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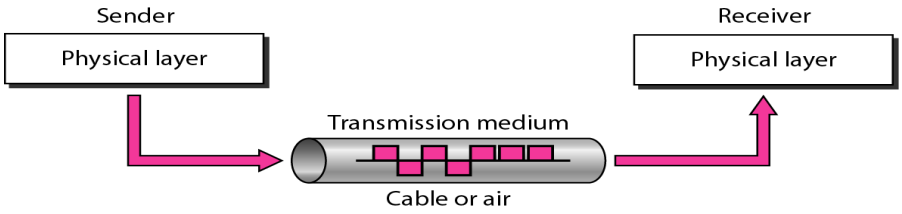
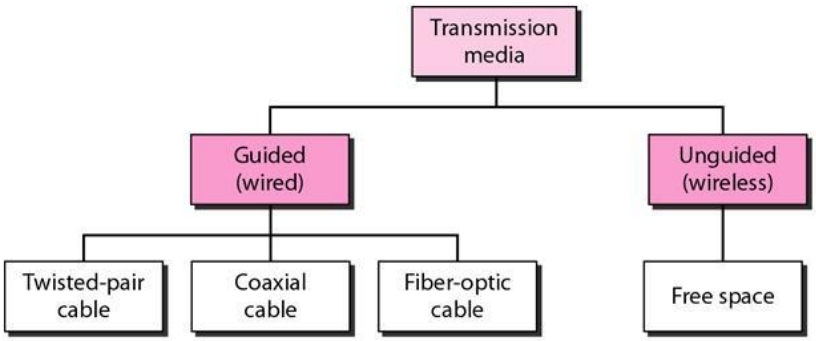
Topic: Transmission Medium:

Transmission media is a pathway that carries the information from sender to receiver. We use different types of cables or waves to transmit data. Data is transmitted normally through electrical or electromagnetic signals. The first layer (physical layer) of Communication Networks the OSI Seven layer model is dedicated to the transmission media.



An electrical signal is in the form of current. An electromagnetic signal is series of electromagnetic energy pulses at various frequencies. These signals can be transmitted through copper wires, optical fibers, atmosphere, water and vacuum Different Medias have different properties like bandwidth, delay, cost and ease of installation and maintenance. Transmission media is also called **Communication channel.**



Wired or Guided Media or Bound Transmission Media: Bound transmission media are the cables that are tangible or have physical existence and are limited by the physical geography. Popular bound transmission media in use are twisted pair cable, co-axial cable and fiber optical cable. Each of them has its own characteristics like transmission speed, effect of noise, physical appearance, cost etc.

Wireless or Unguided Media or Unbound Transmission Media: Unbound transmission media are the ways of transmitting data without using any cables. These media are not bounded by physical geography. This type of transmission is called Wireless **communication.** Nowadays wireless communication is becoming popular. Wireless LANs are being installed in office and college campuses. This transmission uses Microwave, Radio wave, Infra red are some of popular unbound transmission media.

Twisted pair (TP)

Twisted pair copper cable is still widely used, due to its low cost and ease of installation. A twisted pair consists of two insulated copper cables, twisted together to reduce electrical interference between adjacent pairs of wires. This type of cable is still used in the subscriber loop of the public telephone system (the connection between a customer and the local telephone exchange), which can extend for several kilometres without amplification. The subscriber loop is essentially an analogue transmission line, although twisted pair cables are also be used in computer networks to carry digital signals over short distances.

Twisted pair cable is divided into two categories:

- Unshielded Twisted Pair (UTP)
- Shielded Twisted Pair (STP)

Unshielded Twisted Pair (UTP): UTP is the copper media, inherited from telephony, which is being used for increasingly higher data rates, and is rapidly becoming the de facto standard for horizontal wiring, the connection between, and including, the outlet and the termination in the communication closet.

Advantages:

- Installation is easy
- Flexible
- Cheap
- It has high speed capacity,
- 100 meter limit
- Higher grades of UTP are used in LAN technologies like Ethernet.

