

Computer Network:-

A Collection of interConnected Computer/devices/nodes that are able to communicate with each other is known as a Computer Network.

* The interconnection can be wired/wireless.

* The Communication refers to sending and received data.

* A Network is simply a way/line of communication b/w two nodes.

⇒ Network Hardware :-

The physical equipments used to build a connection b/w two nodes are known as Network hardware.

Ex:- Cables, Modem, Router.

Categoriz-

Network Topology :- [Topology ⇒ arrangement

-ing
network
based

The logical Arrangements of nodes in a network, is known as the network topology.

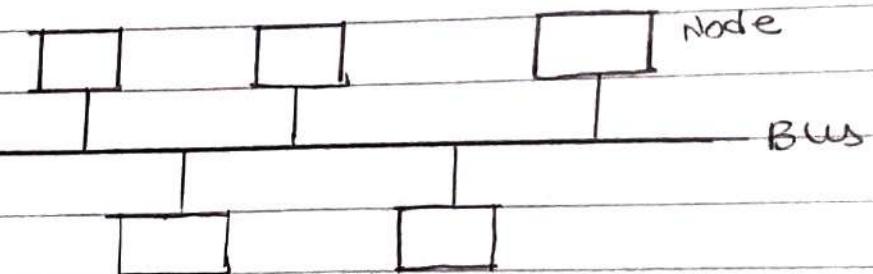
on * These are of (6) types :-

Arrangement
of nodes

- ① Bus
- ② Ring
- ③ Star
- ④ Tree
- ⑤ Mesh
- ⑥ Hybrid

① Bus Topology:-

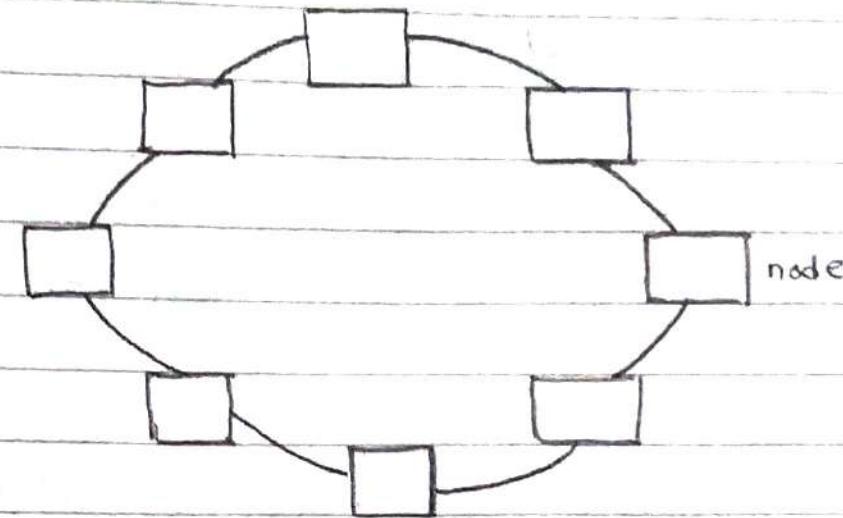
- * All nodes are connected to a common long cable, known as a Bus.
- * If a node wants to send data to another node, the ~~no~~ Sender node places the data in the bus and then the bus carries the data to the Reciever node.



* Disadvantage:- two/more Computers Cannot Communicate Simultaneously i.e., Only one node can put the data into the bus at a time.

② Ring Topology:-

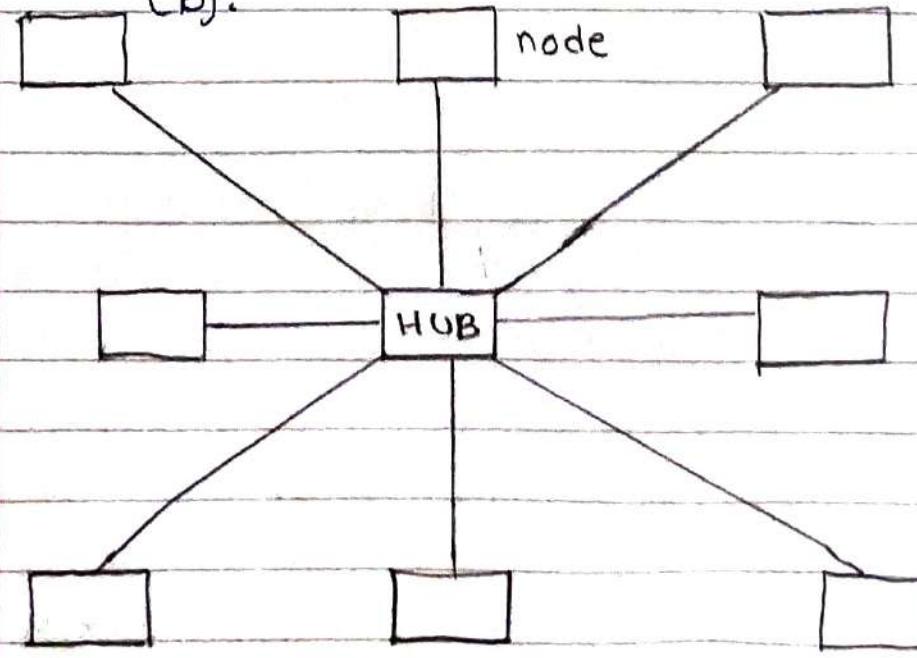
- * The computers/nodes are connected in the form of a ring.
- * Each node has two adjacent neighbours.
- * To send data to a distant node, the data passes through ~~many~~ many intermediate nodes.



* Disadvantage:- Even if one node fails, the whole network breaks down.

③ Star Topology:-

- * All nodes are connected to a Common Central node, known as a hub.
- * To send data from a node (A) and node (B) in the network, the receiver receives the data first, from the node (A). Then, it transfers it to the node (B).



* Hence, the Central hub plays a major role in this type of Network.

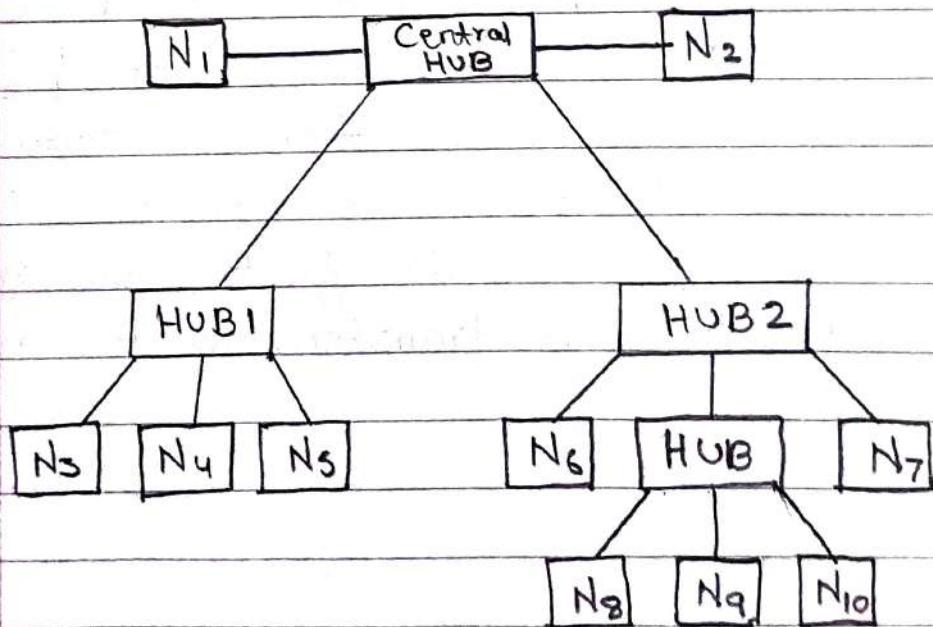
disadvantage:- The whole network breaks down if the central hub fails.

