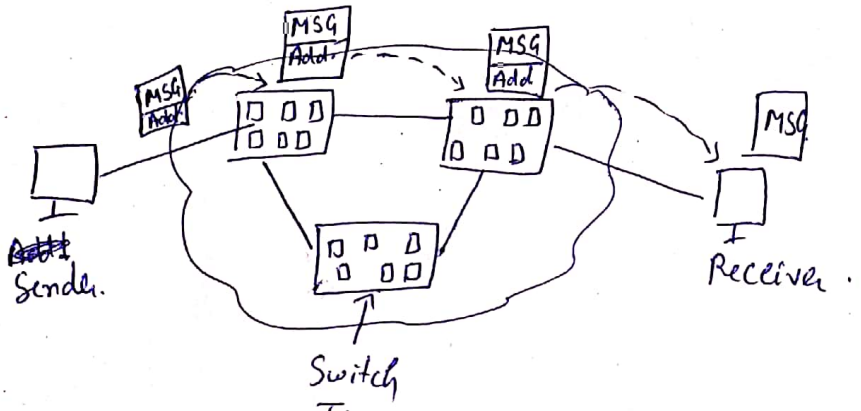
→ The dedicated path guaranteed data rate.
→ No wastage of time; once the connection is established data is transmitted without delay
→ Long Continuous transmission possible.

Disadvantages -

→ As the connection is dedicated it can't be used to transmit any other data even if the channel is free.
→ Inefficient in terms of utilization of system resources.
→ Dedicated channels require more bandwidth.
→ The time required to establish a physical link b/w the two stations is too long.

⇒ Message Switching

The whole message is transmitted without requiring the pre-establishment of dedicated path b/w Sender & receiver.



→ The Sender Appends the Address of Receiver with the Message.
→ The Switching Terminal acts as a keeper of Msg for some time period i.e. it will Store & forward the packet when channel is available to it.
→ Entire Message is stored on the intermediate switch and then transmit the message to next node.
→ This N/W is called Store - forward N/W.

Advantages -

↳ No need to establish the connection.
↳ No dedicated path is required.
↳ Channelk efficiency is better
↳ Traffic congestion can be reduced.

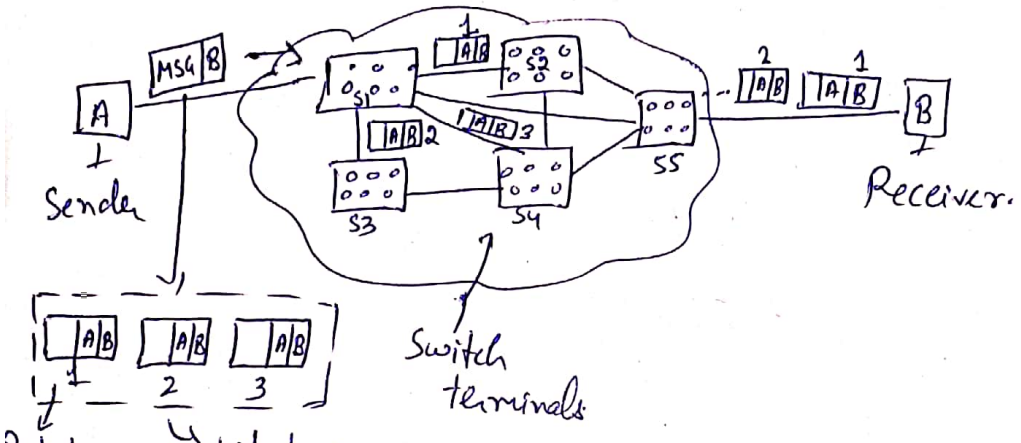
Disadvantages -

↳ Msg Switching is very slow bcoz of Store - and - forward method.
↳ If next node doesn't have enough resources to accommodate large size msg, the switch has to store the msg & wait till the resources are not available.
↳ The internal storage of Switch is used to store the whole message
↳ Not recommended for real-time transmission like voice & video

Applications
↳ Used for transferring E-mails

Packet Switching

The complete message is divided into small-small chunks called Packets & each Packet will have the sequence no. with it.
→ Each Packet includes Source, Destination & intermediate node address. So the packet can be transmitted individually.



