SWAMI SAHAJANAND COLLEGE OF COMPUTER SCIENCE

BCA Semester – 5 [NEP]

Subject : Data Communication and Networking

Minor4 - 26518

UNIT 1

Data Communication Fundamentals

- Introduction of Ancient, Electronic and Computerized Methods of Communication.
- Digital and Analog Data
- Data transmission Modes (Simplex, Half Duplex and Full Duplex)
- Types of Transmission media: Guided and Unguided.
    - Guided Transmission Media: Twisted Pair, Coaxial Cables, Fiber Optics.
    - Unguided Transmission Media: Radio Waves and Micro Waves

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(With effect from Academic Year:2025-26)

Unit	Course Contents	Teaching Hours	Weightage of Marks
Unit-1	**Data Communication Fundamental** • Introduction of Ancient, Electronic and Computerized Methods of Communication. • Digital and Analog Signal. • Data transmission Modes (Simplex, Half Duplex and Full Duplex) • Types of Transmission media: Guided and Unguided • Guided Transmission Media: Twisted Pair, Coaxial Cables, Fibber Optics. • Unguided Transmission Media: Radio Waves and Micro Waves	15	25
Unit-2	**Network Technology and Networking Devices** • Meaning of the basic terms: – Network, Internetwork, Protocol. • Types of Connection (Point to Point and Multipoint.) • Types of Computer Network (LAN, MAN, WAN). • Different types of Server: File Server, Application Server, Mail Server, Web Server, Database Server • Introduction and Characteristics of LAN. • LAN Topologies : Bus, Ring, Star, Tree, Mesh • Functions of Various Networking Components: Repeater, Hub, Switch, Router, Bridge, and Gateway	15	25
Unit-3	**Network Model** • Switching Technique: Circuit, Packet, and Message Switching • Layered Tasks: Sender, Receiver. • OSI Reference Model. • Connection Less Vs Connection Oriented, Reliable Vs Unreliable Connections • IP Packet Format and IP Addressing(IPV4)	15	25
Unit-4	**Network Applications** • Domain Name System: DNS Basics, Characteristics, Working Of DNS, DNS Hierarchy. • File Transfer Protocol: FTP Basics, FTP Modes, FTP Commands. Email: Email Basics, Email Structure, How Email Works? • Email Protocol :SMTP,IMAP, MIME and POP • HTTP Protocol & UDP Protocol.	15	25

Communication System & Channel

What is Communication?

- Communication means to convey a message, an idea, a picture or speech that is received and understood clearly and correctly by the person for whom it is conveyed.
- Telephonic communication is popular because it is easy and cheap.
- Data communication containing messages, pictures and voice has taken the importance.

Basic factors that affect the data communications are:

- The cost of conveying message should be low.
- The transmission should take place without any doubt / confusion in the mind of receiver.
- The message should reach within a reasonable time.
- The message should be safe and secured.

Ancient, Electronic and Computerized Methods of Communication.

Ancient Methods of Communications

These are the oldest methods of communication, it includes the following ….

- Use of Horse and pigeon for message delivery.
- Postal Services.
- Telegraph services.
- Telecommunications.

Electronics Methods of Communications

Invention of telephone instruments and the communication satellites, the means of electronic communication has become very popular.

- **Examples**: Telephone, Mobile, Radio, Television and FAX etc….

Telephonic communication method has following limitations:

- Both sender and receiver should be available at the same time.
- They must use common language.
- Telephonic communication is Not Secured.
- It is use for voice communication only.
- It is affected by environment including natural and artificial.

Computerized Communication

- Because of Computers and Smart phone, they are the latest in the field of communication.
- It can send data with Faster with High accuracy.
- **Examples**: Mobile Communication, Internet and Internet related Data Applications like Email, Voice over Internet.

Advantages:

- Voice calls can be made to any part of world.
- Pictures, sounds and text data can be sent with confirmation of successful delivery.
- Messages can be coded so that it is not understood by anybody else except the person who is sending and who is receiving.
- Any language can be used for communication. Special training is not required for achieving computer communication.

What is data communication or communication system?

Data Communications: The exchange of data between two devices via some form of transmission medium such as a wire cable. The effectiveness of a data communication system depends on four fundamental characteristics: **delivery, accuracy, timeliness, and jitter**.

Delivery : The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.

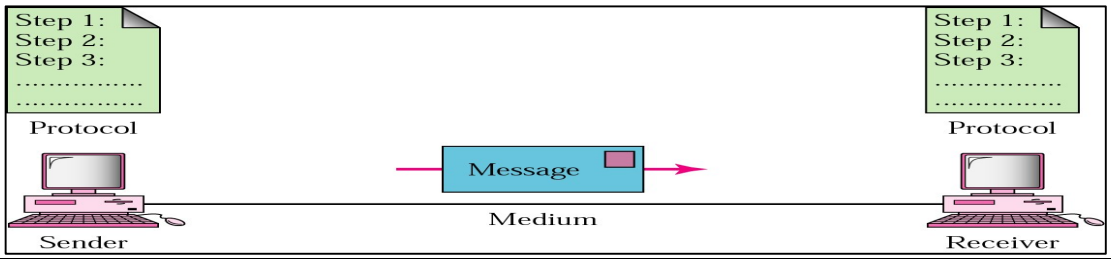
Accuracy : The system must deliver the data accurately.

Timeliness: The system must deliver data in a timely manner
This kind of delivery is called **real-time transmission**.

Jitter : Jitter refers to the variation in the packet arrival time.
It is the uneven delay in the delivery of audio or video packets.

What are the Components of Data Communication System?

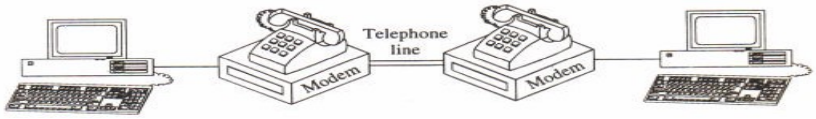
A data communication system has five components.



1	**Message:**	The message is the information (data) to be communicated. It includes text, numbers, pictures, audio, and video.
2	**Sender:**	The sender is the device that receives the message. It can be a computer, workstation, telephone, video camera, etc…
3	**Receiver:**	The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.
4	**Transmission medium:**	The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.
5	**Protocol**:	A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without a protocol, 2 devices may be connected but not communication.

What is communication system?

The communication system has sole purpose of passing data or information in the most effective manner. Block diagram of communication is shown under:



- Communication system is the combination of hardware, software and data transfer links, making up a communication facility for transferring data in a cost effective manner.