④ Tree Topology:-

A hierarchy of hubs to which the nodes are connected as children, is known as tree topology.

* The Root hub is known as central hub.

~~root node~~



Ex- $N_1 \rightarrow N_2 : N_1 \rightarrow \text{Central hub} \rightarrow N_2$

$N_3 \rightarrow N_5 : N_3 \rightarrow \text{HUB1} \rightarrow N_5$

$N_4 \rightarrow N_7 : N_4 \rightarrow \text{HUB1} \rightarrow \text{Central hub} \rightarrow \text{HUB2} \rightarrow N_7$

⑤ Mesh Topology:-

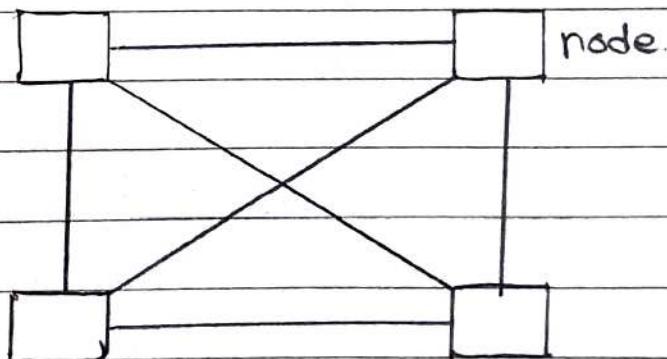
* A node is Connected directly to Every other node in the network.
i.e., if there are (n) nodes in a network, then a node has (n-1) Connections.

* The no.of Connections in the network are :-

$$\frac{n(n-1)}{2}$$

where,

$n \Rightarrow$ no.of nodes.

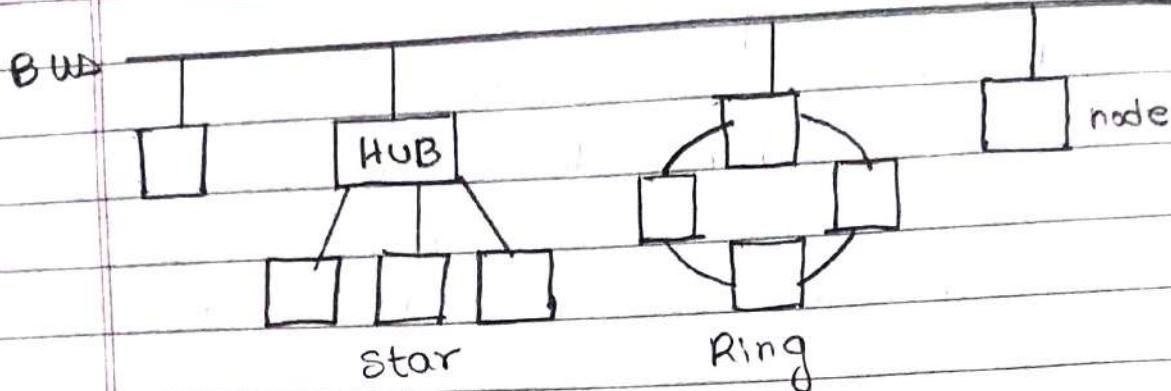


*disadvantage: The network is Complex and Costly to build.

⑥ Hybrid Topology:-

* It is formed when two/more topologies are Connected together.

Ex:- Creating a hybrid topology by using Bus, Star and ring topologies:-



Categorization of Network based on the
Range :-

- ① LAN
- ② WAN
- ③ MAN
- ④ PAN

① Local Area Network [LAN] :-

* It is a private network that covers the small area, such as office, home, etc.

* This network is limited upto a building or a campus.

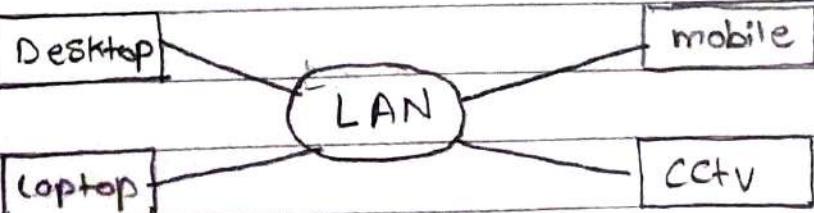
LAN

→ Range: upto 2 KM

→ Technology used: Ethernet (and) WiFi

→ Area: within building.

→ Ownership: private.



~~QUESTION~~

② Wide Area Network [WAN] :-

- * It is a public/private network that covers large area, such as a city, country, etc.
- * LANs are connected with WANs.

WAN

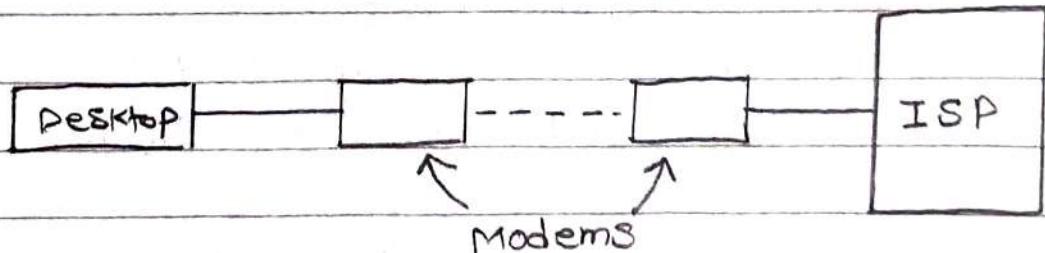
- Range: ~~upto~~ Above 50km.
- Technology used: Leased Line, Dial-up.
- Area: within Countries.
- Ownership: public/private.

* This Network is of two types:-

- (i) Point-to-Point
- (ii) Switched.

(i) Point-to-Point WAN :-

The Network is used to connect a LAN with an ISP (Internet Service provider) which requires atleast two modems.



(ii) Switched WAN :-

In this Network, all the nodes are connected to a Subnet.

* A Subnet is a Collection of Switches.

* A Switch refers to a Router.

