18/6/24 Computer Networks

Textbooks:

1. By Andrew. S. Tanenbaum

2. By Data-communication Network written by B. Forouzan.

Computer Network: * A network is a group of systems or computers that are inter-connected to exchange the data or information

* There are 2 types.

1. Bandwidth: Network capacity.

2. Throughput: Data transfer at that particular interval (in no. of bits per sec.)

Ex: Take a bridge, its capacity to travel 1000 vehicles/min which is termed as 'Bandwidth'. But due to some restrictions (traffic), travels only 100 vehicles/min which is termed as the 'throughput'.

Internet: Nothing but 'o' computer Network.

WWW: (World Wide Web) works on the top of the internet to access web pages (or) applications

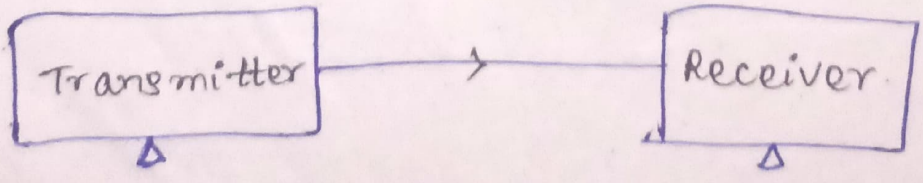
History of Computer Networks: UNIT-1

	Internet	WWW
Year of Established:	1969 ↓ (In service) 1988	1993
1st version Released:	ARPA Net	NSF Net
Comprises of:	Copper, Twisted pair cables, fiber optical cables or wireless	Files, Folders, Doc.
Governed by:	IP (Internet Protocal)	HTTP (HyperText Transfer Protocal)
Nature:	Hardware	Software
Dependency:	Independent	Depends on Internet

Dataflow: * It is of 3 types.

1. Simplex: * Transmits the data from the Transmitter to Receiver.

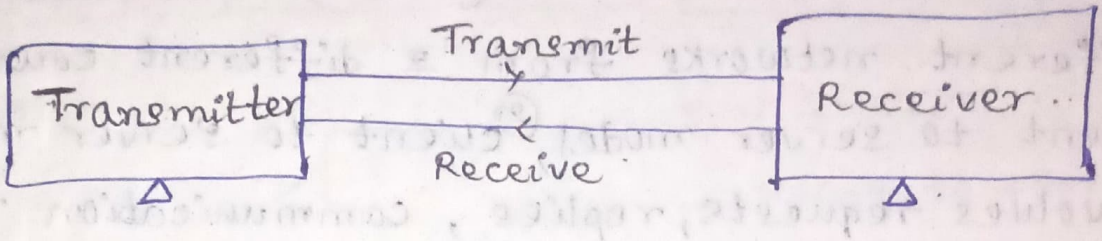
* We can transmit the data but can't receive the data => Unidirectional



Ex: Keyboard, Mouse, TV, Monitor, Joystick

2. Half Duplex : * We can transmit the data and receive the data but not at a same time.

* It is Bidirectional.

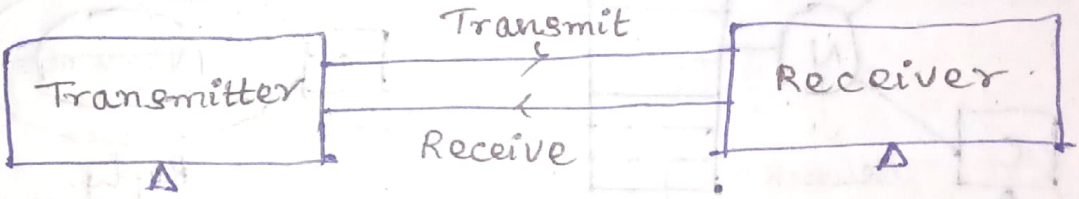


Ex: Walky - Talky (Mike), Citizen Band Radius.

3. Full Duplex :

* We can transmit the data and receive the data but at a same time.

* It is Bidirectional.



Ex: Telephone.

Q. A network with a Band width of 10 Mbps can pass only an average of 12000 frames/min with each frame carrying an average of 10,000 bits. What is the 'throughput' of the network?

Sol: Throughput = $\frac{(12,000)(10,000)}{60}$ frames.

60 → 1 min = 60 sec.

$= (4000)(500)$

$= 2000000$

$= 2$ Mbps.

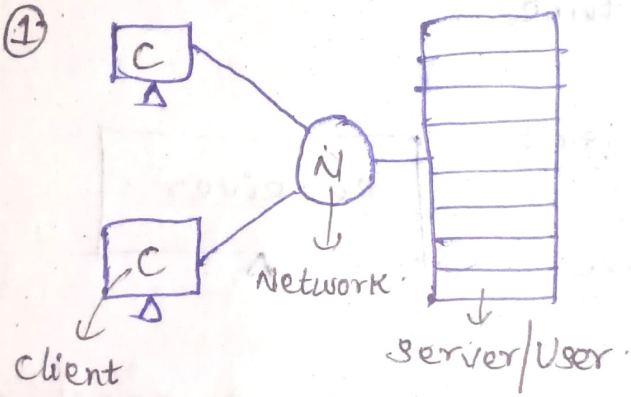
But Given, Bandwidth = 10 Mbps.

19/6/24 Uses and Applications of Computer Networks:

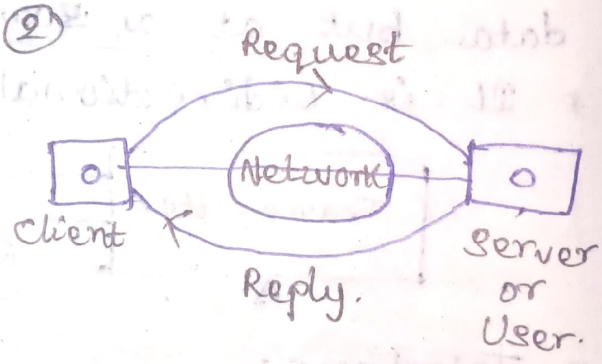
1. Business Applications :

Resource sharing, Sharing Physical Resources, Virtual Private Networks (VPN's) => Connecting 2 different networks from 2 different countries, (1) Client to server model, (2) Client to server model involves requests, replies, communication medium, Email, VoIP (Voice over IP) (Ex: Whatsapp, Insta, etc => Using Internet calls these are done), Desktop sharing, E-Commerce (Electronics using desktop).

