# Satellite Communication

By Amit Patel

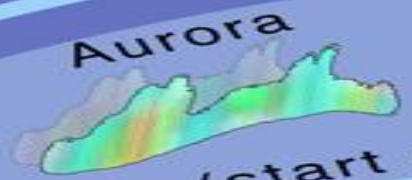
# UNGUIDED (UNBOUNDED) MEDIA

- Unguided or wireless media sends the data through air (or water), which is available to anyone who has a device capable of receiving them.
- It is also known as unbounded media because data signals are not bounded to cabling media.
- Unbound transmission media extend beyond the limiting confines of cabling.
- They provide an excellent Communication Networks alternative for WANS.
- Unbound media typically operate at very high frequencies.
- The transmission and reception of data is carried out using antenna.
- There are two main ways that antenna work:
  - Directional (in a beam)
  - Omnidirectional (all around)

# Layers of the Atmosphere

**Exosphere**
960 to 6,200 miles
Up to 2,700°F


Exobase




**Thermosphere**
86 to 372 miles
932°F to 3,632°F

Kármán line (start of outer space)


**Mesosphere**
32 to 85 miles
32°F to -130°F


**Stratosphere**
11 to 31 miles
-60°F to 5°F

Ozone layer

**Troposphere**
0 to 10 miles
62°F to -60°F



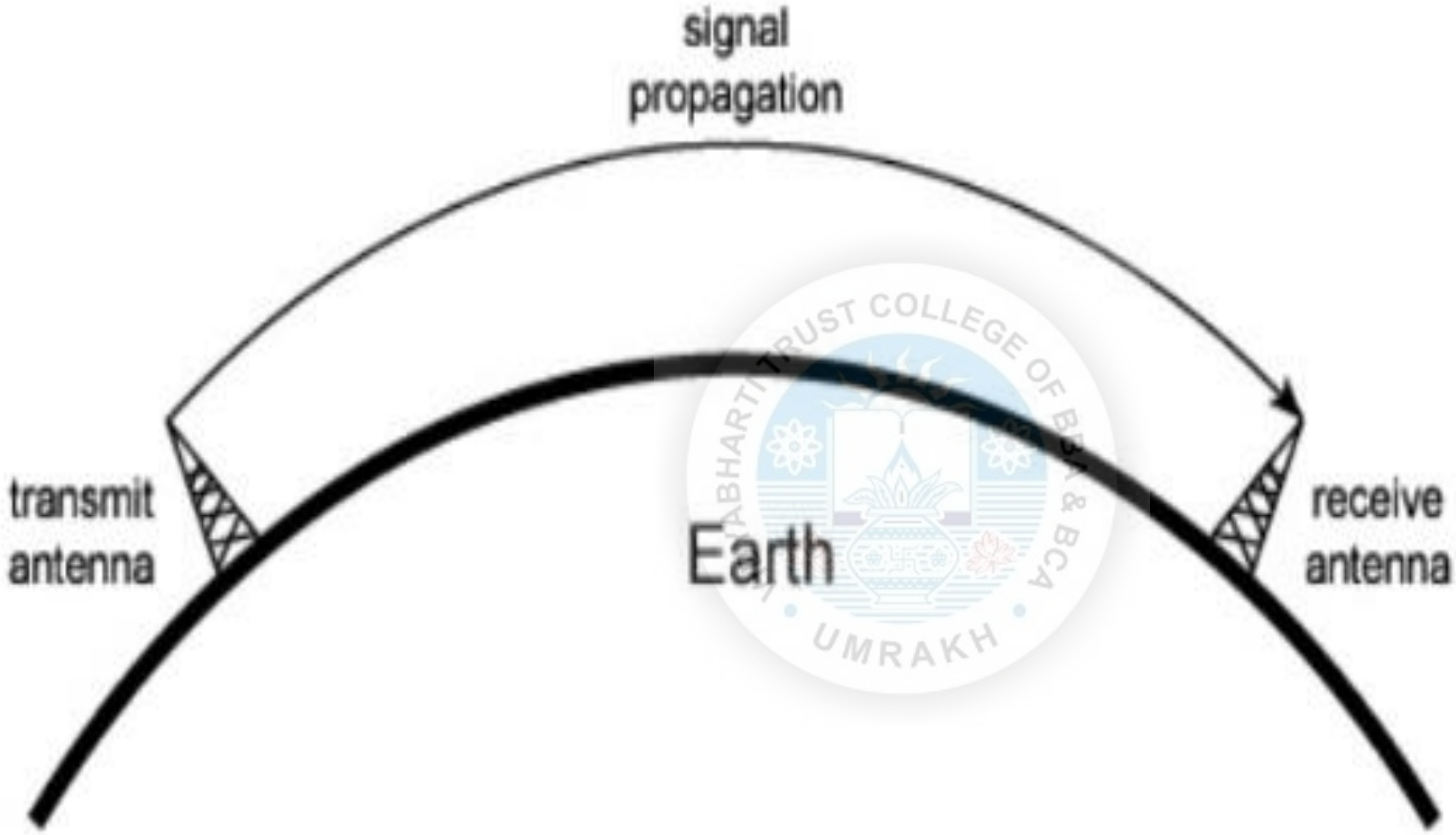
# UNGUIDED (UNBOUNDED) MEDIA

- It is travel from source to destination in several ways
  - Ground Propagation
  - Sky Propagation
  - Line of sight propagation

# UNGUIDED (UNBOUNDED) MEDIA

## Ground Propagation

- In ground propagation, radio waves travel through the lowest portion of the atmosphere .
- These low frequency signal emanate in all directions from the transmitting antenna and follow the curvature of the planet.
- Ground wave propagation is usually suitable for the transmission of low-frequency electromagnetic signals (usually up to 2 or 3 MHz).
- Example : AM, FM Radio and TV broadcasting