* The Subnet (Collection of Switches)

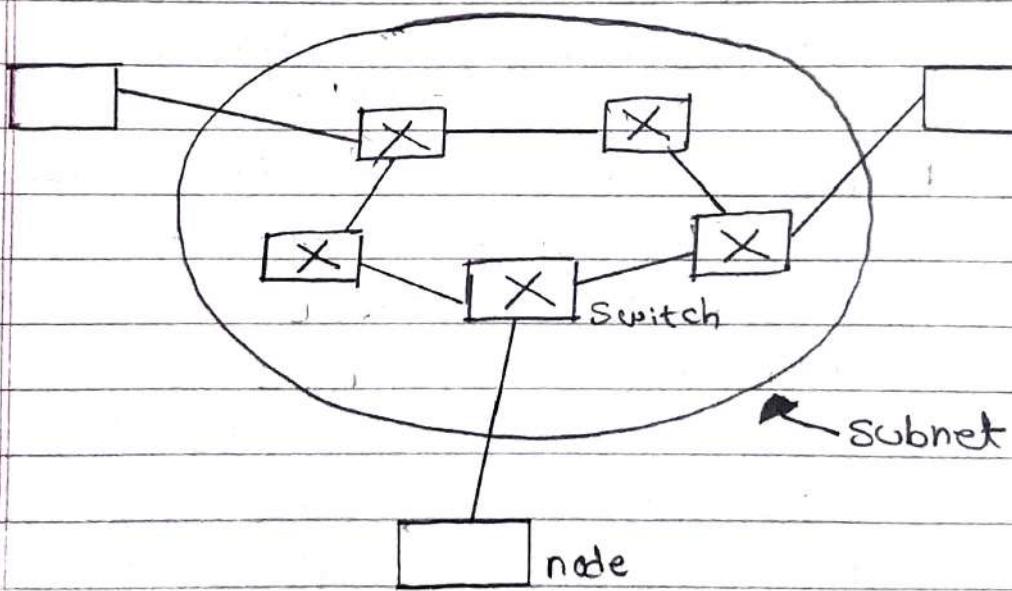
provide the following facilities :-

↳ Packet Forwarding

↳ Routing (Reaching destination)

↳ Data traffic optimization.

↳ Link/path Selection (high speed network)



③ Metropolitan Area Network (MAN) :-

A Network Similar to LAN but larger than LAN and ~~also~~ smaller than WAN is Known as MAN.

MAN

Ex - Cable television

→ Range: 5 - 50KM

→ Technology used: FDDI, CDDI, ATM

→ Area: within a city

→ ownership: public/private

(4) Personal Area Networks (PAN):-

A network that interconnects several computing devices which must be located physically together.

PAN

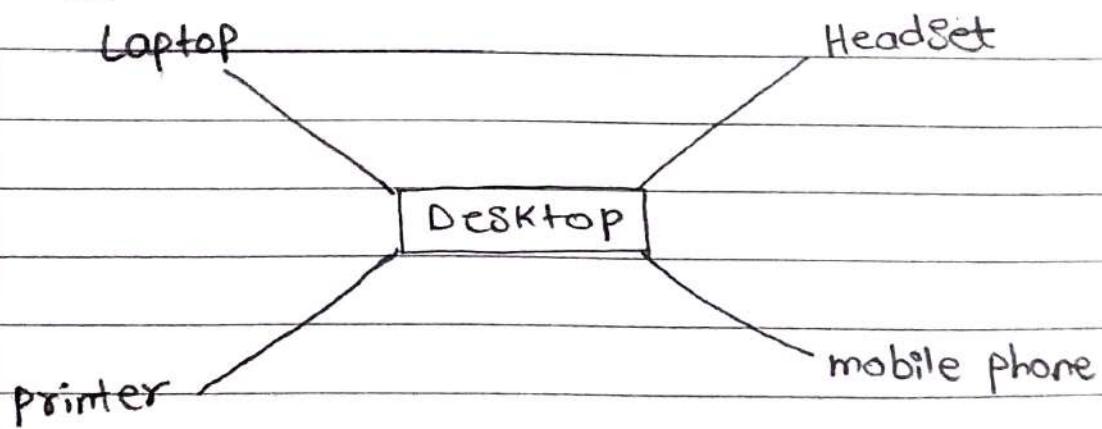
→ Range: 1 - 100 Meter

→ Technology used:- Bluetooth, USB, hotspot.

→ Area: within a Room.

→ ownership: private.

Ex:-



⇒ Network Software

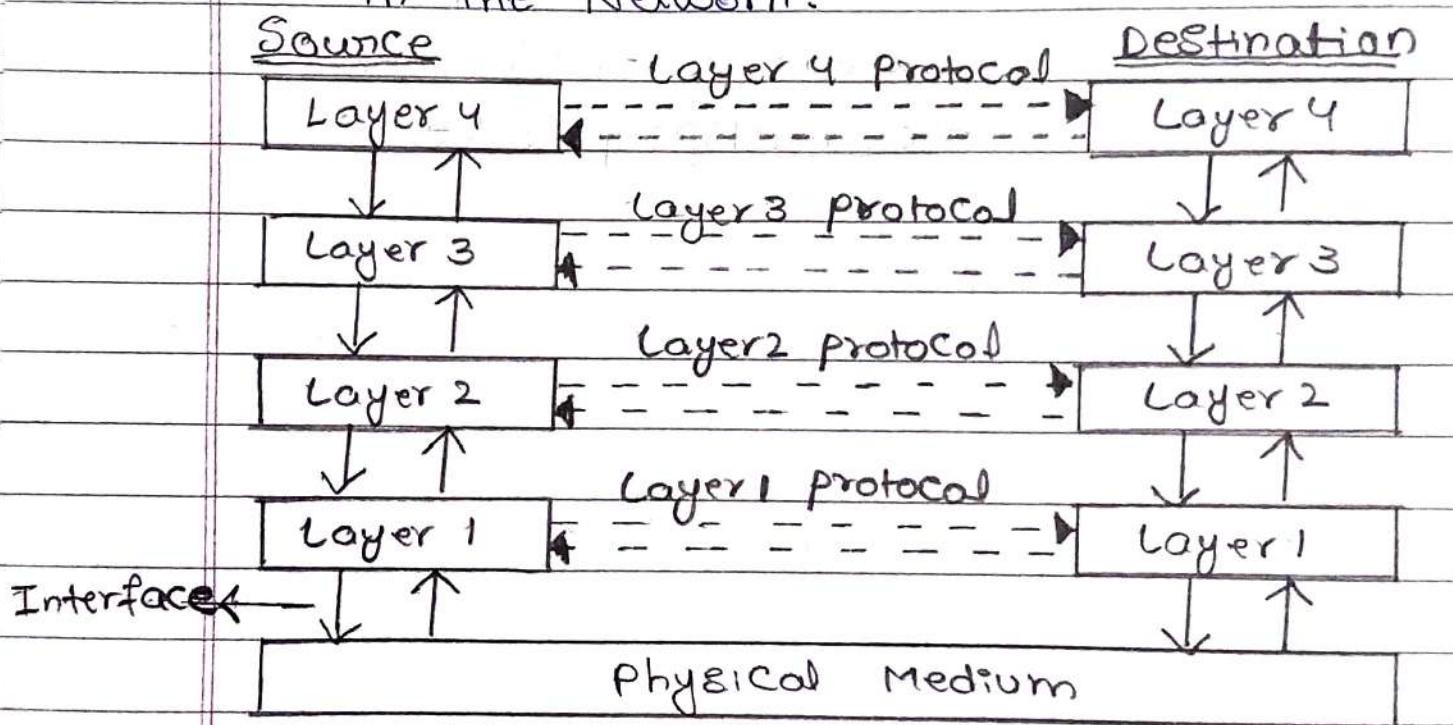
The Software of a Network is designed based on Layered Model.