Advantages-
↳ Resource Utilization is better as compare to Packet Switching.
↳ Required Bandwidth for transmission is low.
↳ Packets can move independently over N/w.
↳ Congestion over the transmission N/w is lower.
↳ Transmission delay is less.

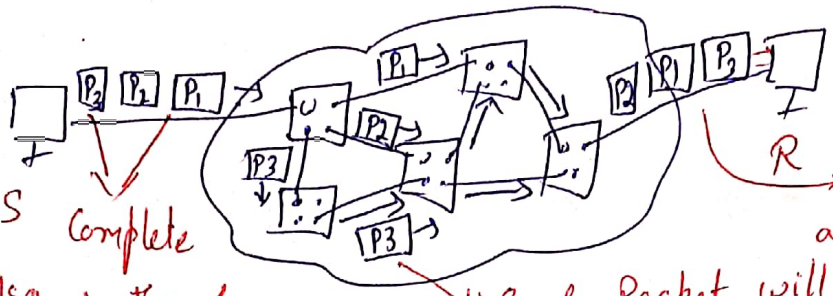
Disadvantages-
↳ Packet loss chances are more.
↳ Doesn't guarantee the delivery of all packets.
↳ Data Packets can be received in wrong Order.

Applications
↳ Used for Data transmission over N/w.

Types of Packet Switching N/ws.
↳ Datagram N/w
↳ Virtual Circuit N/w.

1) Datagram Packet Switching N/w.

In this the whole msg is divided into small packets. Then the each packet will be transmitted independently over the switching terminals from Sender to the receiver node.



Complete Msg in the form of packets.

The Packets can be arrived in random order at Destination.

Each Packet will have Seq. No, Add. of Sender & Receiver.

Info	Addr. Source	Addr Desti	Seq. no.

Each Packet is transmitted to the connected switching device from it will be forwarded to the Next Available resource at that time.

* All the Packets may or may not follow the same path for each packet's ~~depart~~ transmission.

2.) Virtual Circuit N/w –

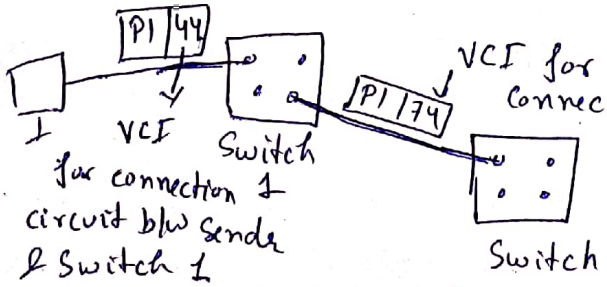
It is the combination of Circuit Switched N/w & Packet Switched N/w. In this, like Circuit Switching, a temporary Circuit is created b/w Source & destination for the transmission.

It is connection-oriented switching. ~~In case~~ Resource allocation can be done during the setup Phase or On-demand. All packets follow the same path established during the connection.

→ Virtual Circuit Identifier (VCI) is used for data transmission.

Every Switching terminal has Incoming Ports as well as Outgoing ports.

Each connection from one switch to another have different & unique VCI no.