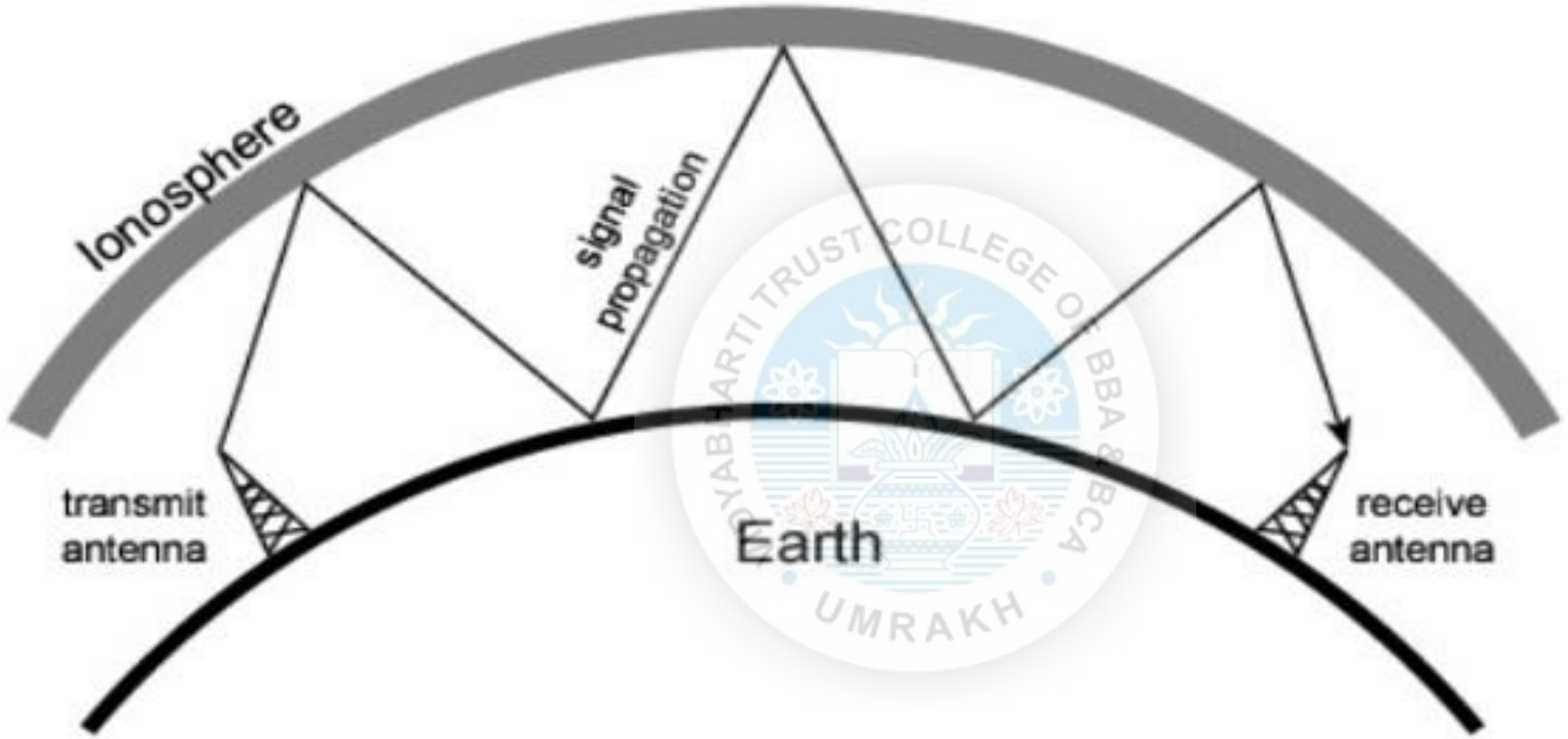
# UNGUIDED (UNBOUNDED) MEDIA

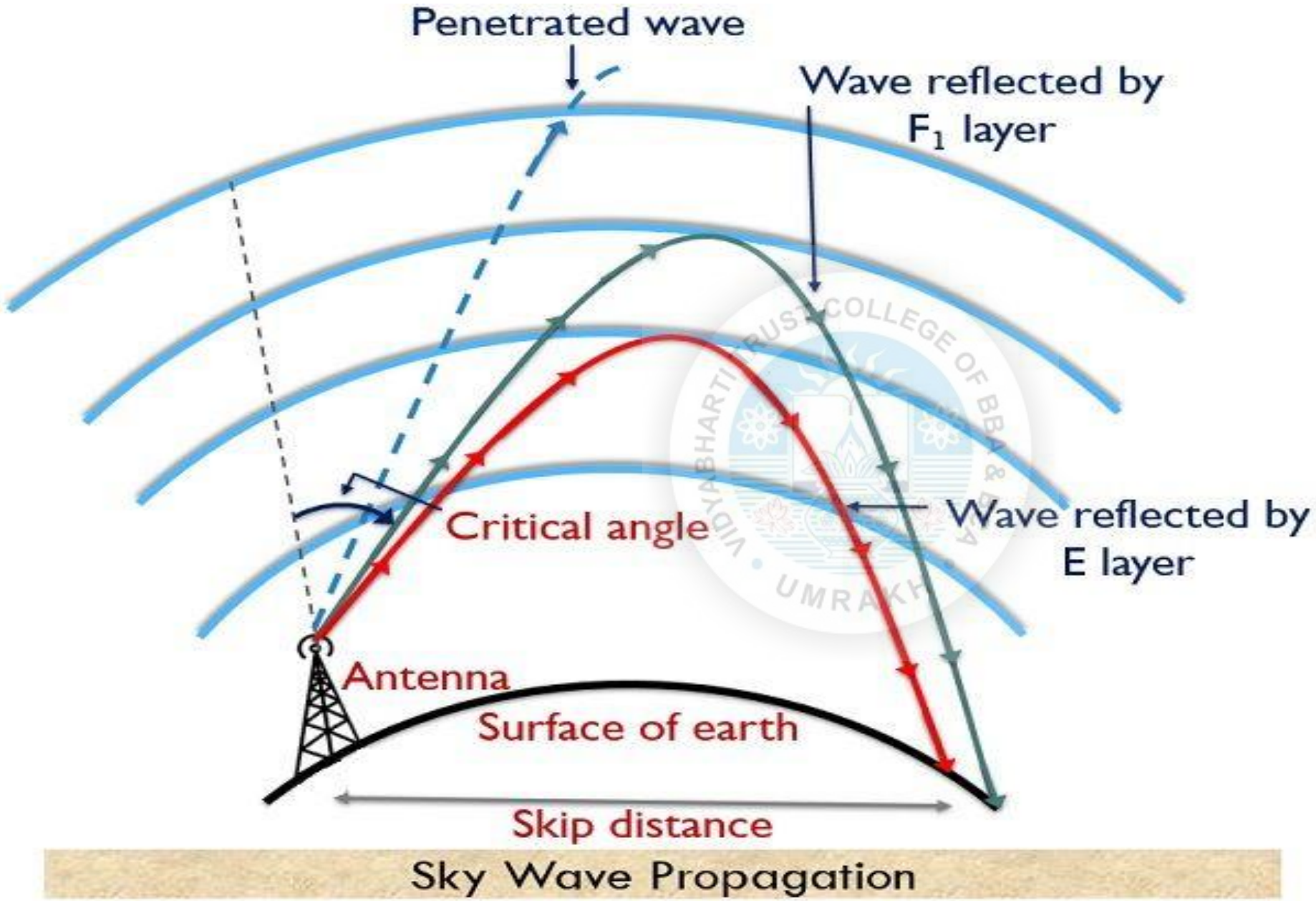
- Disadvantage Of ground wave propagation Suitable only for short-range operation.
- This is so because the induced wave in ground wave propagation causes attenuation of the propagated signal. Therefore, in order to transmit the signal with the least attenuation, it is preferred that the signal is transmitted only to short ranges, in the case of ground wave propagation.