(1)



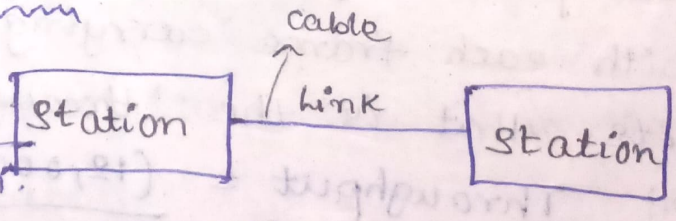
(2)



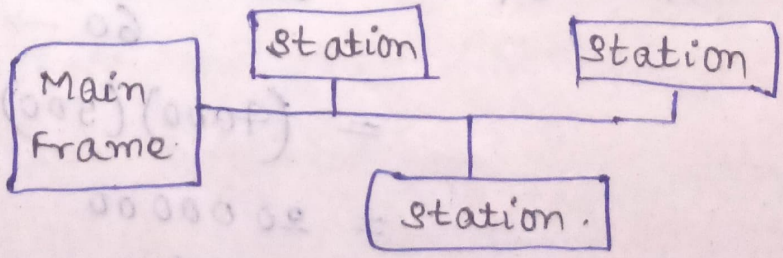
Network Topologies:

Types of connection:

1. Point to point:

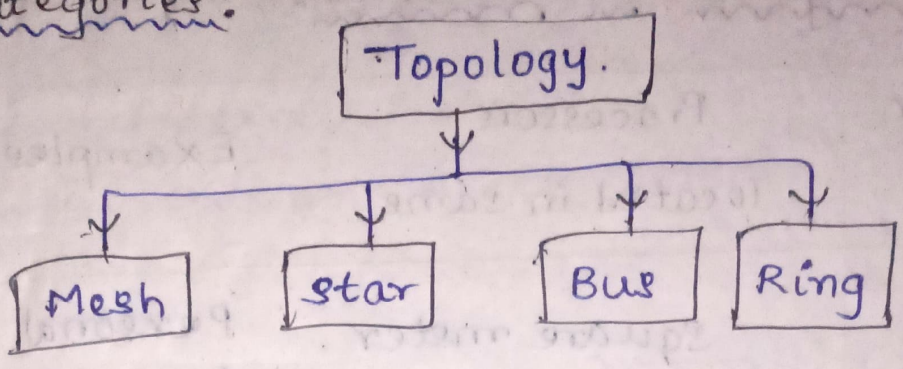


2. Multipoint:

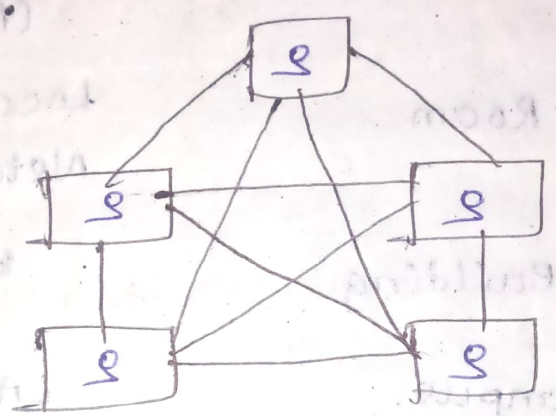


Connecting each and every station to a long cable.

Categories:



① Mesh:



S => Station

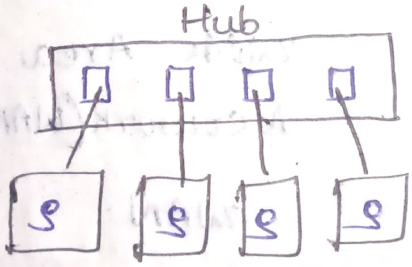
→ Point to point

→ Connecting each and every station is connected

=> More security (advantage)

Disadvantage: More no. of wires.

② Star:

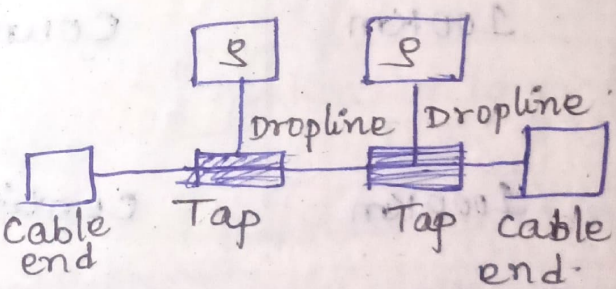


→ point to point

→ No. of wires reduced than mesh.

→ If Hub is down, entire communication is down.

③ Bus:



→ Multi-point

→ No. of wires ↓

Drawback: If cable is break, can't send communication to next station

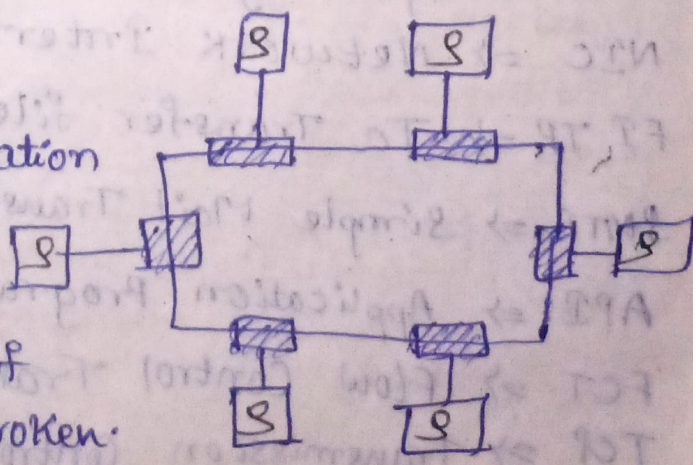
④ Ring:

→ Multi-point

→ Repeators purpose is used in digital communication

→ placed for every 50m to boost up the speed.

→ connected to ring, so if ring is broken, comm^{n} is broken.



20/6/24 Categories Of Networks:

Inter-processor Distance	Processors located in same	Examples.
1m	square meter	Personal Area Network (PAN)
10 m	Room	Local Area Network (LAN)
100 m	Building	LAN
1 Km	Campus	LAN
10 Km	City	MAN Metro-Politan Area Network
100 Km	Country	Wide Area Network (WAN)
1000 Km	Continent	WAN
10,000 Km	Planet	The Internet

V. Imp

ISO - OSI Reference Model:

ISO => International standard Organisation.