* In layered Model, the Components of a Network with similar functionalities, are organized into a single Module. i.e., the whole Architecture of the Network is modularized based on the functionalities and services.

* Each layer have its own protocol to communicate with the same type of layer in another computer.

i.e., two computers must use same layered model to communicate.

* A protocol is a set of rules followed by a network layer to communicate with other computers in the network.



Elements of Layered Model :-

① Service (A layer) :- ~~functions~~

~~and~~ ~~provides~~ A similar set of functionalities which can perform

• a specific type of task.

② Protocol :- A set of rules used

by ~~the~~ a layer for exchanging data with its peer ~~the~~ (similar layer) entities.

③ Interface:- A channel that allows to transmit the messages from one layer to another.

④ Physical Medium:- The Actual hardware, Such as Cables, Satellites (or) other transmission media, over which the communication b/w two nodes occurs.

* If a layer(N) on a machine wants to send data to layer(N) on another machine, it will first sent to the layers below it, and then the data is transferred to the another machine, through the physical medium.

* When the data is sent by a layer to its lower layers, the specific protocol is initiated with which the specific layer at destination machine, is able to access the sent data.

Features of Layered Model:-

① Modularity:- The similar functionalities are modularized for easier understanding about the Architecture

② Independence b/w layers :- Changes made in one layer, does not affect the lower (or) higher layers.

Applications of Layered Model Reference Models

There are (2) models that are built using layered model, viz:-

- ① OSI Reference Model
- ② TCP/IP Reference Model

⇒ ① Open Systems Interconnection (OSI) :-

- * An open system is a system which is open for communication with other systems.
- * This model is used for connecting the open systems for their communication.
- * This model has seven layers (and) each layer is a package/collection of protocols and services.
- * These layers transmit the data among themselves, through the interfaces (communicating channel).

① Application Layer [Layer (7)] :-

- * This layer is used by Network Applications [APPS that run with internet], such as browsers, ~~Skype~~, etc.
- * Some of the protocols provided by this layer, are :-

- HTTP/HTTPS — for web surfing.
- FTP — for file transfer.
- SMTP — for emails, etc.

② Presentation Layer [Layer(6)]:-

The functionalities of the layer are (3), viz:-

- Data Translation [Encoding/decoding]
(changing the format of data)
- Data Compression (for fast transfer)
- Data Encryption [Encrypt/decrypt]
(for securing data) [SSL Protocol]

③ Session Layer [Layer(5)]:-

The functionalities of this layer are (2),

viz:-

- Establishing, maintaining, and terminating the communication sessions b/w devices.
- Synchronizing the data exchanges.

④ Transport Layer [Layer (4)]:-

This layer has three(3) functionalities:-

- Segmentation of data - dividing the data into multiple variable-sized partitions. ~~processes data sequentially~~
- Flow Control - Controlling the data transfer rate. [Mbps]
- Error Detection - A Checksum Value (a string of numbers and letters) associated

Connection protocol \Rightarrow Packet is transferred in segments.

Connectionless protocol \Rightarrow ^{whole}Packet is transferred at once

with each ~~data packet~~, is used to identify ~~non~~ non-transferred/incorrect segments ~~data packets~~ to re-initiate the transfer of that ~~segment~~. Segment

* The protocols with these functionalities are :-

(Connection Protocol) (1) TCP (Transport Control Protocol)

(Connectionless Protocol) (2) UDP (User Datagram Protocol)

* here, only TCP has the error detection functionality, ~~connectionless~~ (and) it is used for real-time data transfer, such as, file transfer, web-surfing, emails

* UDP is for live video calls, etc. ~~connectionless~~

⑤ Network Layer [Layer(3)]

This layer has two(2) Responsibilities :-

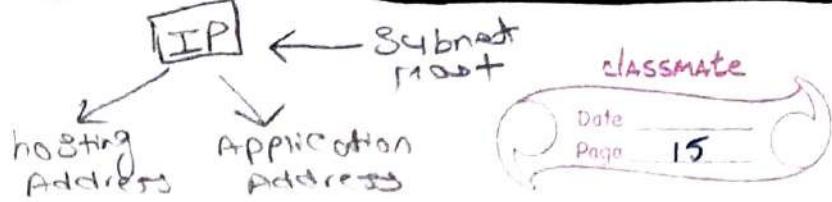
[Data Packing]

\rightarrow Route Addressing - Associating the IP addresses of source machine and destination machine, with the data segments, to form data packets
data packet \Rightarrow [IPs] Segment [IPo]

$X:X:X:X$ $X \Rightarrow 0-255$ IP (Internet Protocol) Address is a unique number assigned to a device within a network.

(One part of it tells about the device and other part tells about App)

\rightarrow Path Determination - determining the suitable (and) efficient path for the transfer of data packets, among



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multiple paths. [Each path goes to the corresponding device]

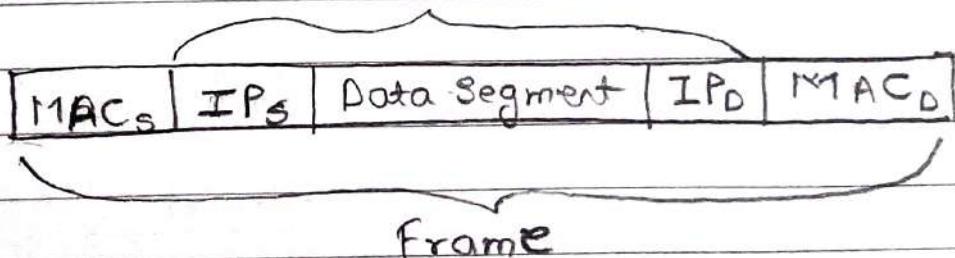
* The Subnet Mask ~~[x:x:x:x]~~ [$x:x:x:x$] is used to divide the IP Address into hosting Address and Application Address.

⑥ Data Link Layer [Layer(2)]:-

[Linking the data Packet with the device]

This layer, assigns the MAC (Media Access Control) Address [device identity number] of the source machine and destination machine, to the data ~~blocks~~ packets.

data Packet



* This process of Assigning MAC Addresses to the data packets, is known as framing.

⑦ Physical Layer [Layer(1)]

This layer represents the medium, through which the ~~blocks~~ binary data can be transmitted.

* The frame here, is nothing but

a binary sequence of bits (0,1)

* These bits of frame are transmitted to the destination device, in the form of Signals.