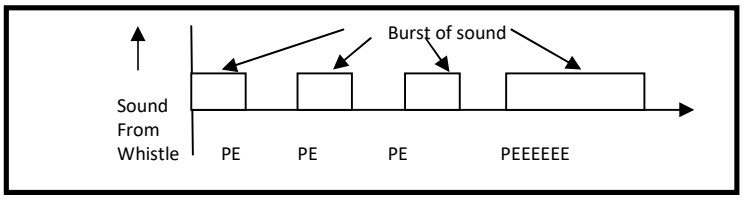
- The digital data are to be sent over analog telephone lines, the digital signals must be covered to analog form.
- The technique by which a digital signal is converted to its analog form is known as modulation. The reverse process is known as demodulation. This process is carried out by Modem.
- In a data communication network, the task of network designers is to select and co-ordinate
- The network components so that the necessary data are moved to the right place, at right time with minimum errors, and at the lowest cost.

Analog Data and Digital Data

Digital Data

- You would have noticed on the hokey playground. The referee blows a whistle and all the players in the field understand the message.
- The whistle is blown in short bursts of high pitched sound like PEE, PE, PE, PE or it may have a long burst PEEEEEEEEE.
- Both of these whistle calls convey different meaning to the players. The first one is an indication to the players to start the game. The second long whistle is to stop the match immediately.
- The message conveyed by the burst of this sound energy in short pulses is very clear to all the players.

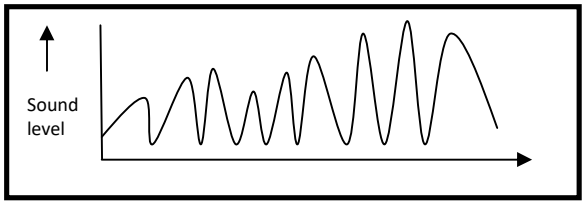
A sample of digital Pulses of sound Blow using a whistle



- There is no chance of any confusion even if the distance of a player is large from the referee.
- This is an example of *Digital data* transmission. Short burst of sound energy are sent by the sender to the receiver and the receiver is able to understand it clearly.
- This type of digital data is as shown pictorially in figure.

Analog Data

- In a concert hall where many musical instruments are being played by different players.
- Say one musician is playing Sitar and the other is playing Table. The harmony of sound coming out from these two instruments gives you the pleasure of listening.
- If there is any mismatch between the timing of the tune of Sitar and the Table, you get the unpleasantness and thus consider it a noise rather than music. This is an analog data communication.



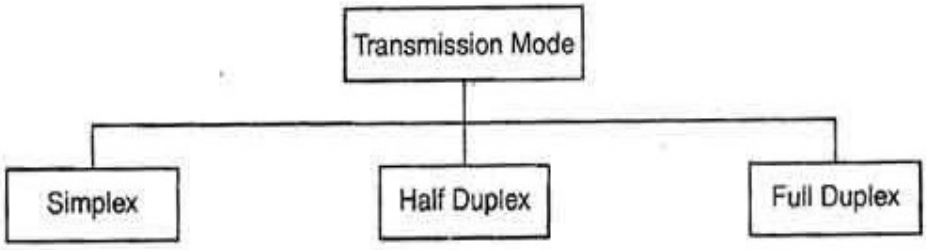
- "Sitar" and "Guitar" are sending sound waves in the same sequence but there is different rhythm and harmony.
- The moment, there is some disturbance say noise in the mike system, you feel disturbed.

Advantages of Digital Transmission over Analog Transmission

- The voice, data, music, images (TV, FAX, Video) can be transmitted to make more efficient use of the circuit and equipment.
- Much higher data rates are possible using existing phone lines.
- Digital transmission is much cheaper than analog transmission.

- Maintenance of digital system is cheaper than any analog system.
- A digital signal can pass through an arbitrary number of regenerators with no loss in signal and thus travel long distance with no information loss.

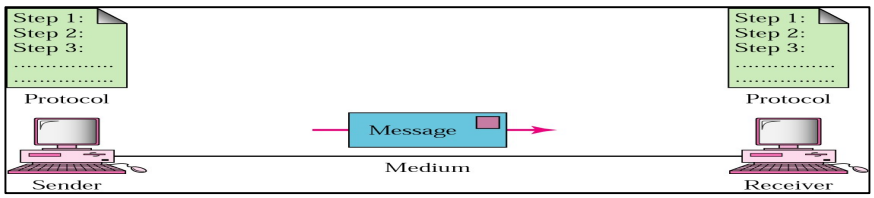
Data transmission Modes (Simplex, Half Duplex and Full Duplex)



How data will flow in data communication system? OR Explain: - Transmission Modes

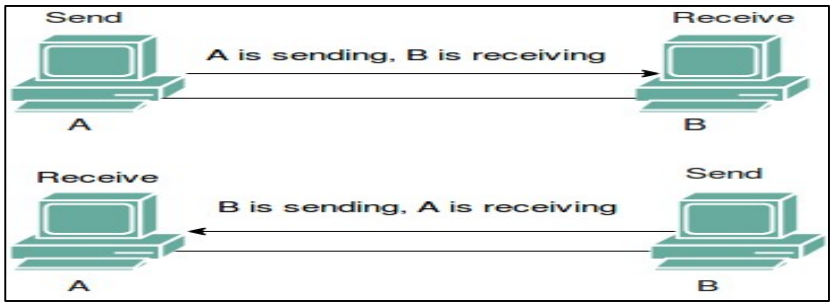
(1) Simplex:

- In simplex mode, the communication is on a one-way.
- Only 1 device can transmit data, the other can only receive.
- Keyboard and monitors is an example of simplex device.
- The keyboard can only input device; the monitor can only accept output.
- Other Examples are: Radio and TV.



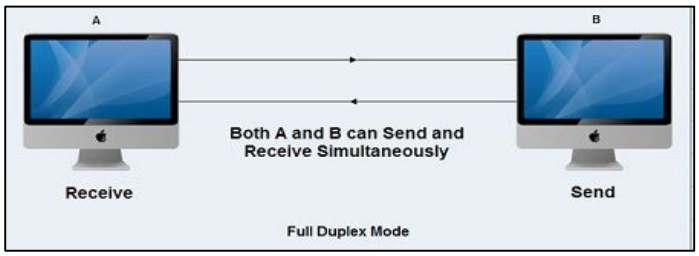
(2) Half-duplex:

- Each station can both transmit and receive data, but not at the same time.
- When one device is sending, the other can only receive, and vice versa.
- The entire capacity of the channel can be utilized for each direction.
- Example: Walkie-talkies like radios are half duplex systems.
- Walkie- Talkie in which message is sent one at a time and messages are sent in both the directions.