It consists of two insulating copper wires (1mm thick). The wires are twisted together in a helical form to reduce electrical interference from similar pair.

Disadvantages:

- Bandwidth is low when compared with Coaxial Cable
- Provides less protection from interference.

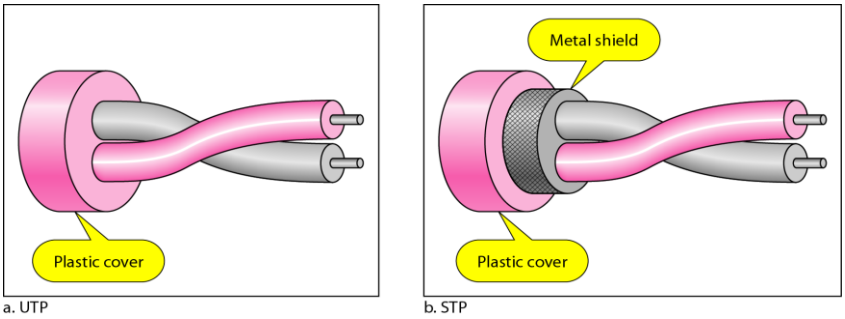
Shielded Twisted Pair (STP): STP is heavier and more difficult to manufacture, but it can greatly improve the signalling rate in a given transmission scheme Twisting provides cancellation of magnetically induced fields and currents on a pair of conductors.

Advantages:

- Easy to install
- Performance is adequate
- Can be used for analog or Digital transmission
- Increases the signalling rate
- Higher capacity than unshielded twisted pair
- Eliminates crosstalk

Disadvantages:

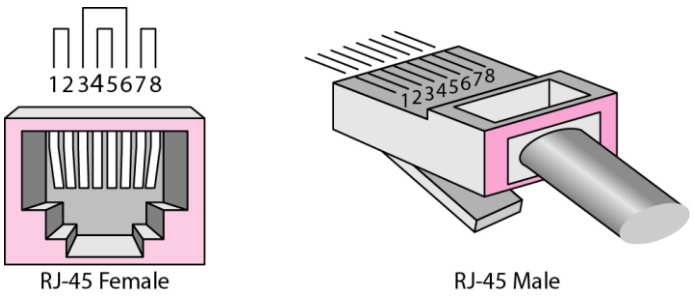
- Difficult to manufacture
- Heavy



Categories of unshielded twisted-pair cables

Category	*Specification*	*Data Rate (Mbps)*	*Use*
1	Unshielded twisted-pair used in telephone	< 0.1	Telephone
2	Unshielded twisted-pair originally used in T-lines	2	T-1 lines
3	Improved CAT 2 used in LANs	10	LANs
4	Improved CAT 3 used in Token Ring networks	20	LANs
5	Cable wire is normally 24 AWG with a jacket and outside sheath	100	LANs
5E	An extension to category 5 that includes extra features to minimize the crosstalk and electromagnetic interference	125	LANs
6	A new category with matched components coming from the same manufacturer. The cable must be tested at a 200-Mbps data rate.	200	LANs
7	Sometimes called SSTP (shielded screen twisted-pair). Each pair is individually wrapped in a helical metallic foil followed by a metallic foil shield in addition to the outside sheath. The shield decreases the effect of crosstalk and increases the data rate.	600	LANs