OSI => Open system Inter connection.

NIC => Network Interface card.

FTP => To Transfer files i.e. File Transfer Protocal

SMTP => Simple Mail Transfer Protocal (To transfer Mails)

API => Application Program Interface

FCT => Flow Control Transmission

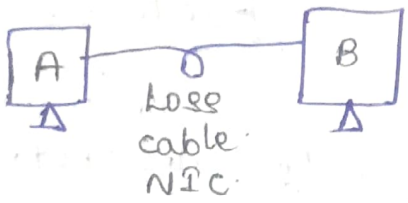
TCP => Transmission Control Protocol (With connection-oriented service) => Reliable bcz data is transmit or not, we can see

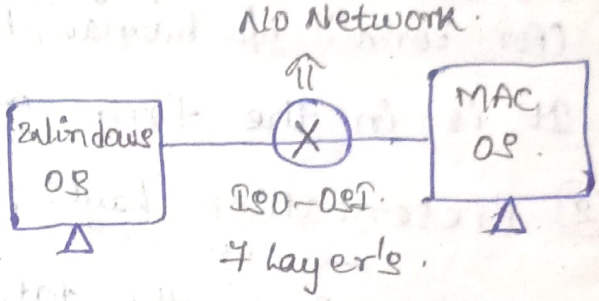
UDP => User Datagram Protocol (Connection-less Service => Not Reliable)

IP => Internet Protocol.

MAC => Medium Access control.

*

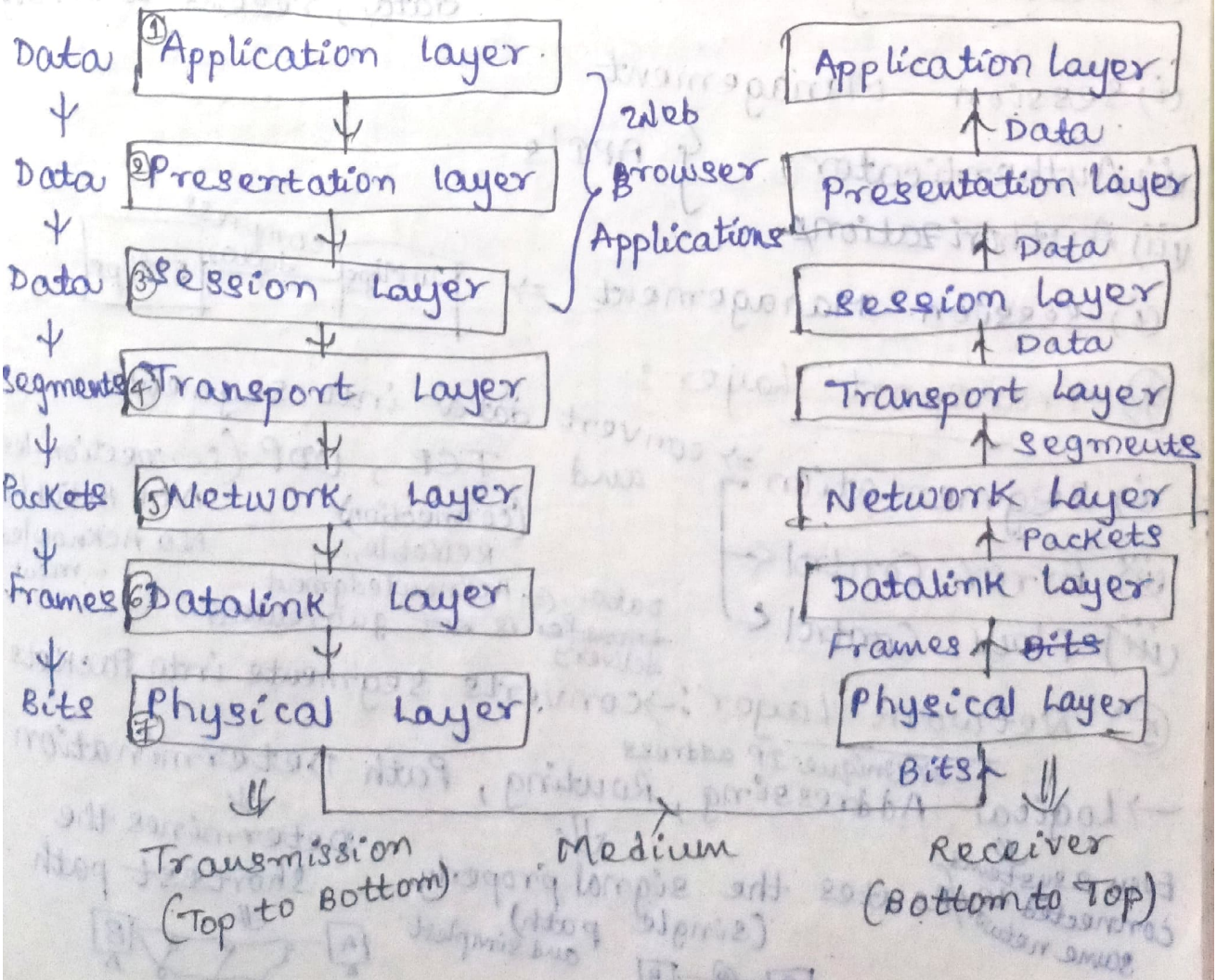




→ Here, A, B systems both should be of same operating system then, we can transfer the data through a loss cable.

→ Here, A, B are 2 different operating system so we can't transfer them through a cable. So, we use an ISO-OSI technique which is of 7 layers.

* The 7-layers are:



(1) Application Layer: It contains the protocols (package of) such as FTP, HTTP, SMTP, Virtual terminal TELNET

Web surfing
(To search the web pages)
(for conn^n b/w human, browser)
It is in the form of 'Data'

* It is User-Interactive layer bcz of their protocols.

(2) Presentation Layer: (or) connectors

→ It transfers the data into no's, alphabets.

→ Ecogisjkl (connectors) —convert→ Binary 76096278 (no's) → 10101011 0 (so many bits ⇒ compress the data)

Data compression → Binary 10101 (Decrypt) → Encrypt 010101

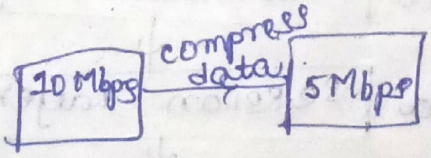
(1) Lossy
(2) Lossless
⇓
As data compresses, speed ↑, for that 2 techniques.