(3) Full-duplex:

- In full duplex mode (duplex), both stations can transmit and receive simultaneously.
- Examples: computer network, Telephone and Mobile Communication.
- When two people are communicating, both can talk and listen at the same time.
- Full duplex mode is used when communication in both directions is required all the time.
- The total channel capacity of the media must be divided between the two directions.

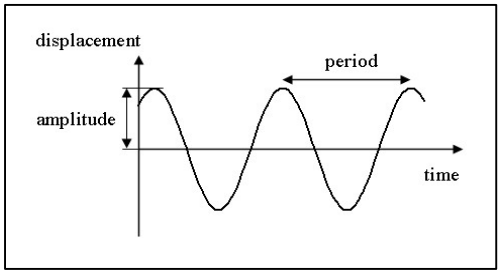


Give the difference between Simplex, half-duplex and full duplex transmission

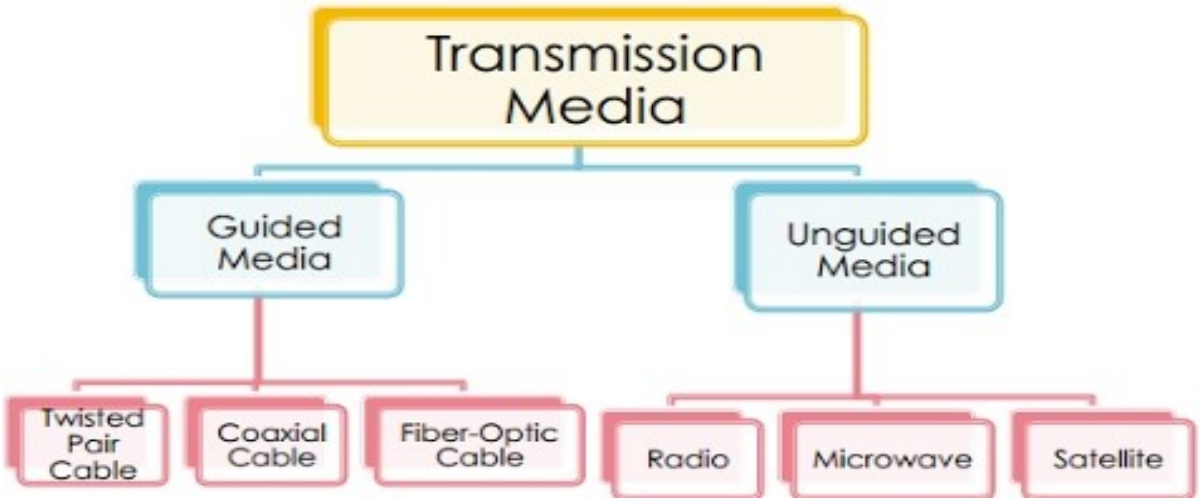
Simplex	Half-duplex	Full-duplex
Data flows in one direction only	Data flows in both directions, but only one direction at a time	Communication in both directions simultaneously
No acknowledgement possible	Delayed confirmation of message	Immediate confirmation of message receipt
Two wire transmission	Two wire transmission	Four wire transmission
Low cost	Medium cost	High cost
Used for TV, radio and broadcasting applications	Used for telephonic communication	Used for data communication in PC's

Baud Rate and Bit rate

- **Baud** is the **oscillation of a sound** wave on which single bit data is carried. It is measurement of digital signaling rate in a channel.
- **Bit rate** a measure of the digital bit values the channel conveys with each baud.
- **Bandwidth**: The range of frequencies available for data transmission. Wider bandwidth of Communication System – more data can be transmitted in a given period of time.



Types of Transmission media: Guided and Unguided.



Guided Media:

It is also known as **Bounded Media or Connection Oriented Media**.

Guided Media uses a "cabling" system that guides the data signals along a specific path.

Unguided Media:

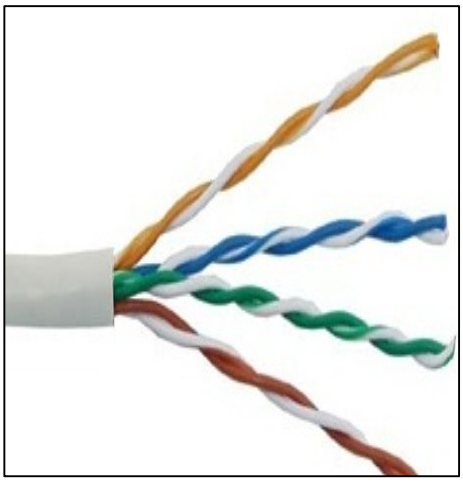
It is also known as **Unbounded Media or Connectionless Media**.
Unguided Media relates to data transmission through the air and is also known as wireless.

(1) Twisted Pair Cable (Twin – Wire) :

- Twisted Pair cable is also known as "Twin-Wire".
- A twisted pair consists of two wires (copper conductor), each with its own plastic insulation, twisted together.
- One of the wires is used to carry signals to the receiver, and the other is used as a ground.
- The receiver uses the difference between the two.
- The twisting reduces the Noise and EMI (Electro Magnetic Interference).
- There are 2 types of twisted-pair cable. (1) UTP (2) STP.

(I) Unshielded Twisted Pair Cable (UTP)

- UTP cables consist of a number of twisted pairs with a simple plastic casing.
- It is commonly used in telephone systems and computer network.
- It is the Low cost cable type.
- Common UTP data rates range from 4 Mbps to 100 Mbps.
- It is Also Known as **10BaseT** [**10** = 10 Mbps Speed, **Base** = Baseband , **T**=Twisted Pair Cable]
- UTPs are light, flexible and are connected to network using **RJ-45** connectors.



- UTP cable is available in the following 5 grades, or **categories.**

Categories 1 & 2 : Voice Grade cables for voice and for low data rates (below 4 Mbps).
Category 3 : : Data Grade cable, It gives data rates up to 10 Mbps.
Category 4: : Data Grade cable, 4 twisted pairs wires, gives data rate of 16 Mbps.
Category 5: : Data Grade cable, 4 twisted pairs, it Gives data rate up to 100 Mbps.

Advantages:

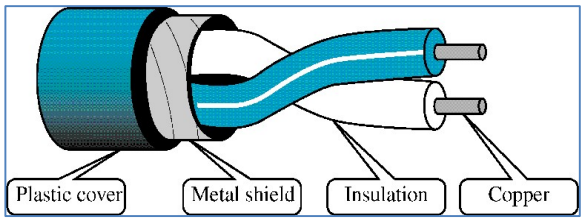
- It is used in telephone lines to provide voice and data channels.
- Maximum Data rate is 10 to 100 Mbps(Mega bits Per Second).
- Easy to Install.
- Flexible and low cost

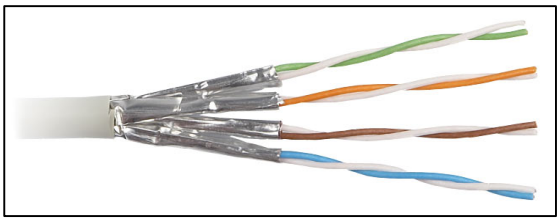
Disadvantages:

- It is use for limited distance. (Maximum 100 meter).