UTP connector

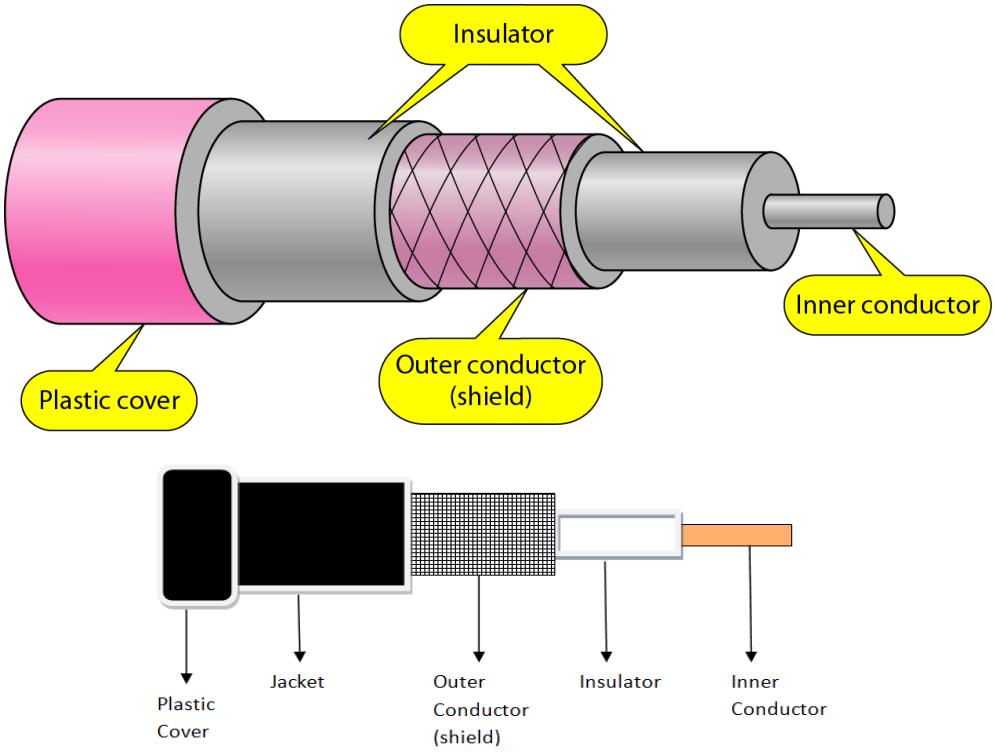


RJ45 (Registered Jack 45)

Coaxial Cable

Coaxial is called by this name because it contains two conductors that are parallel to each other. Copper is used in this as centre conductor which can be a solid wire or a standard one. It is surrounded by PVC installation, a sheath which is encased in an outer conductor of metal foil, barid or both.

Outer metallic wrapping is used as a shield against noise and as the second conductor which completes the circuit. The outer conductor is also encased in an insulating sheath. The outermost part is the plastic cover which protects the whole cable.



There are two types of Coaxial cables:

BaseBand

This is a 50 ohm (Ω) coaxial cable which is used for digital transmission. It is mostly used for LAN's. Baseband transmits a single signal at a time with very high speed. The major drawback is that it needs amplification after every 1000 feet.

BroadBand

This uses analog transmission on standard cable television cabling. It transmits several simultaneous signal using different frequencies. It covers large area when compared with Baseband Coaxial Cable.

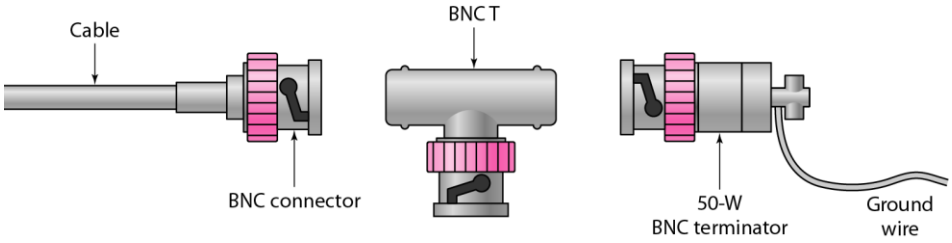
Advantages :

- Bandwidth is high
- Used in long distance telephone lines.
- Transmits digital signals at a very high rate of 10Mbps.
- Much higher noise immunity
- Data transmission without distortion.
- The can span to longer distance at higher speeds as they have better shielding when compared to twisted pair cable

Disadvantages :

- Single cable failure can fail the entire network.
- Difficult to install and expensive when compared with twisted pair.
- If the shield is imperfect, it can lead to grounded loop.