Checkbox

Encrypt, decrypt the data, resend to binary.

(3) Session Layer:

(i) Session Management
(ii) Authenticator } API's.
(iii) Authorization

(i) session Management ⇒ 

(4) Transport Layer:

(i) Segmentation ⇒ convert data into segments
(ii) Error Control
(iii) Flow Control

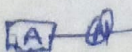
and TCP, UDP (connection-less)
(connection) Reliable, Acknowledgment is guaranteed
Not Reliable, No Acknowledgment
data transfer/delivery

(5) Network Layer: → converts segments into Packets.

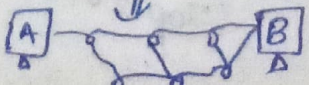
⇒ Unique IP address
→ Logical Addressing, Routing, Path Determination.

Even 2 systems connected to same network

Routes the signal properly (single path) and simplest



Determines the shortest path



(6) Data link Layer: → Uses IP.

→ converts Packets into frames.

→ converts Logical Addressing into Physical addressing (adds Header, Tailer to packets).

(7) Physical Layer: → converts Frames into Bits

→ This is an error detection service.

→ Here, Transfer the data using medium.

Ex: 

Electrical signal. uses copper wire

Light ↓ Uses fibre optics

wifi ⇒ Electro Magne -tic signal ↓ Uses Air

Protocol: set of rules to transfer data in understanding manner.

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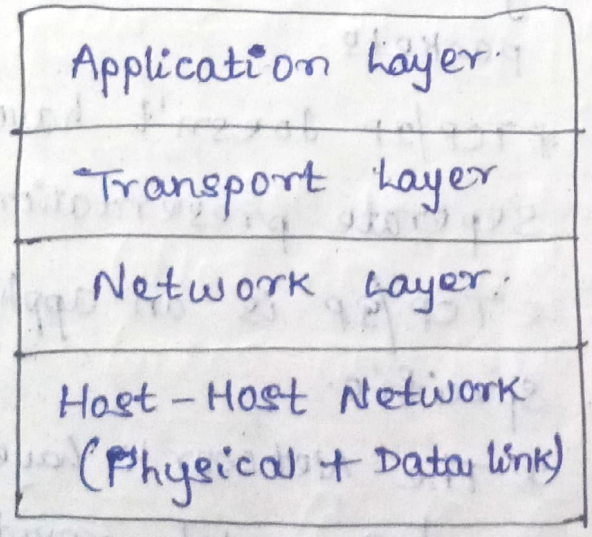
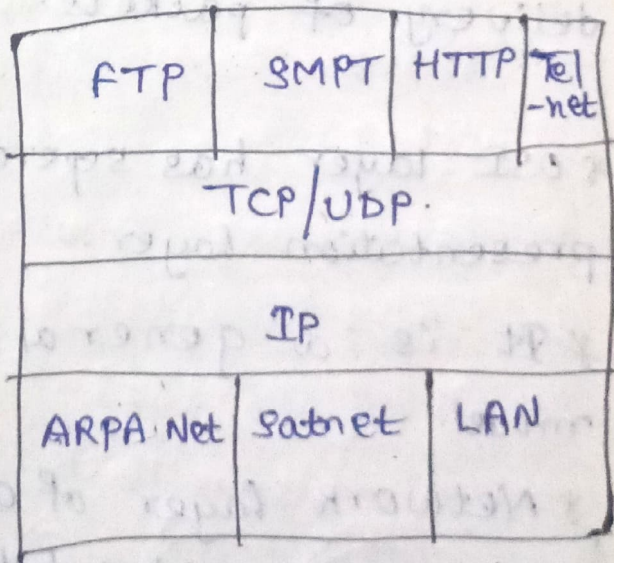
TCP/IP Reference Model: IP ⇒ Internet Protocol

TCP ⇒ Transmission Control Protocol.

It consists of 4 Layers.



(a) TCP/IP



(b) Protocals used in TCP/IP.

* If both computers are of different types, we use Reference model.

* As Presentation, Session layers are also of 'data' type. We combine, replace them with 'Application layer'.

* ARPA => Advanced Research Project Agency Network.

Comparision between ISO-OSI and TCP/IP Reference Model:

ISO-OSI Reference Model.	TCP/IP Reference Model
* OSI provides layer functioning and also defines the functions of all the layers.	* It is more based on the protocols and protocols are not flexible with other layers.
* It has 7 layers.	* It has 4 layers.
* In OSI model, the transport layer guarentees the delivery of packets.	* In TCP/IP Model, the transport layer doesn't guarentee delivery of packets.
* OSI layer has seperate presentation layer.	* TCP/IP doesn't have a seperate presentation layer
* It is a general model.	* TCP/IP is an application specific.
* Network layer of a OSI model provides both connection-oriented, connection less services.	* The Network layer of TCP/IP model provides connection-less service.

* OSI model has a problem of fitting the protocols in the model.

* Protocols are hidden in OSI model and are easily replaced as the technology changes.

* OSI model defines services, interfaces, protocols very clearly and makes clear distinction between them.

* It is General-Purpose

Ex: up → It can be used anywhere.

* TCP/IP doesn't fit any protocol.

* In TCP/IP, replacing the protocol is not easy

* In TCP/IP, it is not clearly seperated its services, interface and protocols.

* It is "application-oriented layer." =>
Ex: light, AC, washing machine.
i.e. It has only a single function (can't use everywhere)

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Design Issues for the layers:

* Mechanism to detect whether it is sender or receiver.
* Proper Addressing Mechanism
* Rules of Data Transfer → Simplex, Half Duplex, Full Duplex
* No. of Logical channels required → Normal, Urgent
* Error Control.
* Flow Control (Speed mismatch b/w 2 devices)
* Multiplexing (converting many to one signal)
* Routing (choosing the best path for communication)

Physical Layer: The purpose of physical layer is to transport the raw bite stream from one machine to another machine. Various physical media can be used for actual transmission, each one has its own. The suits in terms of bandwidth, delay, cost and easy of installation and maintainance.

Transmission Media.