(II) Shielded Twisted Pair cable (STP Cable)

- It is similar to UTP Cable except that the twisted pairs are enclosed in a foil shield.
- The shield is used here for additional layer to reduce EMI (Electromagnetic Interference).
- It uses RJ45 as well as older connector's types for cable installation.





Advantages:

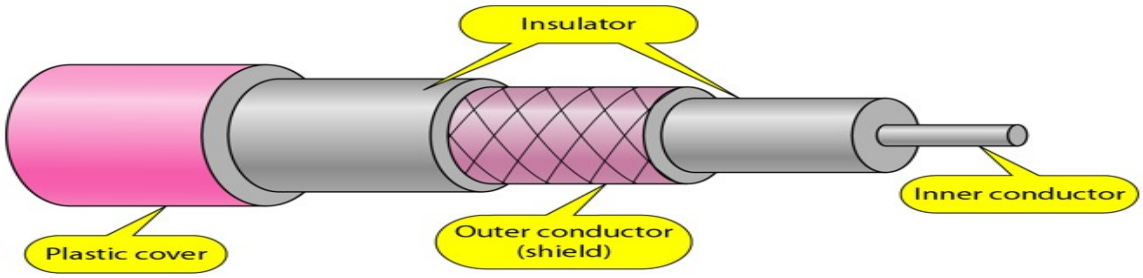
- Maximum Data rate is 10 to 100 Mbps (Mega bits Per Second).
- It Can be used for Analog or Digital transmission
- STP is capable of transmission speed up to 500mbps, Higher capacity than UTP.
- Reduced crosstalk, Noise and EMI.

Disadvantages:

- It is Difficult to install
- It is Heavy
- It is Costly than UTP cable.

(2) Coaxial Cable:

- The coaxial cable has better shielding than twisted pairs, so it can span longer distances at higher speeds. Two kinds of co-axial cable are widely used.
  1. ***50 Ohm Cable (Used in Digital Network)***
  2. 75 Ohm Cable (Used in Cable TV Network)



- The 50 Ohm cable is commonly used for Digital Transmission.
- Co-axial cable consists of a copper wire as the core, surrounded by an insulator.
- The insulator is encased by a cylindrical conductor, a closely-woven braided net.
- The outer conductor is covered in a protective plastic sheath.
- The construction and shielding of the coaxial cable give it a good combination of high bandwidth and excellent noise immunity.
- The bandwidth possible depends on the cable quality, length, and signal-to-noise ratio of the data signal.

Advantages of Coaxial Cable:

- Coaxial cable is the most widely used network cable
- Coaxial cable is low Cost, light Weight, Flexible and Easy to Install.
- Data rate(Bandwidth) is 100 Mbps to 500 Mbps
- Node Capacity: Maximum number of nodes(devices) can be 30 to 100 nodes.
- Segment Length: Coaxial cable is a good choice for distance of 100 to 500 Meter.

Disadvantages of Coaxial Cable:

- It is not Flexible so does not bend easily
- It is difficult to install.

Types of Coaxial Cable

1. **Thin-net coaxial cable (10Base2)**
2. **Thick-net coaxial cable (10Base5)**

1. Thin-net coaxial cable

- Thin-net coaxial cable is also referred to as RG-58 and 10Base2.
- **10Base2** [**10**=Mbps Speed, **Base** = Baseband, **2**=200 Meter Segment Length]
- It is a flexible Coaxial cable about **0.25** inches thick.
- The 2 represent maximum segment length of 200 meters.
- It has ability to support maximum 30 nodes. (devices or computers)
- It is popular in small networks, like linear bus networks.
- Thin net coaxial cable can carry a signal up to approximately 185 meters before the signal starts to end.

2. Thick - net coaxial cable

- Thick-net coaxial cable is also known as RG-11 and 10Base5.
- 10Base5 [10=Mbps Speed, Base = Baseband, 5=500 Meter Segment Length]
- It is a flexible Coaxial cable about 0.50 inches thick.
- The 5 represent maximum segment length of 500 meters.
- It has ability to support maximum 100 nodes. (devices or computers)
- Thick coaxial cable has an extra protective plastic cover that protect center conductor.
- It has ability to support data transfer over longer distance.
- It is sometimes used as a backbone cable to connect several nodes of network.

Co-axial cable connectors:

Basically there are 4-type of connectors are used for coaxial cable.

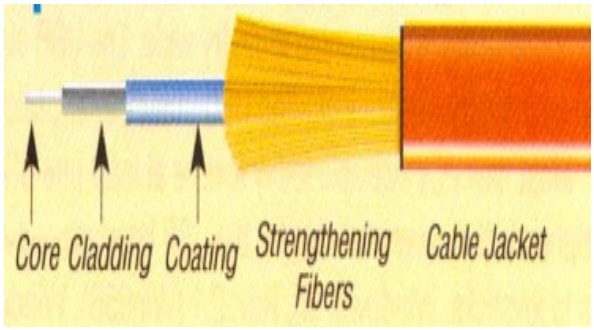
1. Barrel connectors
2. T-connectors
3. BNC connector
4. Terminators

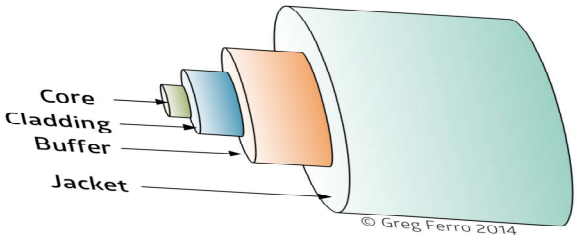
(3) Fiber Optic Cable

What is Fiber-Optic Cable? Give Advantages and Disadvantages

- Fiber Optic cable consists of very fine fiber made from 2 tubes of glass for inner core & Outer Core. So the transmission medium is an ultra-thin fiber glass.

- Pulses of light are used to carry signal, So A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.





Advantages:

- Very High Speed of Transmission, Useful for High speed network.
- Most reliable for data transfer
- Data cannot be tapped from the cable and hence security is extremely high.
- Low Power loss / Usage.
- No Interference. (No Electro Magnetic Interference)
- It allows longer transmission distances up to 2000 Meter.
- No Electrical Noise.
- Very Thin Size, Flexible and Light Weight cable.
- Highly Secure. Because It Carries Pulses of light as signal.