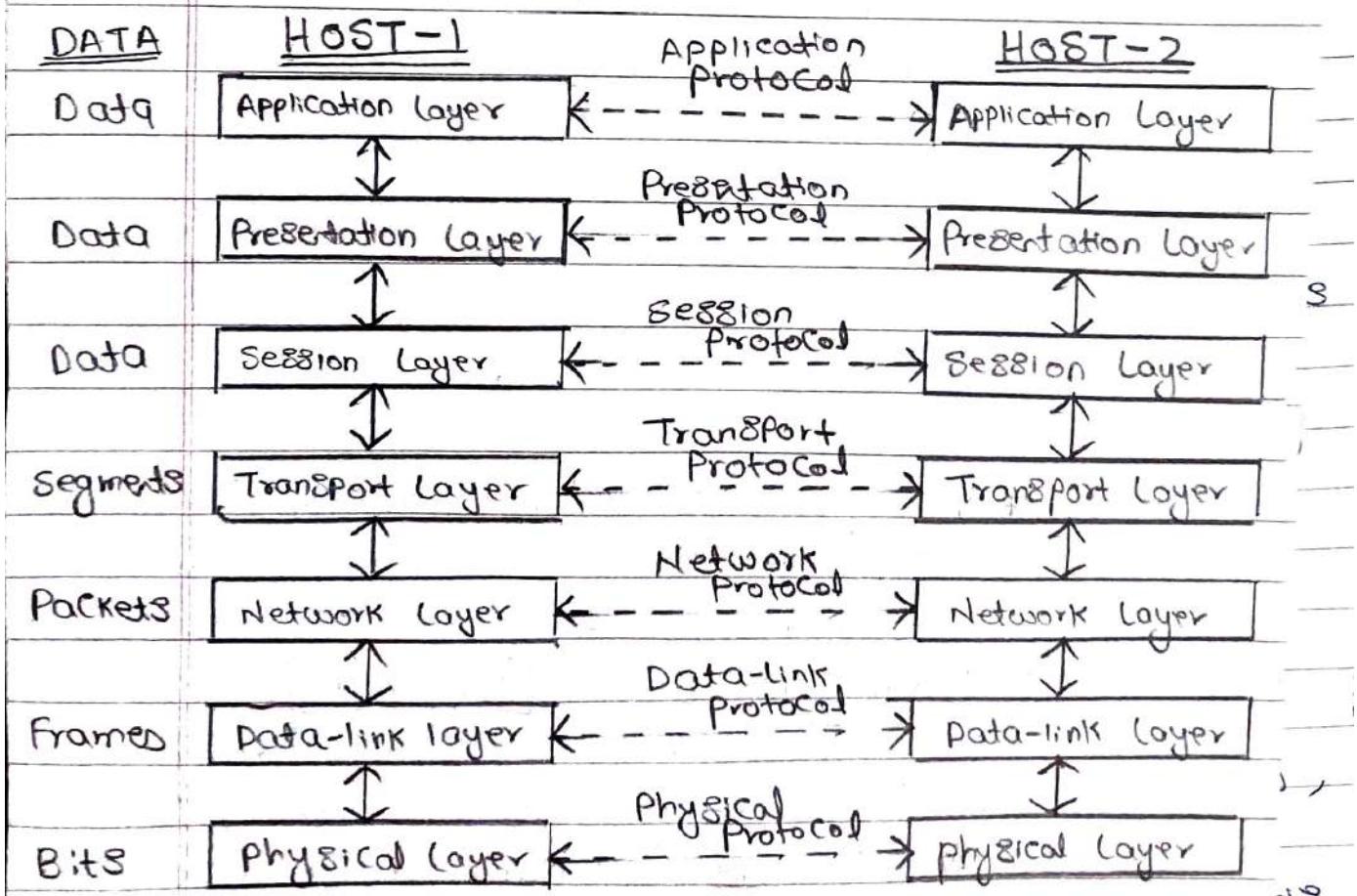
* The Signal can be of three types [based on the material used in physical layer], viz:-

If the Physical ~~does~~ medium is :-

(1) Cable, the signal is Voltage.

(2) Optic fibre, the signal is light.

(3) Air, the signal is Radio wave.



* The same process is followed in reverse order, ~~back~~ from the physical layer to Application layer, on the Destination device.

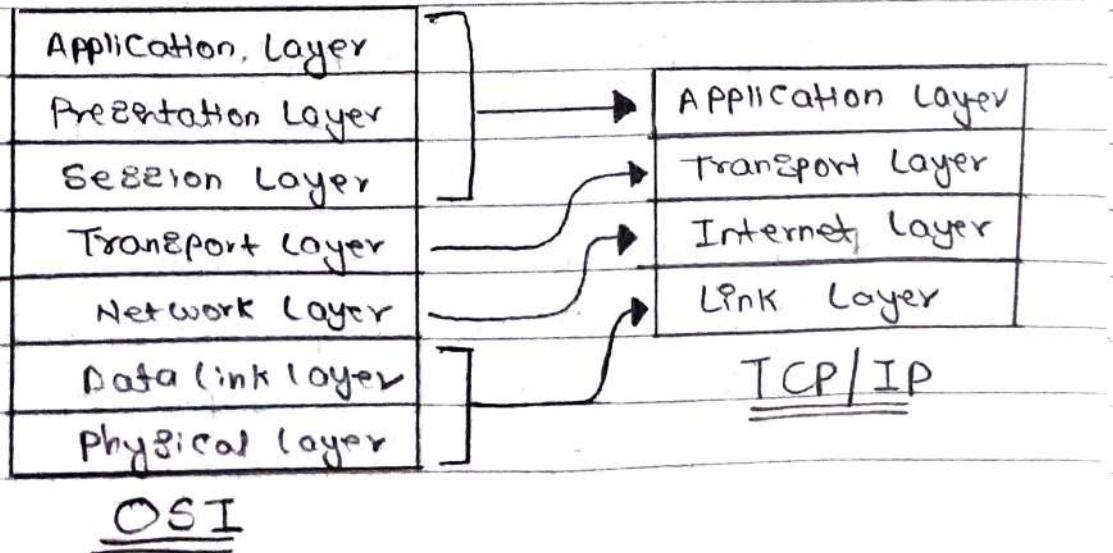
② TCP/IP (Transmission Control Protocol / Internet Protocol)

* Some of the layers of OSI Model are merged together to form a single Layer, to form TCP/IP Model.

* The Reason for merging is to have better performance and to have global compatibility.

i.e., any two types of network devices can communicate with each other, irrespective of operating systems, (or) device type, etc.

* Hence, the TCP/IP Model is a (4) layered Model and is more reliable and global compatible than OSI Model.



* As a result, the the protocol of different layers are merged into the single layer in TCP/IP Model

⇒ Physical Layer

The lowest layer of a Network ~~Communication~~ Model [OSI OR TCP/IP]

which represents a medium through which the actual bits of the frames (containing the data packets) are transmitted, to make inter Communication possible, is known as the physical layer.

* The bits are transmitted in the form of Signals.

* Based on the type of Medium, Signals are of three types, viz:-

① If (Medium = Cable), then

(Signal = Voltage)

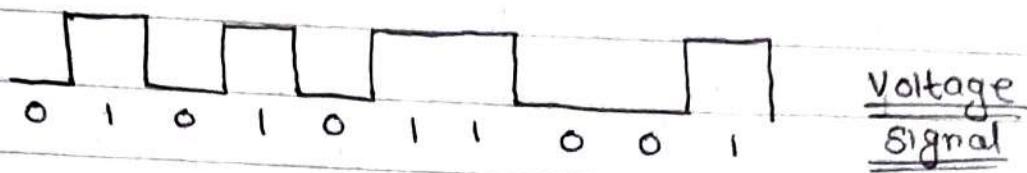
② If (medium = optic fibre), then

(Signal = light pulse)

③ If (Medium = Air/vacuum), then

(Signal = Radi wave).