# UNGUIDED (UNBOUNDED) MEDIA

## Sky Propagation

- In the sky propagation, higher frequency radio waves radiate upward into the ionosphere where they are reflected back to the earth.
- Ionosphere is the upper portion of atmosphere between 50Km to 350 KM above the earth
- It allow for greater distances with lower output power.
- The permissible frequency range in the case of sky wave propagation lies between 3 MHz to 30 MHz.
- Example: Military Communication, satellite communication.





# UNGUIDED (UNBOUNDED) MEDIA

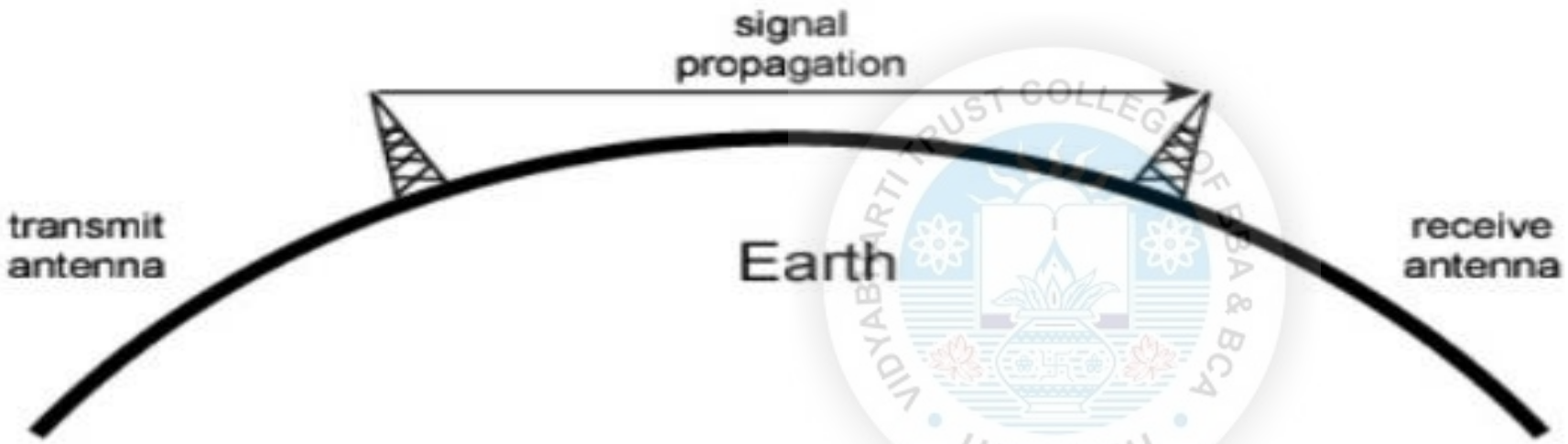
Why sky wave propagation is suitable only for this particular range of frequency?

- Basically the electromagnetic waves in the range of 3 to 30 MHz get reflected by the ionosphere. However, the signals with frequency beyond 30 MHz despite undergoing reflection get penetrated.
- So, due to this reason, sky wave propagation is suitable only for this particular range of frequency.

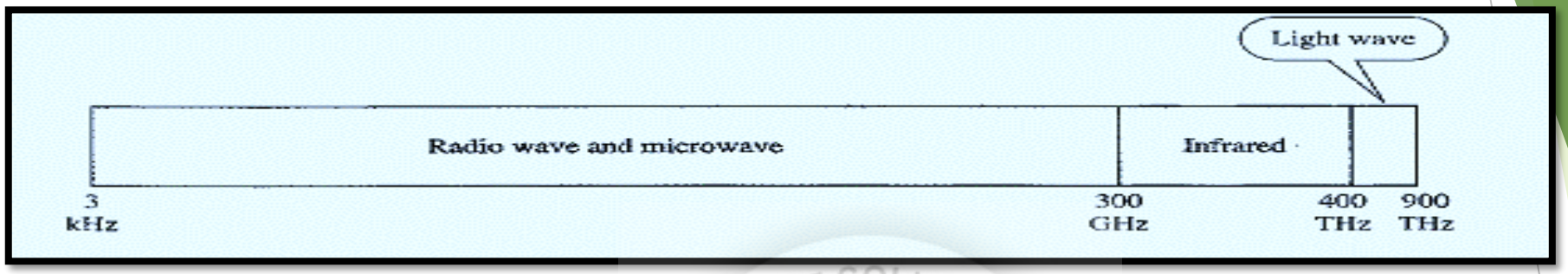
# UNGUIDED (UNBOUNDED) MEDIA

## Line of sight propagation Or Space Wave

- Line of sight (LoS) is a type of propagation that can transmit and receive data only where transmit and receive stations are in view of each other without any sort of an obstacle between them.
- The EM wave propagates from the transmitter to the receiver in the earth troposphere is called Space wave.
- In line of sight propagation, very high frequency signal are transmitted in straight lines directly from antenna to antenna.
- Antenna must be directional, facing each other, and either tall enough or close enough