Disadvantages:

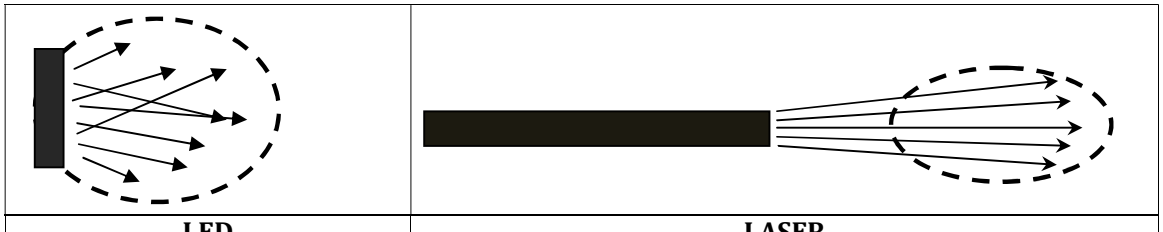
- High cost of cable and Expensive to install.
- Works on Half-Duplex Transmission Mode.
- Easy to cut or damage the cable.
- It cannot be Curved or bend. The signal can be damage or loss.

What is the Source of Light? How Optical Source is used in digital communication system?

There are 2 type of light source are available.

1. LED (Light Emitting Diodes)
2. LASER (Light Amplification by Stimulated Emission Radiation)

- The LEDs emit a lower level of light but concentrate light into a tighter cone pattern.
- The laser diodes emit light. The pattern of light is shown in following figure.
- From the given figure it is evident that the light-emitting diode pattern is broader, since light is emitted from the surface of the diode.
- Lasers project light from their edge, forming a more intense and narrow cone.

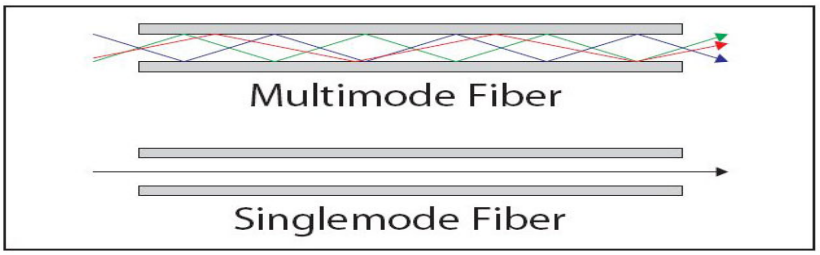


LED	LASER

- An optical transmission system has 3 main components.
  - Light source
  - The Transmission medium
  - The detectors
- Presence of light pulses indicates by “Binary I” and absence of light indicates a “Binary 0”.

What are the Types of Fiber Optic?

- Optical fiber can be of two types. (1) Single mode (2) Multi mode.
- Single Mode fibers allows single light path, used with laser signaling, allow greater bandwidth.
- Multimode allows multiple light paths, so it is more expensive, It gives very high bandwidth.

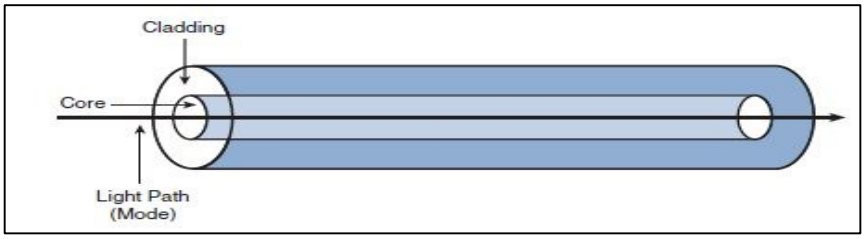


Explain Propagation in fiber

- In an optical fiber, a central core of glass is surrounded by so-called cladding (cutaway), a similar material with a lower refractive index.
- Light pulsed through the fiber will be bent at interface towards material with higher refractive index at the core.
- The diameter of core and difference between the refractive indicates of core and cladding determines the clarity of the signal received at the other end of an optical fiber.
- Fiber optic cables are constructed to operate in one of the following 3 modes.
    1. **Single Mode Optic Fiber.**
    2. **Multimode: Step Index Optic Fiber.**
    3. **Multimode: Graded Index Optic Fiber.**

1. Single Mode Fiber Optic Cable

- It uses LASER as the light-sources.
- In a single-mode fiber, the glass core is very narrow.
- The rays of a light pulse have little space to bounce from side to side.
- It moves at the speed of light with the least distortion and attenuation.
- The single mode concentrates the passage of light to the center of the fiber core.
- A core is "micro-meters (µm)" wide limits light to one path.
- Pulses of light can travel much farther in a single-mode fiber before the signal requires regeneration. It is 4 times faster than multimode fibers.



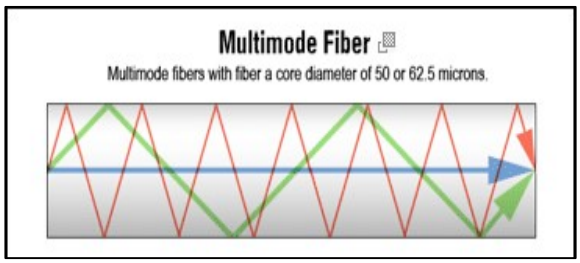
Multimode Optical Fiber:

- Multimode Optical Fiber allows more than two light rays for transmission.
- There are two types of Multi mode fiber optic cable. (1) Step Index (2) Graded Index
- Multimode fiber gives you high bandwidth at high speeds (100Mbps to 1Gbps, up to 2km).

- Multiple paths of light can cause signal distortion at the receiving end.
- The multimode fiber optic cable allows more than one ray of the light at a moment.

Multimode: Step Index Fiber

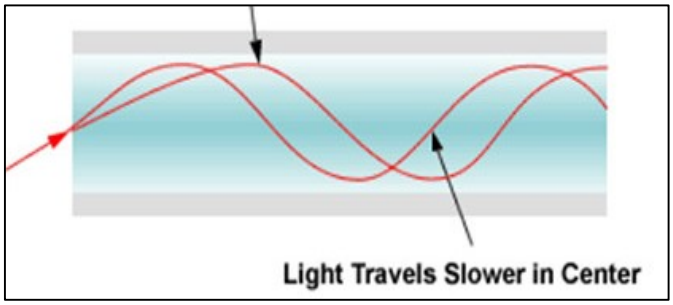
- **STEP-INDEX MULTIMODE FIBER** has a large core, up to 100 microns in diameter.
- With each ray at a slightly different angle from the other in a wider core.
- The light ray enters the core, is refracted slightly and travels through the core as it is reflected from one side of the cladding to the other.
- Some of the light rays that make up the digital pulse may travel a direct route, whereas others zigzag as they bounce off the cladding.