Guided Media (Wired)	UnGuided Media (Wireless)
1. Magnetic Media	1. Electromagnetic Spectrum
2. Twisted Pair cable	2. Radio Transmission
3. Co-axial cable	3. Microwave Transmission
4. Fibre-Optic cable	4. Infrared & Millimeter Waves
5. Copper Wire	5. Light wave Transmission

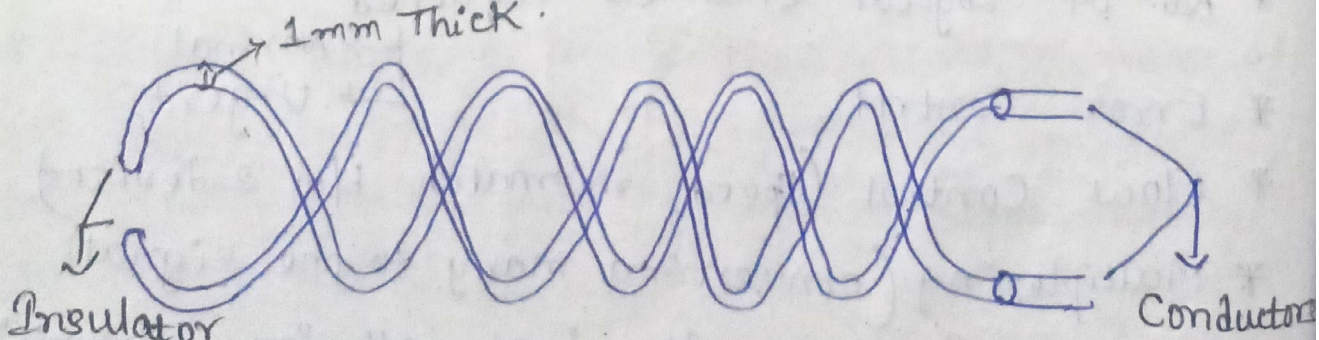
18/7/24 **Guided Media**:

* Transmission Media can be in 2 ways.

Twisted Pair Cable:

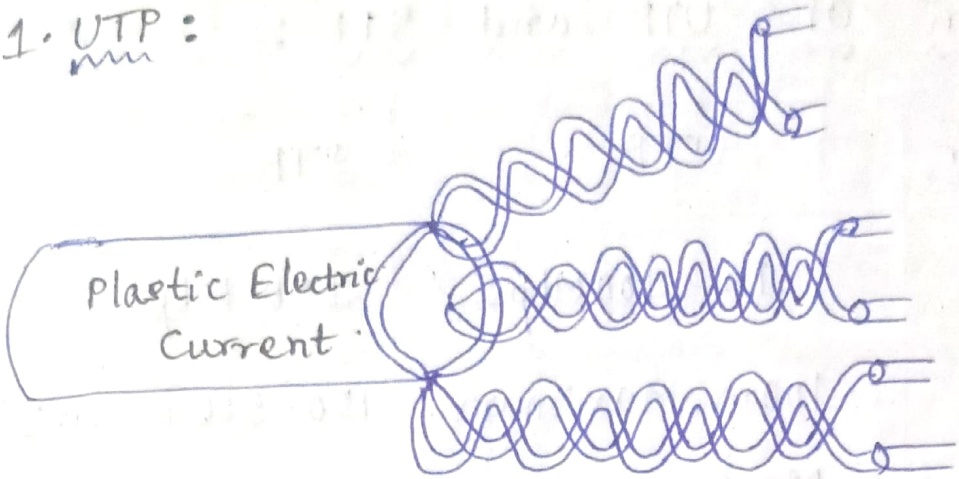
* There are two types. They are

1. UTP (Unshielded Twisted Pair Cable)
2. STP (Shielded Twisted Pair Cable)



Twisted Pair Cable

1. UTP :

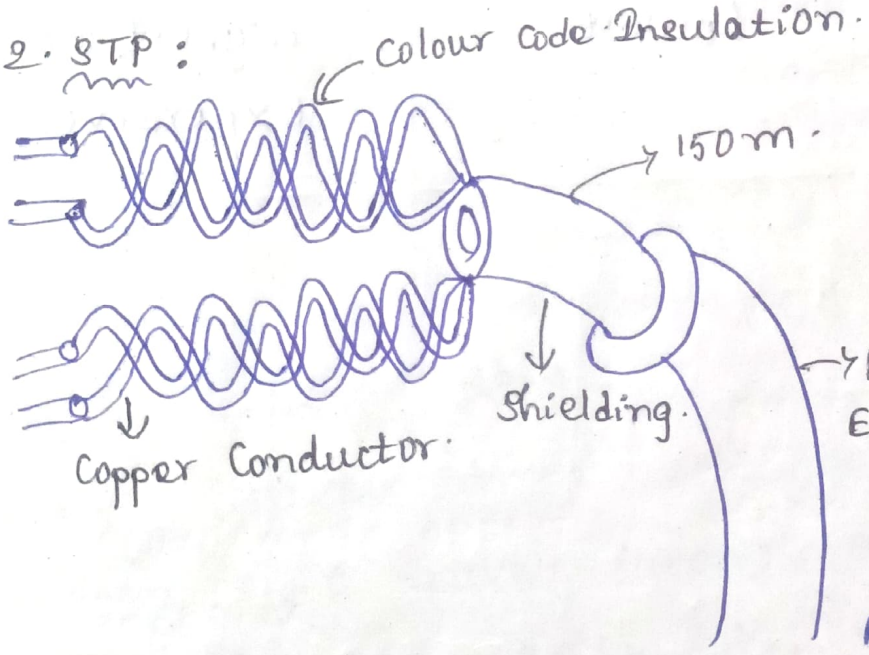


Categories in UTP :

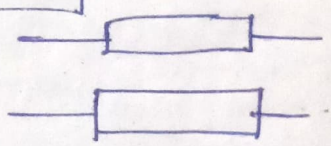
cat – 5	: 100 Mbps	cat – 2	: 4 Mbps
cat – 4	: 16 Mbps	cat – 1	: Low speed
cat – 3	: 10 Mbps		

Voice Communication < 1 Mbps.

2. STP :

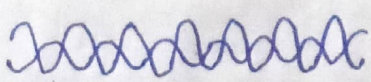


* Whenever 2 copper wires are placed adjacently then there produces Electro-magnetic Interface (EMI) i.e. Cross talk.