Connector



BNC (Bayonet Neill–Concelman) connector

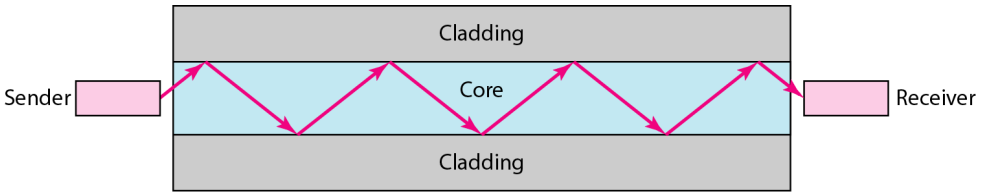
Fiber Optic Cable

These are similar to coaxial cable. It uses electric signals to transmit data. At the centre is the glass core through which light propagates.

In multimode fibres, the core is 50microns, and In single mode fibres, the thickness is 8 to 10 microns.

The core in fiber optic cable is surrounded by glass cladding with lower index of refraction as compared to core to keep all the light in core. This is covered with a thin plastic jacket to protect the cladding. The fibers are grouped together in bundles protected by an outer shield.

Fiber optic cable has bandwidth more than **2 gbps (Gigabytes per Second)**



Advantages :

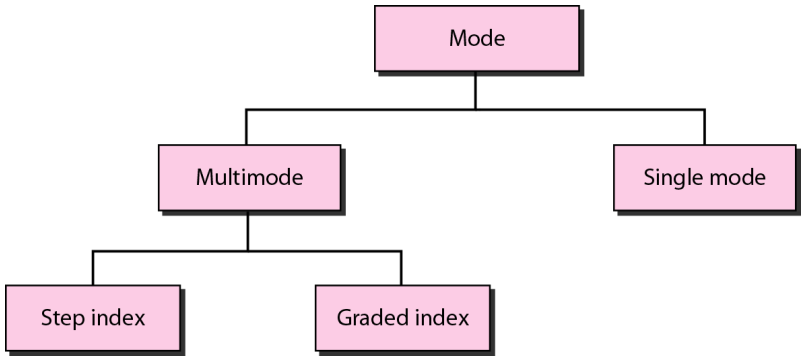
- Provides high quality transmission of signals at very high speed.
- These are not affected by electromagnetic interference, so noise and distortion is very less.
- Used for both analog and digital signals.

Disadvantages :

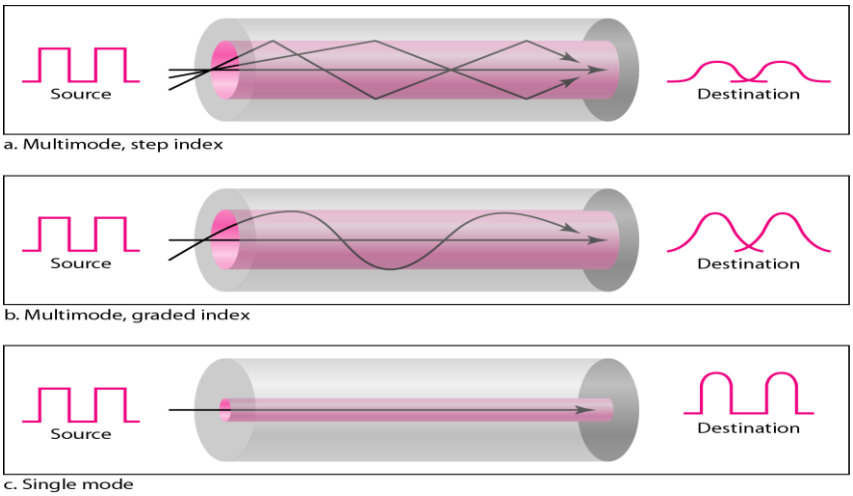
- It is expensive
- Difficult to install.

- Maintenance is expensive and difficult.
- Do not allow complete routing of light signals.