* In the Case of Cable, Every high voltage represents the bit (1) and low voltage represents the bit (0).



through Cables

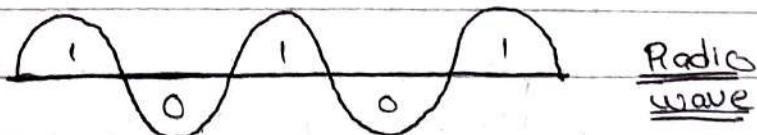
- * In the case of optic fibre (a glass wire), Every "ON" state of light represents the bit (1) and Every "OFF" state represents the bit (0)

"ON" \Rightarrow bit - (1)

"OFF" \Rightarrow bit - (0)

~~In case of Air/Vaccum, the high amplitudes of Radio waves represents (1) and low amplitudes represent (0).~~

- * In case of Air/Vaccum, the crests represent bit (1) and troughs represent bit (0)



through Air/Vaccum [wireless]

- * The Medium is chosen in accordance to the preferences.

i.e., based on the Range, Speed, etc.

Functions of Physical Layer:-

- ① Bit Representation:- The frames, which consists of the data packets, are converted ~~into~~ into binary bits. These bits are then transmitted through the medium, in the form of signals.
- ② Data Rate:- The rate of transmission of data (bits per second) is denoted by this layer.
- ③ Synchronization:- The bit ~~and~~ transfer synchronization (ordering) b/w the Sender and Receiver, is handled by this layer.
- ④ Topology:- This layer represents a network topology such as Star, mesh, ring, etc. for establishing connection b/w multiple devices.
- ⑤ Transmission Mode:- This layer describes the transmission modes, such as Simplex (one-way communication), half-duplex (bidirectional ~~and~~ not - simultaneous), and full duplex (bidirectional and simultaneous).
- ⑥ Transmission Medium:- This layer represents the medium through which the data bits are transmitted, such as Cables, optic fibres, ~~or~~ Air/vaccum.

~~⇒~~ Transmission Media:-

It is a path that enables the Sender and receiver to be interconnected for the purpose of sending and receiving messages (data).

- * It is of two kinds, viz:-
- ① Guided Transmission Media
 - ② Unguided Transmission Media

(wired transmission) 2
(wireless transmission)

① Guided Transmission Media:-

It is a physical path which establishes the connection b/w Sender and receiver, enabling them to send and receive data in the form of voltage signal (or) electromagnetic wave signals [light pulses].

Ex)- fibre cables, metallic cables.

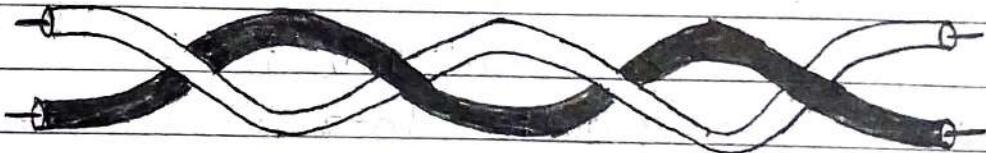
* There are ~~two~~ different types of it, viz:-

- ① Twisted Pair Cable
- ② Coaxial Cable
- ③ ~~Optical Fibre~~
- ④ Optical Fibre.

(a) Twisted Pair Cable:-

* The two Copper made ~~conductors~~ and insulated Conductors twisted together to reduce the noise [unwanted disturbance] caused by ~~electromagnetic interference~~ the Cross-talk [one Conductor interfering the other] through Electromagnetic ~~signals~~ interferences, are known as twisted Cables.

* The quality of signal in twisted pair cables depends upon the no. of twists per unit length, of the cable.



twisted Copper wires.

* Usage of TPC:-

- It is used for both analog and digital signal transmission.
- It is used in personal and business Computers for connecting them to the ISP.
- It can be used for horizontal wiring for LAN Connection installation.

* Types of TPC:-



(i) Unshielded Twisted pair cable

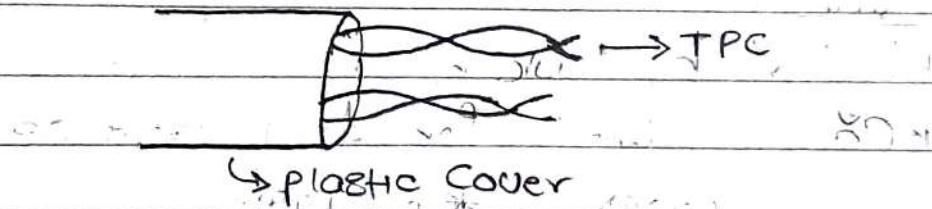
(ii) Shielded Twisted pair Cable

(i) Unshielded Twisted pair [UTP] Cable:-

~~A TPC in which each wire has a single plastic insulation without any shielding (additional insulation)~~

A TPC without any shielding around them, is known as ~~as~~ UTP Cable.

* It is highly used as Telephone Communication Cables and the Ethernet Cables.



Advantages:-

- * low Cost and easy to install Cables.
- * Can be used for both voice and data transmission.

Disadvantages:-

- * lower bandwidth.
- * Can only be used for Short-distance connections [max 100m]

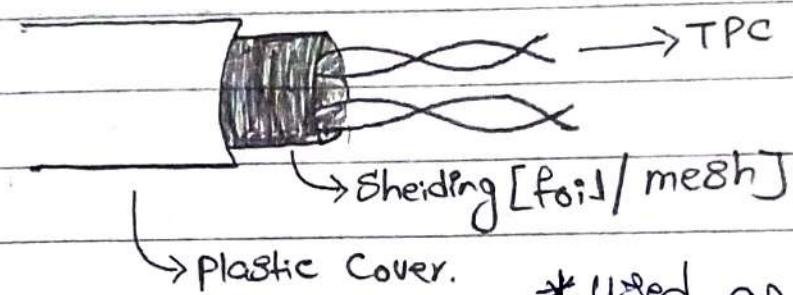
(ii) Shielded Twisted pair [STP] Cable:-

A TPC with a shielding around them made of foil (or) braided metal [threads]; is (mesh)

Known as STP Cable.

- * The Shielding is to provide ^{an} extra protection against electromagnetic interferences and Radio frequency interferences, by grounding it.

~~The shielding metal is grounded~~



* Used as underground cables

Advantages

- * higher bandwidth.
- * Can be used for long distance connections.
- * No interferences.