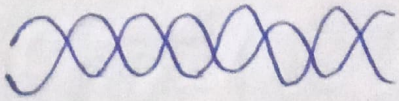


After cross talk STP cable then, Cu wire is twisted.

Category – 5 :



Category – 3 :



Comparision of UTP and STP :

Parameter	UTP	STP
① Data Rate	10 - 100 Mbps	150 Mbps
② Cable length	100m Maximum	150 - 500m Maximum
③ Electrical - Interference	Mast suspectable to Interference (or) Cross Talk.	Less suspectable
④ Installation	Easy to install	Very easy to install.
⑤ Cost	Lowest	Highest (or) Expensive.

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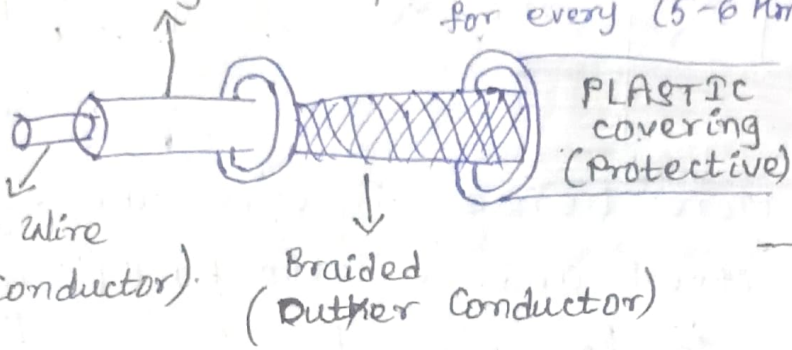
Co-axial Cable: → Used to transmit the data from Analog to Digital by using Amplifiers, Repeaters. for every (5-6 Km), (2-3 Km)



→ High Impedance

Co-axial Cable standards:

Category	Interface	Use
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet : 10Base2
RG-11	50 Ω	Thick Ethernet : 10Base5 (or) Traditional

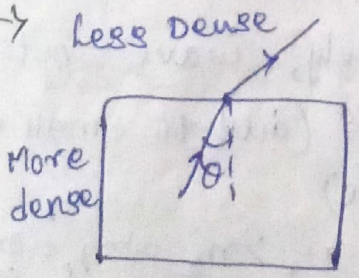
10 Mbps

(In Mbps) Data Rate
Base Band
(In 'm'). Distance

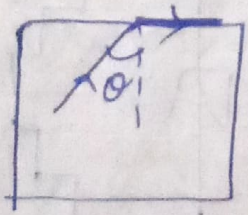
Fibre-Optic Cable:

1. Light travels in a straight line.
2. When Light travels through a medium (fibre optic cable) and comes out then it follows required directions.
3. Directions depends on the
   i. Angle Of Incidence (I) ii. Critical Angle (CA)

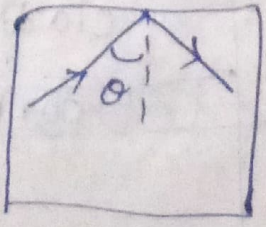
→ Less Dense



I < CA (Refraction)

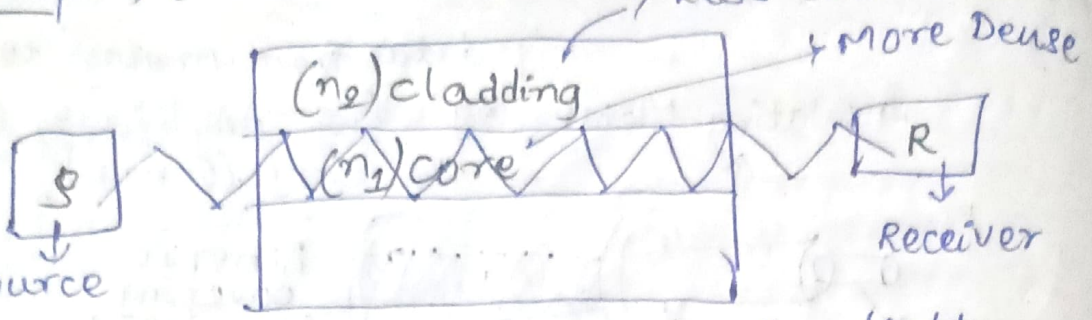


I = CA (Refraction)



I > CA (Reflection).

→ For Example, (for Reflection)



→ Due to More Dense of core, the light travels in itself and reflects back (correct process)

→ Condition is $n_1 \geq n_2$; n ⇒ Refractive Index

GATE

Propagation Modes of fibre Optics:

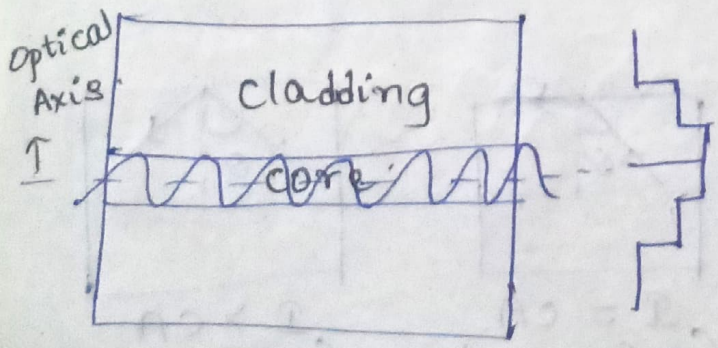
- Single Mode
  - Step Index
- Multi Mode
  - Step Index
  - Graded Index

	Single Mode Step Index	Multi Mode Step Index	Multi Mode Graded Index
Core Diameter :	9 – 10 μm	50 – 250 μm	250 μm
Cladding :	125 μm	250 – 500 μm	500 μm
Numerical Aperture :	0.08 – 0.1	0.12 – 0.5	0.5
Band Width :	> 50 MHz	< 50 MHz	> 100 MHz

*** * There is no Single Mode Graded Index.

Single Mode Step Index:

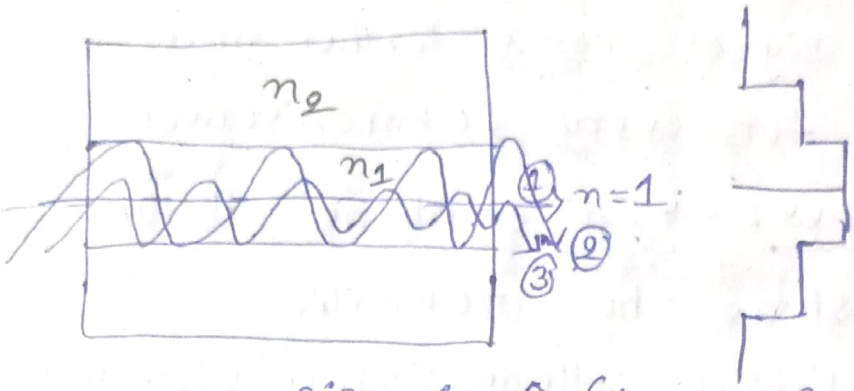
Here, core size is small, Refractive Index = 1 (of core) $= n_1$.