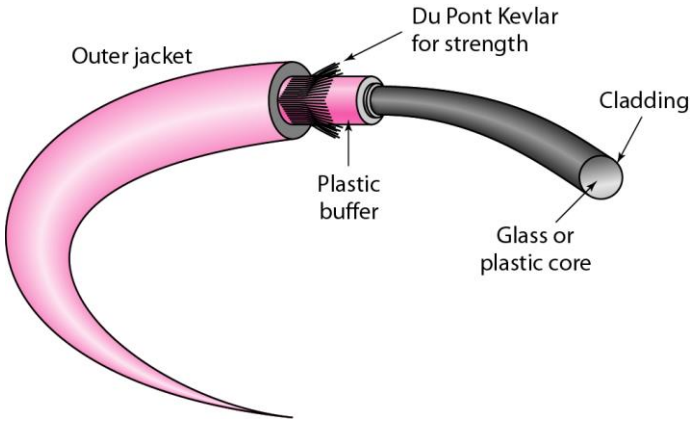
Propagation modes



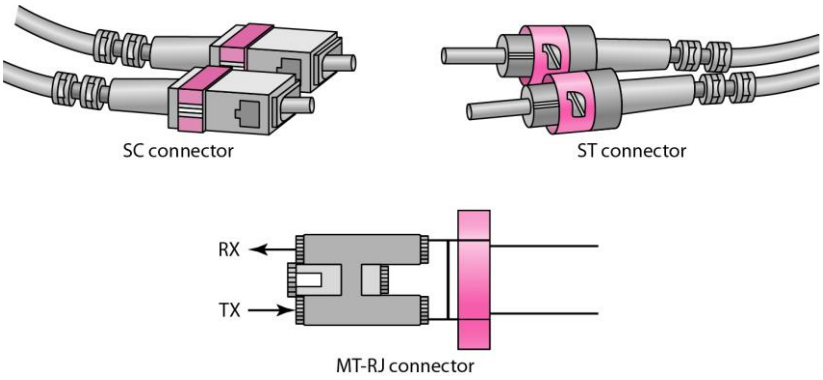
Modes



Fiber construction



Fiber-optic cable connectors

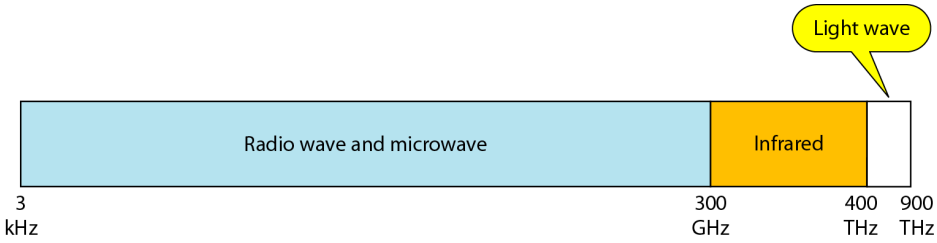


UnBounded/UnGuided Transmission Media

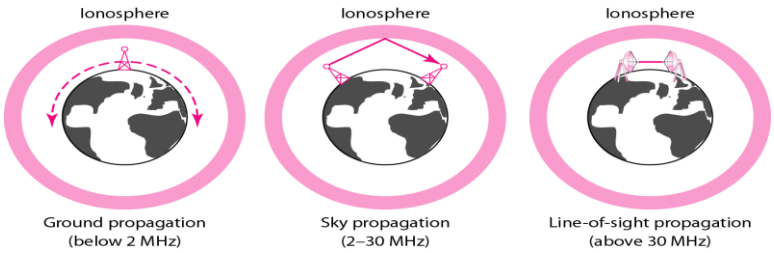
Unguided or wireless media sends the data through air (or water), which is available to anyone who has a device capable of receiving them. Types of unguided/ unbounded media are discussed below:

- Radio Transmission
- MicroWave Transmission
- Infrared

Electromagnetic spectrum for wireless communication



Propagation methods



Surface/ Ground propagation : Radio waves travel through the lowest portion of the atmosphere, hugging the earth. Distance cover by these signals depends on the amount of power in the signal: the greater the power, the greater the distance.

Space/ Sky Propagation: Space propagation utilizes satellite relays in place of atmosphere refraction. A broadcast signal is received by an orbiting satellite, which rebroadcasts the signal to the intended receiver back on the earth.