- These alternative pathways cause the different groupings of light rays, known as modes, to arrive separately at a receiving point.
- This type of fiber optic cable is best suited for transmission over short distances.

Graded Index Multimode Fiber

- The disadvantage of the step index core is removed by the graded index core.
- The incident light ray enters the cable in the same way as in the case of the step index.
- Instead of being reflected straight from the cladding, it is refracted in small increments as it travels through the core.
- The refraction bends the ray way from the cladding back towards the core.



- Thus, there is no loss due to the absorption of light by the cladding.
- So, the gradual paths of refraction are shorter so light rays arrive more nearly simultaneously, resulting in much less distortion of the information.
- In graded-index fibers, the index of refraction is highest in the center of the core and tapers gradually to a lower value in the cladding.

RADIO, VHF, MICROWAVE, INFRARED, and FIBER OPTIC

(1) Radio Transmission. (Radio Waves)

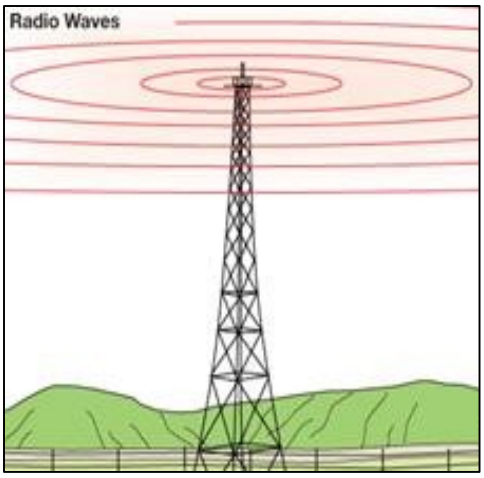
Radio waves have frequency between **3 Kilohertz (KHz) to 1 Gigahertz (GHz)**,
These are …

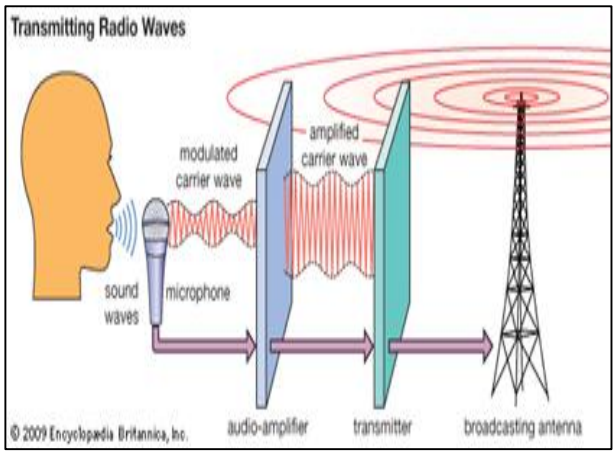
1. Short wave
2. VHF (Very High Frequency) (Used in television and FM Radio)
3. UHF (Ultra High Frequency) (Used in radio and television)

Characteristics of Radio Transmission

- Radio Waves are Omni Directional.
- Radio waves are easy to generate.
- Radio Waves can travel very long distances.

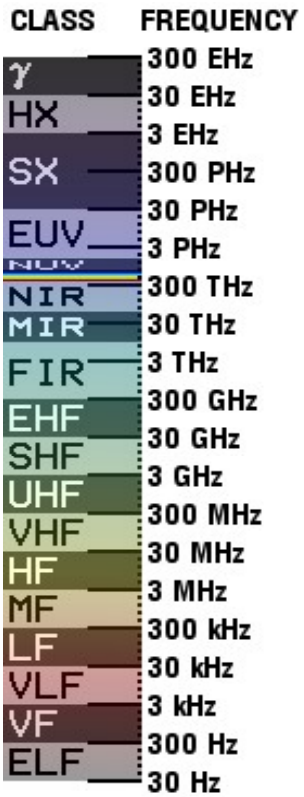
- They can penetrate buildings easily, so they are widely used for communication, both indoors and outdoors.
- Radio waves also are Omni directional, meaning that they travel in all directions from the source, so the transmitter and receiver do not have to be carefully aligned physically.
- The properties of radio waves are frequency dependent.
- At low frequencies, radio waves pass through obstacles well, but the power falls off sharply with distance from the source.
- At high frequencies, radio waves travel in straight lines and bounce off obstacles. They are also absorbed by rain.
- At all frequencies, radio waves are subject to interference from motors and other electrical equipment.





Radio Frequency Allocation

Electro-Magnetic spectrum is divided into frequency ranges, called bands. These bands are rated from very low frequency (VLF) to Extremely High Frequency (EHF).



Propagation in Signals

- Types of propagation used in radio transmission depend on the frequency of the signal.
- Each frequency is suitable for a specific layer of the atmosphere and is most efficiently transmitted and received by technologies adapted to that layer.

(1) VLF (Very Low Frequency)

- VLF waves are propagated as surface waves, through air & sometimes through seawater.
- VLF waves are used mostly for long-range radio navigation and for submarine communication.

(2) LF (Low Frequency): LF waves are also propagated as surface waves.

(3) MF (Medium Frequency)

- MF signals are propagated in troposphere.

- These frequencies are absorbed by the ionosphere.
- The distance they can cover is therefore limited by the angle needed to reflect the signal within the troposphere without entering the ionosphere.
- MF transmissions rely on **line-of-sight antennas** to increase control and avoid the absorption problem. (Example :- AM Radio)

(4) HF (High Frequency)

- HF signals use ionosphere propagation.
- These frequencies move into the ionosphere, where it reflects back to earth.
- Uses include ham radio, international broadcasting, Military Communication, long-distance aircraft and ship communication, telephone, telegraph and facsimile.

(5) VHF (Very High Frequency)

- Most VHF waves use line-of-sight propagation.
- Uses include VHF television, FM radio, aircraft AM radio, and aircraft navigational aid.

(6) UHF (Ultrahigh Frequency)

- UHF waves always use line-of-sight propagation.
- Uses include UHF television, mobile telephone, cellular radio, paging and microwave links.
- Microwave communication begins at 1GHz in UHF and continues in SHF and EHF.

(7) SHF (Super high Frequency)

- SHF waves are transmitted using mostly line-of-sight and some space propagation.
- Uses include terrestrial and satellite microwave and radar communication.

(8) EHF (Extremely High Frequency)

- EHF waves use space propagation. Uses include radar, satellite and Experimental Communications.