Disadvantages-

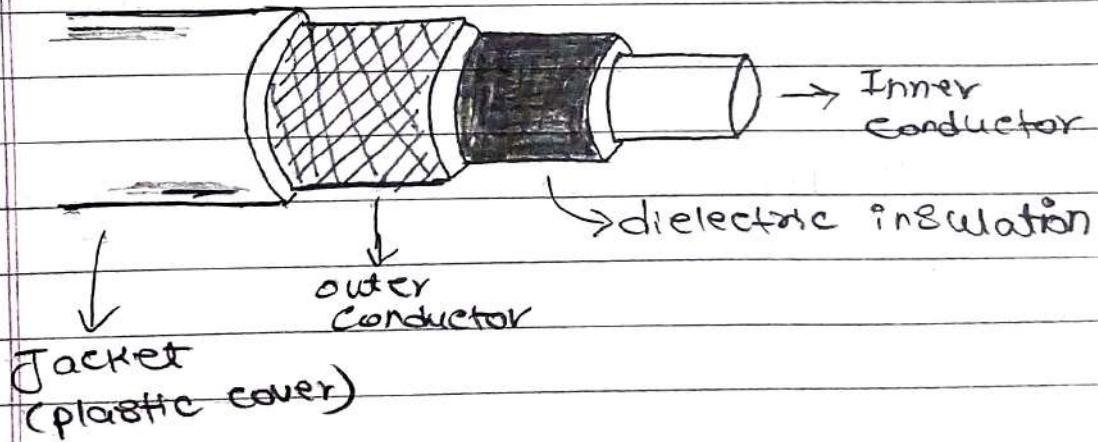
- * high Cost Cables

(b) Coaxial Cables:-

- * The Cables in which the Conductors are arranged in the form of layers, along the Central Axis, and a dielectric material is used as an insulation b/w them, are Coaxial Cables

- * The Central Conductor is known as inner conductor.

- * The layer ~~which~~ which surrounds the dielectric material is known as Outer Conductor.
- * The plastic cover Coated with the wire (which surrounds the outer conductor) is Known as Jacket.
- * The inner conductor is ~~built~~ built as a Solid Copper thick wire.
- * The Outer conductor is built as a Copper made mesh.



- * Co-axial Cables are mostly used as Television ~~cables~~, video, CCTV cables.

Advantages:-

- * Support high bandwidth
- * Easy to install
- * Cross-talk is minimum

Disadvantages

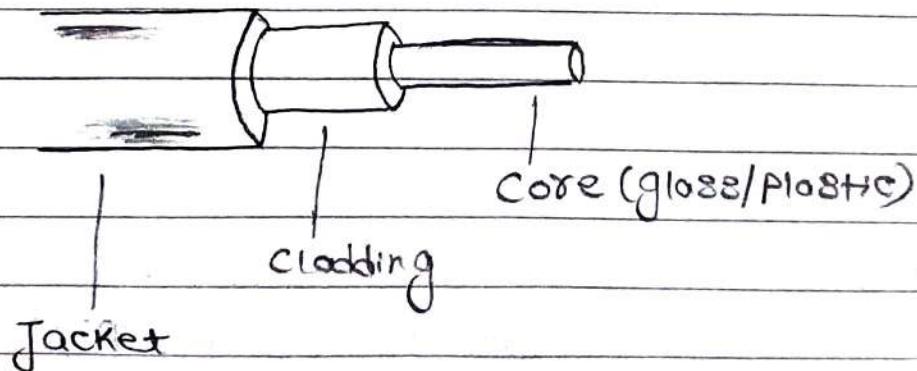
- * high cost.
- * Due to multiple layer, they are bulky cables.

*

(C) Optical Fibers:-

A thin and transparent dielectric material made up of glass (or) plastic, which carries the electro-magnetic waves of optical frequencies (i.e., visible, infrared lights) from one end of the fiber to the other end, by the principle of total internal reflection, is known as an optical fiber.

* It is made of three layers:-



* Cladding is a protective layer to the core which is made in such a way that its density is always lesser than that of core, So that light couldn't escape

from ~~Propagation~~ the Core.

* The most wide usage of this ~~cables~~ fibers are for data transmission for long distances [across countries].

i.e., the world wide internet [inter-communication network] is made possible with the use of fibres.

i.e., they are mostly used for WAN Connections.

Advantages:-

* It is the most fastest, efficient and widely used cables.

* A single fiber can carry 140MB of data upto 220 Km in one second.

* Can be used for long distances.

* External Electromagnetic disturbances does not effect the propagation of light, inside the core.

Disadvantages

* Joining two ends of ~~costly~~ separate cables is complex and expensive.

* difficult to install and maintain.

* very expensive.

Propagating Modes of Optical fibres:-

on the basis of no. of beam (rays) of light through a single core of an optical fiber, the propagations modes are classified into two types:

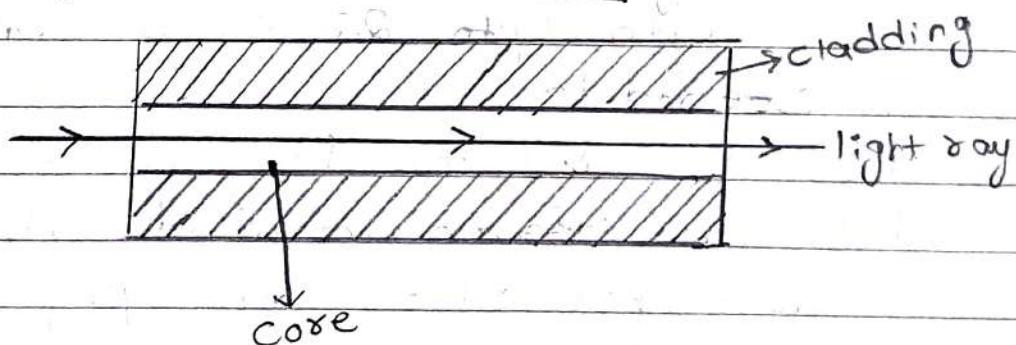
(i) Single Mode

(ii) Multi Mode

(i) Single Mode:-

In this mode, only one light ray is allowed to propagate through the core of the fiber, with the angle of 0° with the axis [i.e., no internal reflections].

* This mode is used for long distance transmission.



(ii) Multi-Mode:-

In this mode, multiple beams (rays) of light are allowed to propagate through the core of a fiber, with different angles with the axis [i.e., with internal reflection].

* This mode is used for Short

distance transmission.

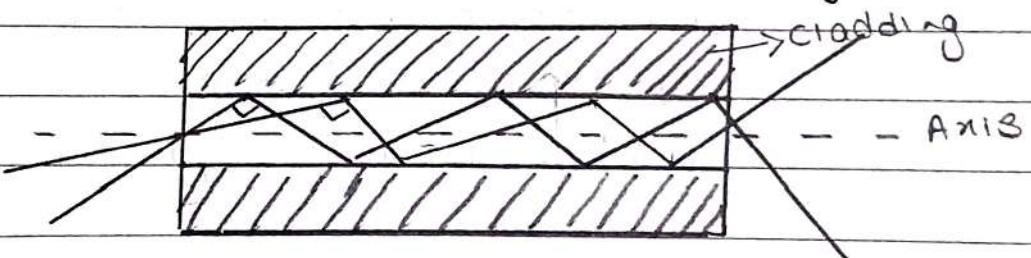
*Based on the Refractive index of the Core , it is of two types, viz:-

(i) Step-index multimode

(ii) Graded-index multimode.

(i) Step-index multimode:-

The refractive index of the entire Core is Constant, which makes the light rays to bounce back to the Core with 90° angle.