→ Here, If we observe closely, wave = optical axis (due to small core size)

→ As $n_1 > n_2$ ⇒ $n_2 = 0.9$ (cor) 0.8

Multi-Mode Step Index:

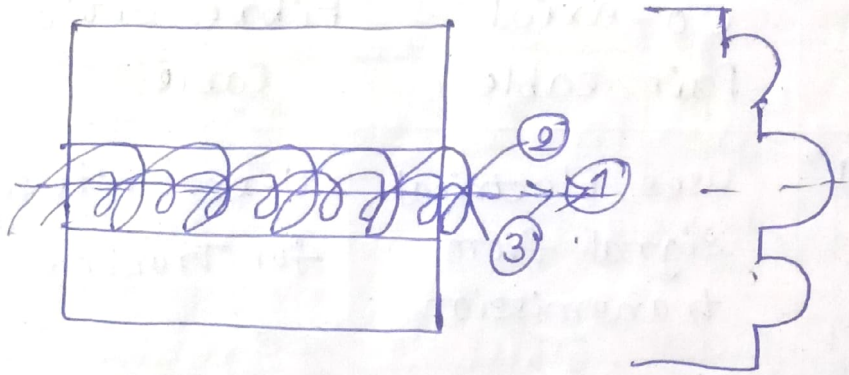


→ Here core size is ↑ (than before), $n = 1$

→ First, (1) reaches then (3) and then (2).

→ Here, Bandwidth ↓ due to "Dispersion".

Multi-mode Graded Index:



→ n=1.
(At centre, n=1
At corners, 'n' is min.)

(D) → To ↓ dispersion, wave occurs in spirals ~~spring~~ type. and Bandwidth ↑.

→ Here, core size is large.

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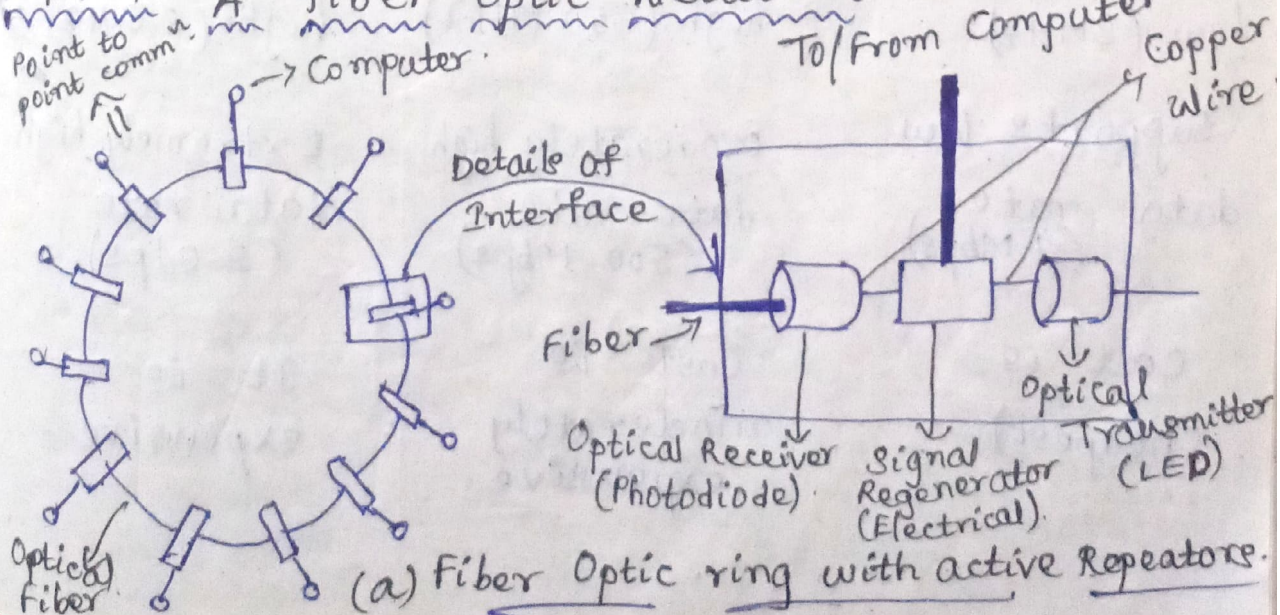
A fiber Optic Network:



(a) Fiber Optic ring with active Repeators.

Repeaters Usage: → While Transmitting a signal when it becomes weak signal, if we apply a Repeater then signal moves further more distance
→ It is placed for every 10 Km distance.

Magnetic Tapes: → To combine all data in a Tape and share the information.
For Example: sharing college information through Gmail (upto 25GB only). So, to share 500 GB, we combine all data in a tape and can share easily.

Differences:

Twisted Pair Cable	Co-axial Pair cable	Fibre Optic Cable
* Uses Electrical signal from Transmission.	Uses Electrical signal from transmission.	Uses white signal for Transmission
Effected by Electro-magnetic Interface (EMI)	Less effected by EMI	Not effected by EMI.
Bandwidth (B.W) is Low (3MHZ)	B.W is moderately high (350 MHZ)	B.W is very high (2 GHZ)
Supports low data rate (4 Mbps)	Moderately high data rate (500 Mbps)	Extremely high data rate (2 Gbps).
Cost is cheapest	Cost is moderately expensive.	It is expensive.