(2) Microwave Transmission

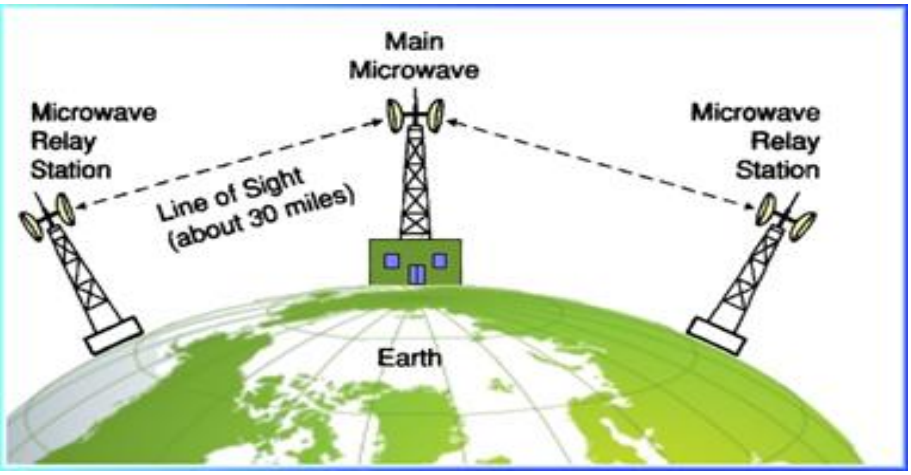
Characteristics of Microwave

- Microwave waves having frequencies between **1 GHz to 300 GHz**.
- Microwaves are Unidirectional (Only one Direction).
- Microwaves travel in straight lines and can therefore be focused
- It uses parabolic antenna(like the satellite TV dish)
- This means that the sending and receiving antennas need to be aligned.
- Transmitting and receiving antennas must be accurately aligned with each other.
- To overcome the problems of line-of-sight and week signals, microwave systems use repeaters at intervals of about 25 to 30 km in between the transmitting and receiving station.
- The first repeater is placed in line-of-sight of the transmitting station and the last repeater is placed in line-of-sight of the receiving station.
- Two consecutive repeaters are also place in line-of-sight of each other.
- The data signals are received, amplified, and re-transmitted by each of these stations.

Applications

- Microwaves are very useful when one-to-one communication is needed between the sender and the receiver.

- Microwave is widely used for long-distance telephone, Mobile communication, Television.
- It is cheaper as compared to Fiber Optic System
- This system permits data transmission rate of about 16 Gbps. At such frequency microwave can carry 2,50,000 voice channel at a same time.

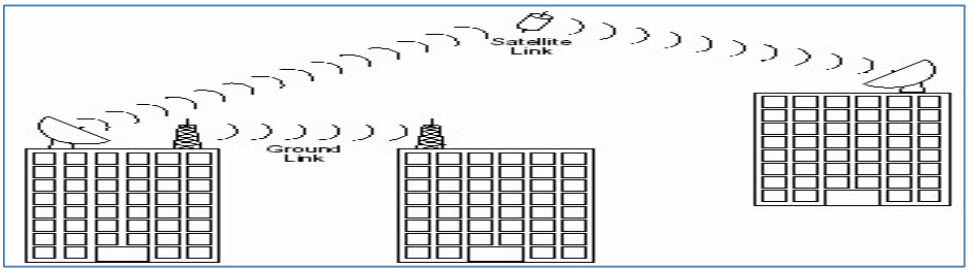


:: Types of Microwave Communication::

1. **Terrestrial (ground) Links**
2. **Satellite Links.**

1. Terrestrial Microwave

- Terrestrial microwave communication systems use directional **parabolic antennas** to send and receive signals in the lower Gigahertz range.
- The signals are highly focused and physical path must be **line-of-sight**.



- Relay towers are used to extend signals.
- Terrestrial microwave systems are used when cabling is highly costlier.
- Terrestrial microwave like telephone relay towers, placed every few miles to relay telephone signals across a city/state/Country.
- Microwave transmissions use a parabolic antenna.
- Parabolic antenna produces a narrow, highly directional signal.
- The transmitter and receiver are highly focused; they must be adjusted carefully so that the transmitted signal is aligned with the receiver. It is called as “Line of Sight”.
- Terrestrial microwave systems costs are highly.
- Terrestrial microwave systems operate at data rates between 1 and 100 Mbps.
- Terrestrial microwave systems can be affected by Pollution, Fog and Rain Like atmosphere.

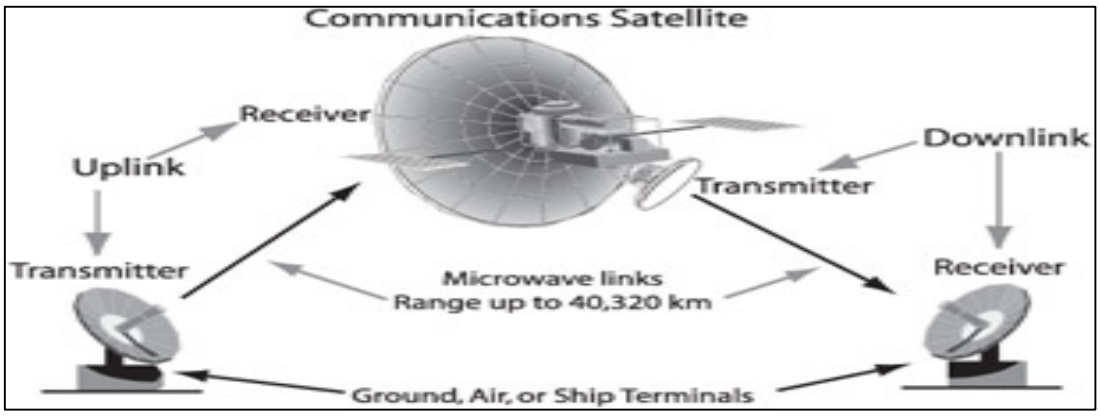
2. Satellite Microwave

What is Satellite?

- An artificial body placed in orbit round the earth for communication. It is Larger Repeater station outside of earth.
- It is equipped with a number of devices called "*transponders". It is used for sending and receiving frequencies.*
- Each of which uses some portion of the frequency, amplifies an incoming signal (*uplink*), and re-broadcasts it at another frequency (*downlink*).