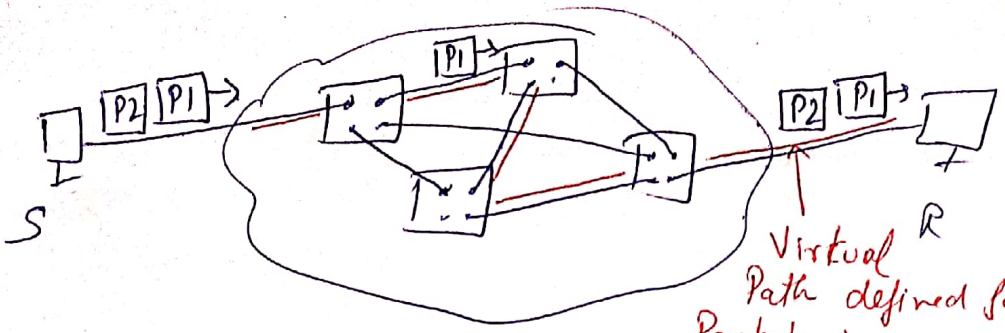
For connection 1 circuit b/w Sender & Switch 1

Incoming		Outgoing	
Port	VCI	Port	VCI
1	44	3	74
1	36	2	68

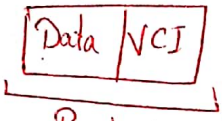
Suppose Switch1 has this Routing table for data received at one port & other

For this Virtual Circuit

→ Switch 1's Port 1 if receives a Packet with VCI no. 44, then it will be transmitted towards the respective Outgoing which in this case is Port 3 with VCI no. 74.



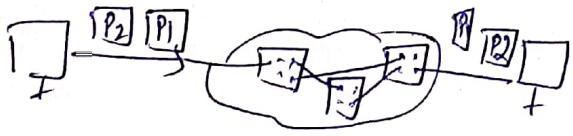
The Path followed by the 1st Packet will be used by rest of the packets from the same Sender node untill the transmission of all packets.



→ No need to attach the address of S & R.
→ The Sequence No. is also not required.

Datagram N/W

→ Connection less
→ No Reservation of resources in advance.
→ Random Packet receiving at Receiver End.



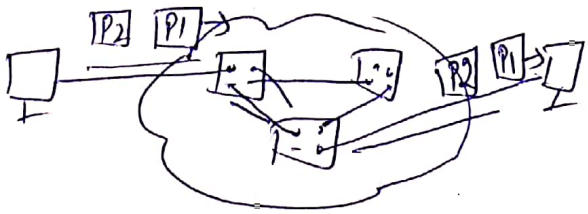
Random Order

→ Overhead is high as we attache the add. of Sender, Receiver & Seq. no. with each Packet.
→ Packet loss is high.
→ Packets travels independently.

e.g. Used in Internet.

Virtual Circuit N/W

→ Connection Oriented.
→ Resource Reservation is done in Setup Phase.
→ The Order is same as the order of packets transmitted from Sender node.



Same order.

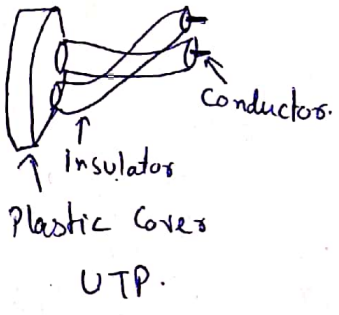
→ Overhead is less as we just attach VCI with each packet.
→ Packet loss is less
→ Packets will follow the same path decided during the set up Phase.
→ e.g. X. 25

Circuit Switching	Msg switching	Packet switching.
① Physical Connection b/w Sender & Receiver.	No Physical Path is established.	No Physical Path established
② All packets will follow same path to transmit.	Packets are Stored & forward.	Packet travels independently.
③ Need an End-to-End Path before data transmission.	No need of end-to-end path.	No need of End-to-End path
④ Reserves the entire bandwidth/channel in advance.	Don't reserve channel in advance.	Don't reserve channel in advance.
⑤ Wastage of channel is possible.	No wastage of bandwidth/ channel.	No wastage of Channel.
⑥ Not suitable for handling interactive traffic.	Suitable for handling interactive traffic.	Suitable for handling interactive traffic.
⑦ Complete message is transmitted as soon as it is received on dedicated Path.	If resource not available on next device, switch will store whole msg & forward when resource available.	The whole message is divided into small packets and transmitted to diff. switches available.
⑧ Ab. Telephone Calls.	Email Transfer	Voice, Video transmission over internet.
⑨ Connection-oriented Switching technique	Connection-less	Connection-less

Medium-1

Transmission Medium

- Guided Medium
  - Twisted Pair Cable
    - STP (Sheilded Twisted Pair Cable)
    - UTP (Unsheilded Twisted Pair Cable)
  - Coaxial Cable
  - Fibre-Optic Cable.
- UnGuided Medium
  - Radio
  - Microwave
  - Satellite.