Line-of-Sight Propagation: In line-of-sight propagation, very high frequency signal are transmitted in straight line directly from antenna to antenna. Antennas must be directional, facing each other, and either tall enough or close enough together not to be affected by the curvature of the earth. Example of line-of sight system is microwave link using dishes and towers. A 60m-tower gives 60 km line of sight.

Bands

Band	*Range*	*Propagation*	*Application*
VLF (very low frequency)	3–30 kHz	Ground	Long-range radio navigation
LF (low frequency)	30–300 kHz	Ground	Radio beacons and navigational locators
MF (middle frequency)	300 kHz–3 MHz	Sky	AM radio
HF (high frequency)	3–30 MHz	Sky	Citizens band (CB), ship/aircraft communication
VHF (very high frequency)	30–300 MHz	Sky and line-of-sight	VHF TV, FM radio
UHF (ultrahigh frequency)	300 MHz–3 GHz	Line-of-sight	UHF TV, cellular phones, paging, satellite
SHF (superhigh frequency)	3–30 GHz	Line-of-sight	Satellite communication
EHF (extremely high frequency)	30–300 GHz	Line-of-sight	Radar, satellite

Radio waves are used for multicast communications, such as radio and television, and paging systems.

Radio frequency is easier to generate and because of its large wavelength it can penetrate through walls and structures alike.Radio waves can have wavelength from 1 mm – 100,000 km and have frequency ranging from 3 Hz (Extremely Low Frequency) to 300 GHz (Extremely High Frequency). Radio frequencies are sub-divided into six bands.

Radio waves at lower frequencies can travel through walls whereas higher RF can travel in straight line and bounce back.The power of low frequency waves decreases sharply as they cover long distance. High frequency radio waves have more power.

Lower frequencies such as VLF, LF, MF bands can travel on the ground up to 1000 kilometers, over the earth's surface.

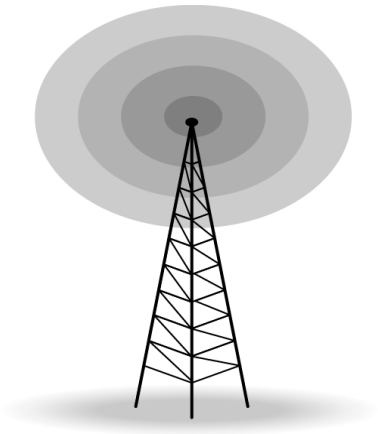
- They can penetrate through walls.
- Highly regulated.
- Use omnidirectional antennas

Types of Propogation

Radio Transmission utilizes different types of propogation:

- **Troposphere :** The lowest portion of earth's atmosphere extending outward approximately 30 miles from the earth's surface. Clouds, jet planes, wind is found here.
- **Ionosphere:** The layer of the atmosphere above troposphere, but below space. Contains electrically charged particles.

Omnidirectional antenna



Microwaves are used for unicast communication such as cellular telephones, satellite networks, and wireless LANs.

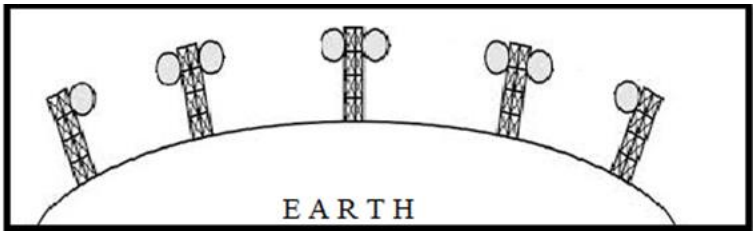
- Higher frequency ranges cannot penetrate walls.
- Use directional antennas - point to point line of sight communications.

There are 2 types of Microwave Transmission :

1. Terrestrial Microwave
2. Satellite Microwave

Terrestrial Microwave

For increasing the distance served by terrestrial microwave, repeaters can be installed with each antenna .The signal received by an antenna can be converted into transmittable form and relayed to next antenna as shown in below figure. It is an example of telephone systems all over the world.