Satellite Microwave System

- Satellite microwave systems relay transmissions through communication satellites that operate in geosynchronous orbits at 22,300 miles above the earth.
- Satellites orbiting at this distance remain located above a fixed point on earth. Earth stations use parabolic dish antennas (satellite dishes) to communicate with satellites.
- These satellites can retransmit signals in broad or narrow beams, depending on the locations set to receive the signals. When the destination is on the opposite side of the earth, for example, the first satellite cannot transmit directly to the receiver and thus must relay the signal through another satellite.
- Satellite microwave communication is possible with most remote sites and with mobile devices, which enables communication with ships at sea and motor vehicles.
- The distances involved in satellite communication result in an interesting phenomenon: Because all signals must travel 22,300 miles to the satellite and 22,300 miles when returning to a receiver, the time required to transmit a signal is independent of distance on the ground. The delays encountered with satellite transmissions range from 0.5 to 5 seconds.



Cost: Satellite communication is extremely expensive.

Bandwidth Capacity: - Typical data rates are 1 –100Mbps.

Attenuation: Depend on frequency, power, and atmospheric conditions.

Example:

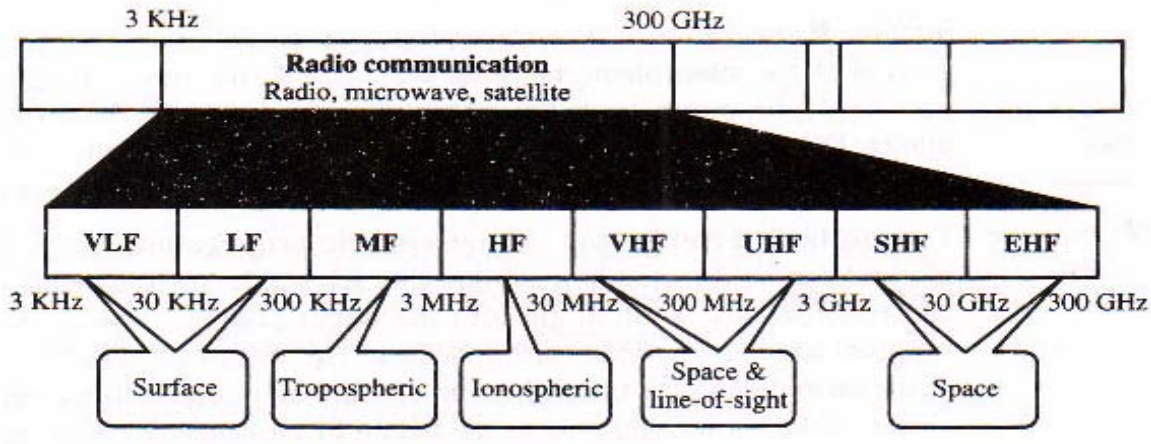
I. 6,000 to 12,000 miles – Low earth Orbit and Medium Earth Orbits
II. 22,223 Miles –: Geo-stationary Orbits

- Weather forecasts visually us each day with images from weather satellites, typically 22,223 miles over the equator.
- Many countries use weather satellites for their weather forecasting and storm observations.

- Data, television, image and some telephone transmissions are routinely received and re-broadcast by communications satellites.
- Typical satellite telephone links have 550 to 650 milliseconds of round-trip delay that contribute to consumer dissatisfaction with this type of long-distance carrier.
- It takes the voice communications that long to travel all the way up to the satellite and back to Earth.
- Geostationary orbits are perfect for weather satellites and communications satellites.

Propagation of Radio Wave and Types of Propagation

- Radio wave transmission utilizes five different types of propagation:
  1. **Surface. (0- 6 km)**
  2. **Troposphere (6-10km)**
  3. **Ionosphere (60km to 100 km)**
  4. **Space (Over 100 km)**
  5. **Line of Sight**
- Radio technology considers the earth as surrounded by two layers of atmosphere: the troposphere and ionosphere.
- The troposphere is the portion of the atmosphere extending outward approx 30 miles from the earth's surface, and contains air. Clouds, wind, temperature variations and weather in general occur i n troposphere.
- The ionosphere is the layer of atmosphere above the troposphere, but below space.
- It contains free electronically charged particles.



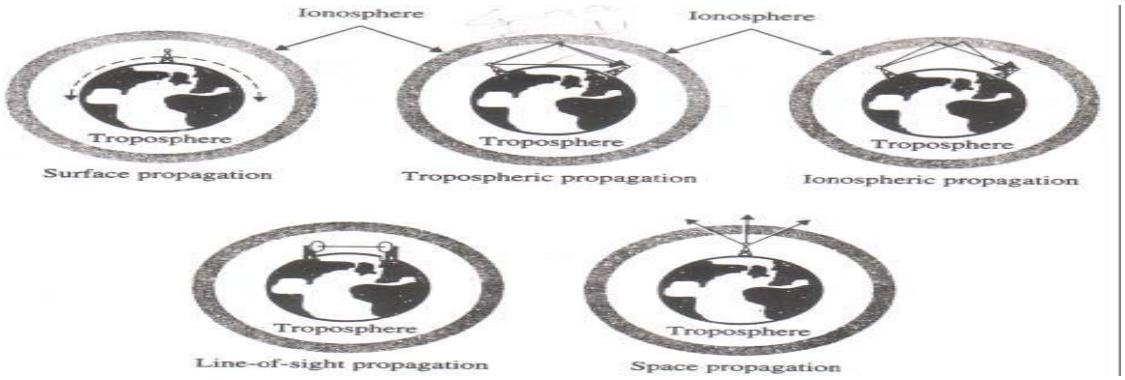
1. Surface Propagation

- In Surface Propagation, Radio Waves travel through the lowest portion of the atmosphere.
- At the lowest frequencies, signals emanate in all directions from the transmitting antenna and follow the curvature of the planet. Distance depends on the amount of power in the signal.

2. Troposphere Propagation

- It can work in 2 ways.
  (1) Signal can be directed in a straight line from antenna to antenna (line of sight), REQUIRE placement of transmitter and receiver within line of sight. Limited by the height of the antennas.

(2) Signal can BE reflected back down to the earth's surface. It allows greater distance to be covered.



3. Ionosphere Propagation

- In this case, higher-frequency radio waves radiate upward into the ionosphere where they are reflected back to earth.
- The density difference between the troposphere and the ionosphere causes each radio wave to speed up and change direction, bending back to earth.
- This type of transmission allows for greater distance to be covered with lower power output.

4. Line-of-Sight Propagation

- In this case, very high frequency signals are transmitted in straight lines directly from antenna to antenna.
- Antennas must be directional, facing each other and either close enough together not to be affected by the curvature of the earth.

5. Space Propagation

- It utilizes satellite relays in place of atmospheric refraction.
- A broadcast signal is received by an orbiting satellite, which rebroadcast the signal to the intended receiver back on the earth.
- Satellite transmission is basically line-of-sight with an intermediary.
- The distance of the satellite from the earth makes it equivalent of a super-high-gain antenna and dramatically increases the distance coverable by a signal.