(ii) Graded-index multimode:-

The refractive index of the Core

decreases from Axis to the

Cladding wall , due to which the

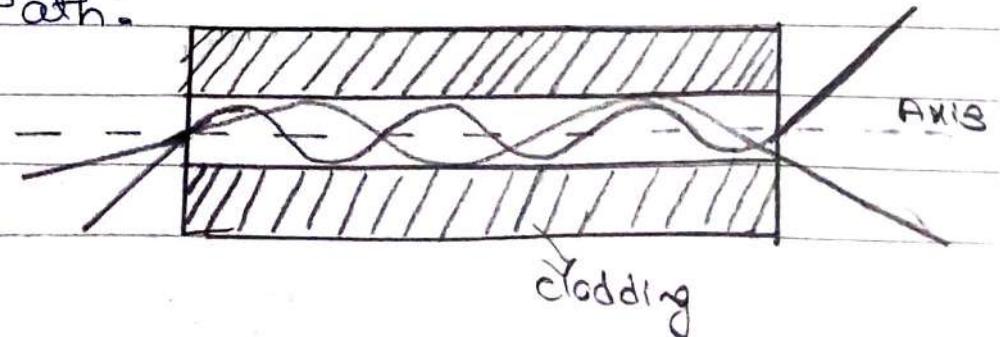
rays keeps on bending as the

refractive index decreases, which

makes the light rays to

propagate in a sinusoidal

Path.



② Unguided Transmission Media

[Wireless Transmission]



* The medium [Air/Vaccum/Seawater] through which the signals are transmitted in the form of ~~wires~~ Electromagnetic waves, is known as unguided transmission media.

i.e., There exists no physical path b/w Sender and Receiver.

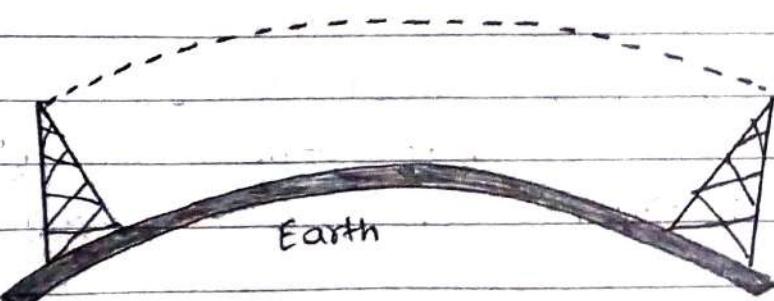
* Propogation modes of wireless Transmission.

- (i) Propogation through ground waves
- (ii) Propogation through sky waves
- (iii) Propogation through line-of-sight.

(i) Propogation through ground waves:-

It is when the signal propagates along the curvature of earth.

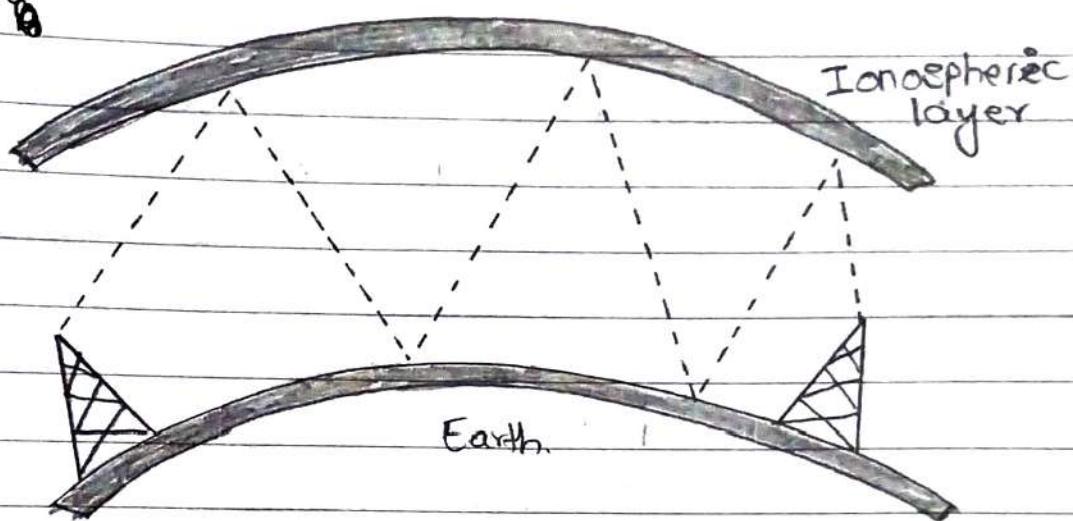
* The frequency can be upto 2MHz.



(ii) Propagation through Sky waves:-

It is when the signal is propagated by going through multiple reflections b/w the Ionosphere and Earth's Surface.

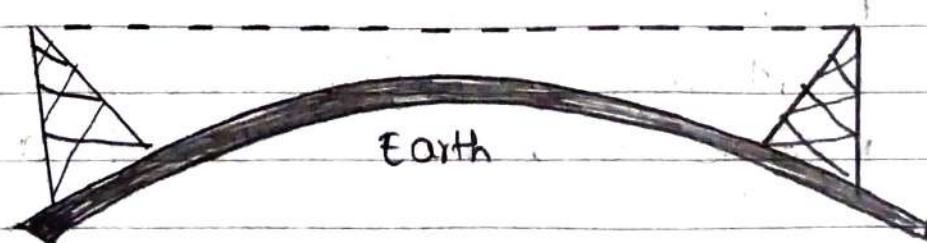
- * The frequency can range b/w 2MHz ~~to~~ to 30MHz



(iii) Propagation through Line-of-Sight:-

It is when the signal follows the straight line ~~to~~ path.

- * The frequency ~~to~~ can be above 30MHz.



* Types of Wireless Transmission

The signal used for wireless transmission is Electromagnetic waves.

* But, an Electromagnetic spectrum consists of ~~so many~~ many waves, differentiated based on the Frequency [no. of cycles per second].

* Hence, based on the ~~coress~~ frequency / wavelength of EM ~~is~~ signal, the wireless transmission ~~is also classified into~~ can be done with (3) types of EM waves, viz:-

(i) Radio waves

(ii) Micro waves

(iii) Infrared Rays.

(i) Radio waves ~~Transmission~~

~~other than~~ bluetooth

* These waves can travel large distances and can penetrate any wall.

* The frequency is ~~10⁴-10⁸~~ $10^4 - 10^8$ Hz

* These waves are generally used for transmitting sound and images \rightarrow ground wave

* Suitable Propagation modes are:- \rightarrow sky wave

(ii) Micro waves ~~Transmission~~

* These waves can travel along the straight path.

* The frequency is $10^8 - 10^{12}$ Hz

* Suitable Propogation modes are:-
→ line-of-sight.

* These waves are generally used for television and telephone(mobile) Communication [cellular network]

(iii) Infrared Rays:-

* These waves ~~are~~ are usually used for short distance communication due ~~to~~ to its long wavelength.

* The frequency is 10^{12} - 10^{16} Hz.

* Suitable Propogation modes are:-
→ line-of-sight.

* These wave are used in TV Remotes, mobile phones, mouse, etc.