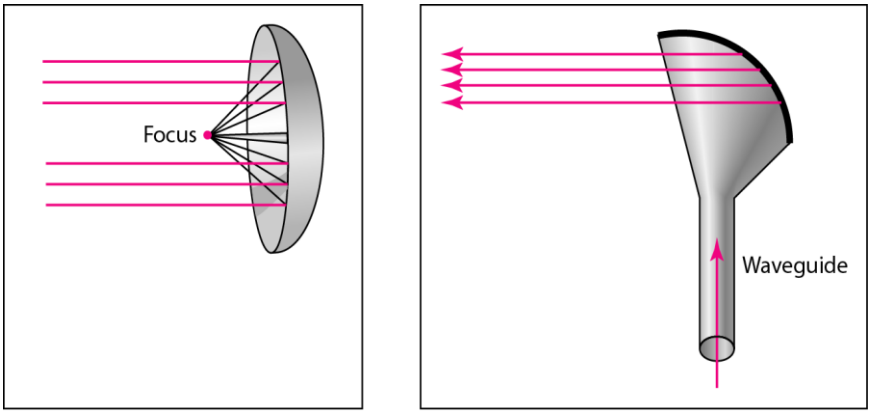


There are two types of antennas used for terrestrial microwave communication :

1. **Parabolic Dish Antenna:** In this every line parallel to the line of symmetry reflects off the curve at angles in a way that they intersect at a common point called focus. This antenna is based on geometry of parabola.

2. **Horn Antenna:** It is a like gigantic scoop. The outgoing transmissions are broadcast up a stem and deflected outward in a series of narrow parallel beams by curved head.

Unidirectional antennas

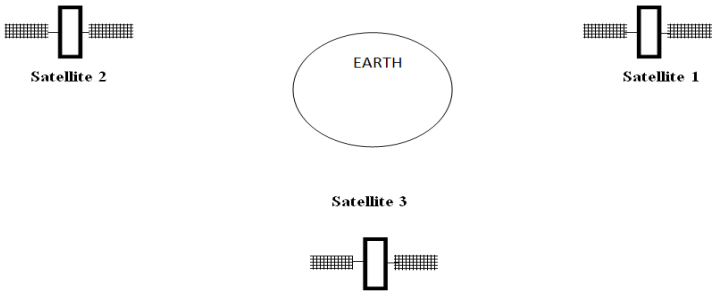


a. Dish antenna b. Horn antenna

Satellite Microwave

This is a microwave relay station which is placed in outer space. The satellites are launched either by rockets or space shuttles carry them.

These are positioned 36000KM above the equator with an orbit speed that exactly matches the rotation speed of the earth. As the satellite is positioned in a geo-synchronous orbit, it is stationery relative to earth and always stays over the same point on the ground. This is usually done to allow ground stations to aim antenna at a fixed point in the sky.



Features of Satellite Microwave :

- Bandwidth capacity depends on the frequency used.
- Satellite microwave deployment for orbiting satellite is difficult.

Advantages of Satellite Microwave:

- Transmitting station can receive back its own transmission and check whether the satellite has transmitted information correctly.

- A single microwave relay station which is visible from any point.

Disadvantages of Satellite Microwave:

- Satellite manufacturing cost is very high
- Cost of launching satellite is very expensive
- Transmission highly depends on whether conditions, it can go down in bad weather

Infrared signals can be used for short-range communication in a closed area using line-of-sight propagation. Infrared wave lies in between visible light spectrum and microwaves. It has wavelength of 700-nm to 1-mm and frequency ranges from 300-GHz to 430-THz.

Infrared wave is used for very short range communication purposes such as television and it's remote. Infrared travels in a straight line hence it is directional by nature. Because of high frequency range, Infrared cannot cross wall-like obstacles.

Characteristics :

- Used by remote controls for TV, VCRs, etc.
- Cheap and easy to build.
- Straight line, no obstacles - even more so than microwaves.
- Used for wireless LANs within a room.