Repeaters placing: 3-2 Km supports all radio frequencies. Frequency Rate: (902-928) MHZ High Attenuation	1-10 Km. supports all radio freq. (902-928) MHZ Low Attenuation	10-100 Km. supports all radio freq. (902-928) MHZ very low Attenuation

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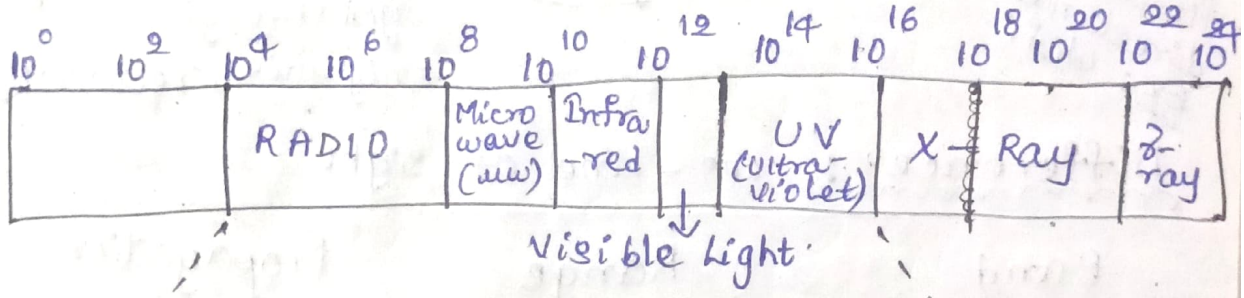
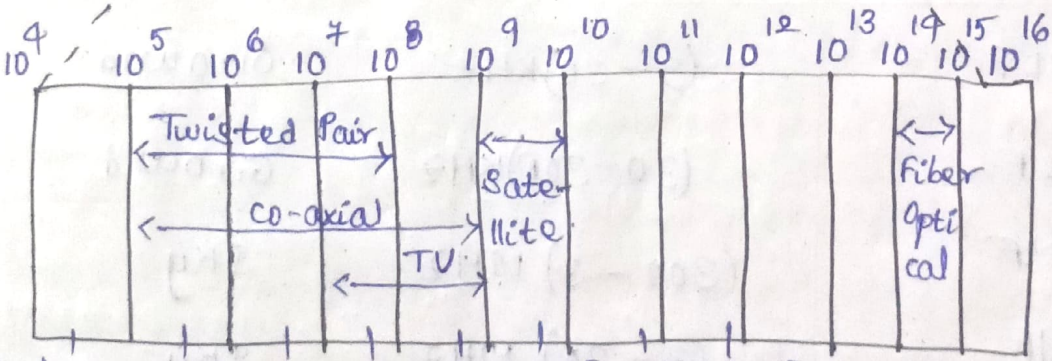
Unguided Media: (Wireless)

Signal Trans^{n} from one medium to another medium through air.

1. Electromagnetic Spectrum:



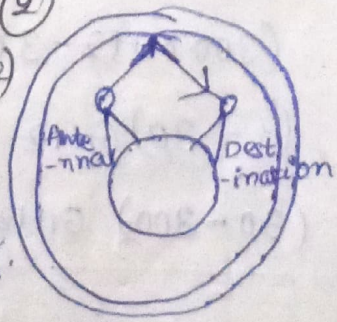


Transmission ① ② ③ 3 wave:

① Ono Sphere (As a Base)

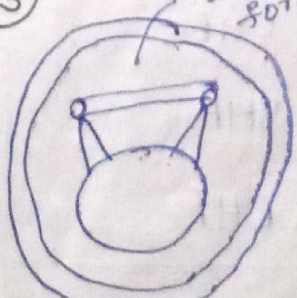
⇒ propagation at lower place of earth.

Ground wave Propagation (below 2MHZ) (Low Freq.)

② 

Sky-Wave propagation. (2-30 MHZ) (High Freq.)

③ when both are straight forward.

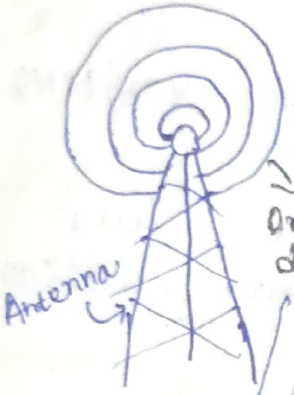


Line-of sight (Las) above 30MHZ

Wireless Transmission

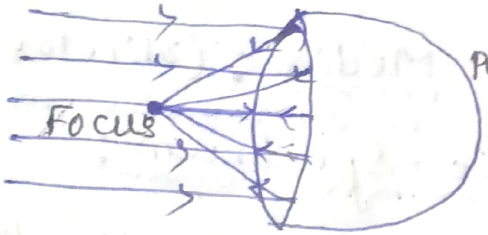
$\lambda \propto \frac{1}{f}$

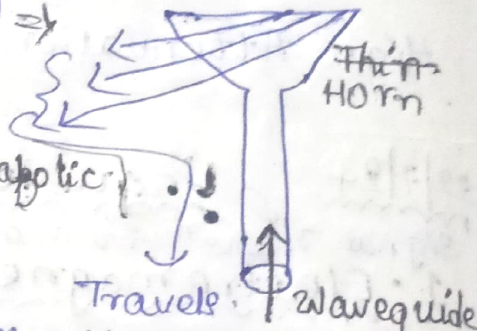
- Radio Waves (3 MHz – 1 GHz)
- Microwave (1 – 300 GHz)
- Infrared (300 – 400 GHz). (λ : 1 mm – 700 nm) (λ = wavelength)



If it covers all directions known as omni-directional. Ex: Wifi.

Unidirectional
- Parabolic Dish Antenna
- Horn Antenna





Differences: LOS – Line of Sight

Band	Range	Propagation
VLF	(3 – 30) KHz	Ground
LF	(30 – 300) KHz	Ground
MF	(300 – 3) MHz	Sky
HF	(3 – 30) MHz	Sky
VHF	(30 – 300) MHz	Sky, LOS
UHF	(300 MHz – 3 GHz)	LOS
SHF	(3 – 30) GHz	LOS
EHF	(30 – 300) GHz	LOS

Comparision of Guided and Unguided Media:

Guided Media	Unguided Media
* The signal energy propagates within the guided media.	* The signal energy propagates through the air.
* Mainly suited for point to point comm^{n}.	* For broad-casting purpose
* The signal propagates in guided media in the form of voltage, current or photons.	* The signal propagates in the form of Electromagnetic waves
* Ex: Twisted Pair Cable, Co-axial pair cable, Fibre Optic Cable.	* Ex: Radio Waves, Micro waves, Infrared Waves.