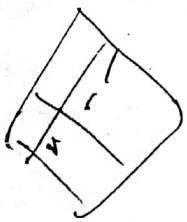


UTP.

Types of T.P.C
- Cat 1 - Telephone (least grade)
- Cat 2
- Cat 3, Cat 4, Cat 5 — LAN
- Cat 6
- Cat 7 — superior Quality

→ RJ45 - connector is used to connect UTP.

Applications →
- Used in Telephone lines
- In LANs.



It has one central core conductor of solid or stranded wire [copper] enclosed in an insulating sheath which is encased in an outer conductor of metal foil.

The outer metallic wrapping serves both as a shield against noise & as a second conductor, which completes the circuit.

→ whole cable is protected by Plastic Cover.

Categories of Coax

Category	Use.
RG-59	TV Cable.
RG-58	Thin Ethernet
RG-11	Thick Ethernet

→ Attenuation is higher in co-axial cable, so we need repeaters.

→ Applications.

Used in Analog telephone N/Ws where single Co-axial N/W can carry 10,000 voice signals.

→ TV Cable uses RG-59 coaxial cable.

Fibre Optic cable is made of glass or plastic & transmit signals in the form of light.

Optical fibers use reflection to guide light through a channel.

Propagation Modes
- Single Mode
- Multimode

The critical angle is close enough to 90° to make the propagation of beams almost horizontal.

Multiple beams from a light source move through the core in diff. paths.

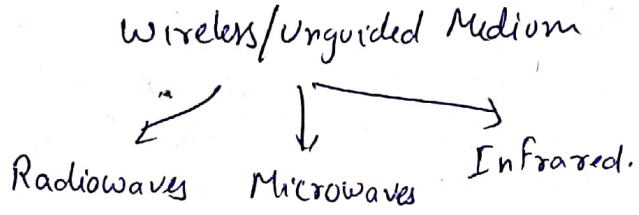
→ Advantages-
- Higher Bandwidth.
- less Signal Attenuation
- Immunity to electromagnetic interference.
- Light weight.
- immunity to tapping

Disadv.
- → Installation & maintenance.
- → Unidirectional
- → Cost effective

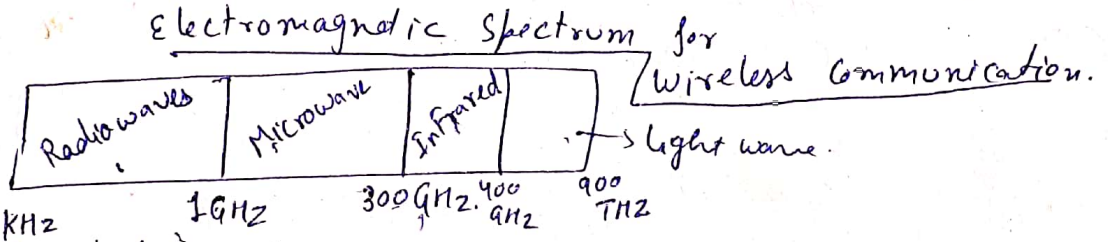
→ Unguided Medium.

Unguided Signals can travel from S to Dest. in several ways.

↳ Ground Propagation
↳ Sky Propagation
↳ Line-of-sight Propagation.



The signals are normally broadcast through free space & thus are available to anyone who has a device capable of receiving them.

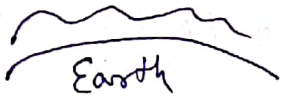


The electromagnetic spectrum defined as radiowaves & microwaves is divided into 8 ranges called Bands.

1) Ground Propagation

The radiowaves travel through the lowest portion of the atmosphere. These low-frequency signals emanate in all directions from the transmitting antenna & follow the curvature of planet.

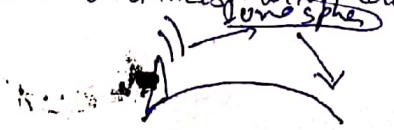
→ Distance depends on the amount of Power of Signal.
↳ more power → more distance coverage.



2) Sky Propagation–

The higher-frequency radio waves radiate upward into the ionosphere and then reflected back to earth.

It allows the transmission for greater distances with lower o/p Power.



3) Line-of-Sight Propagation

Very high frequency signals are transmitted in straight lines directly from Antenna to Antenna. Antennas must be directional, facing each other.

Ground Propagation

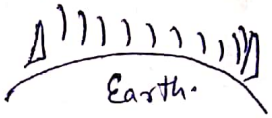
→ Range : Low frequency signal can be transmitted (kHz to 2MHz)

→ Low energy gk signal is transmitted.

→ The wave will follow the curvature of earth to travel from one Antenna to another.

→ Energy loss is high.

→ Attenuation is more.



Ground Propagation

→ Used for local Radio transmission.

Sky Propagation

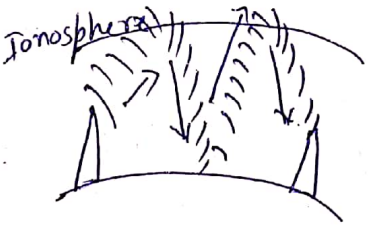
Range : Higher frequency signal (2MHz to 30MHz) can be transmitted.

→ High energy signal is transmitted

→ The wave is transmitted in ionosphere and from where it is reflected back to the earth & same may follow untill it reaches the destination.

→ Energy loss is less.

→ Less Attenuation.



Sky Propagation.

→ Short wave, AM radio broadcast.

→ Long distance Point to Point communication

Line of Sight Propagation

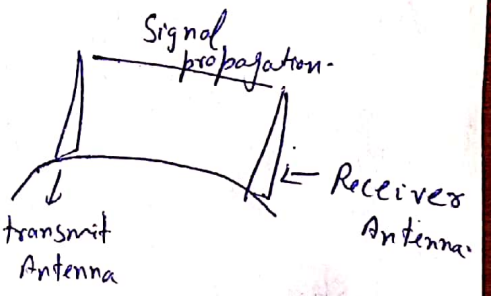
Range : above 30MHz

Higher frequency signal can be transmitted.

→ The Transmitting antenna & Receiving antenna must be facing each other

→ Signal of higher energy can be transmitted.

→ If there is some obstacle b/w sending & Receiving antenna, then signal Attenuation is possible



→ Used for transmission of Infrared & Microwaves

eg. TV & Remote control.

Electromagnetic Spectrum – It is the range of frequencies of electromagnetic radiation & their respective wavelengths. The radiowaves & microwaves are divided into eight ranges, called Bands. These bands are rated from very low frequency (VLF) to Extremely High frequency (EHF).

	Band	Range	Propagation	App
(1)	Very low Freq.	3 – 30 kHz	Ground	Long range Radio navigation.
(2)	Low Freq.	30 – 300 KHz	Ground	Radio beacons & Navigation locators
(3)	Middle Freq.	300 KHz – 3 MHz	Sky	AM Radio
(4)	High Freq.	3 – 30 MHz	Sky	Ship/Aircraft comm.
(5)	Very High Freq.	30 – 300 MHz	Sky & line of sight	VHF TV, FM radio
(6)	Ultra High Freq	300 MHz – 3 GHz	Line of sight	UHF TV, Cellular Phones, Satellite.
(7)	Super High Freq	3 – 30 GHz	"	Satellite comm.
(8)	Extremly High Freq	30 – 300 GHz	"	Radar, Satellite