# UNGUIDED (UNBOUNDED) MEDIA




Electric Magnetic Spectrum

- Electric magnetic spectrum defined as radio waves and microwaves is divided into eight ranges, called frequency band, each regulated by government.
- These band are related to very low frequency(VLF) to extremely high frequency (EHF).

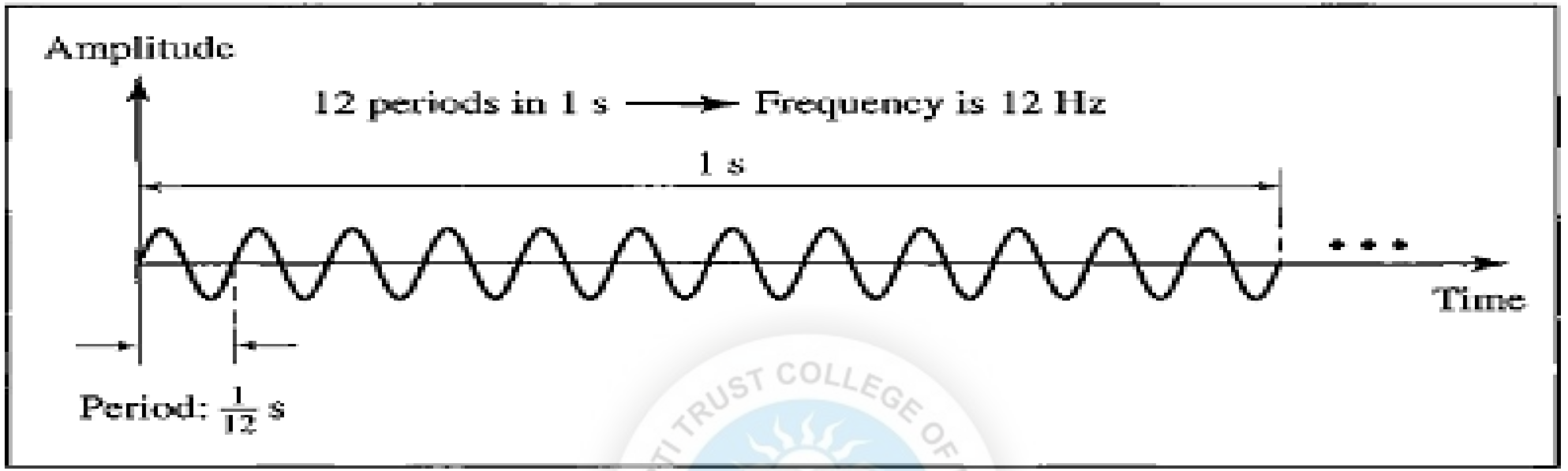
| *Band* | *Range* | *Propagation* | *Application* |
|---|---|---|---|
| VLF (very low frequency) | 3–30 kHz | Ground | Long-range radio navigation |
| LF (low frequency) | 30–300 kHz | Ground | Radio beacons and navigational locators |
| MF (middle frequency) | 300 kHz–3 MHz | Sky | AM radio |
| HF (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 |

| Frequency Band Name | Frequency Range | Application |
|---|---|---|
| Extremely Low Frequency (ELF) | 3-30 Hz | Underwater Communication |
| Super Low Frequency (SLF) | 30-300 Hz | AC Power (though not a transmitted wave) |
| Ultra Low Frequency (ULF) | 300-3000 Hz | |
| Very Low Frequency (VLF) | 3-30 kHz | Navigational Beacons |
| Low Frequency (LF) | 30-300 kHz | AM Radio |
| Medium Frequency (MF) | 300-3000 kHz | Aviation and AM Radio |
| High Frequency (HF) | 3-30 MHz | Shortwave Radio |
| Very High Frequency (VHF) | 30-300 MHz | FM Radio |
| Ultra High Frequency (UHF) | 300-3000 MHz | Television, Mobile Phones, GPS |
| Super High Frequency (SHF) | 3-30 GHz | Satellite Links, Wireless Communication |
| Extremely High Frequency (EHF) | 30-300 GHz | Radar System,Astronomy, Remote Sensing |
| Visible Spectrum | 400-790 THz (4*10^14-7.9*10^14) | Human Eye |

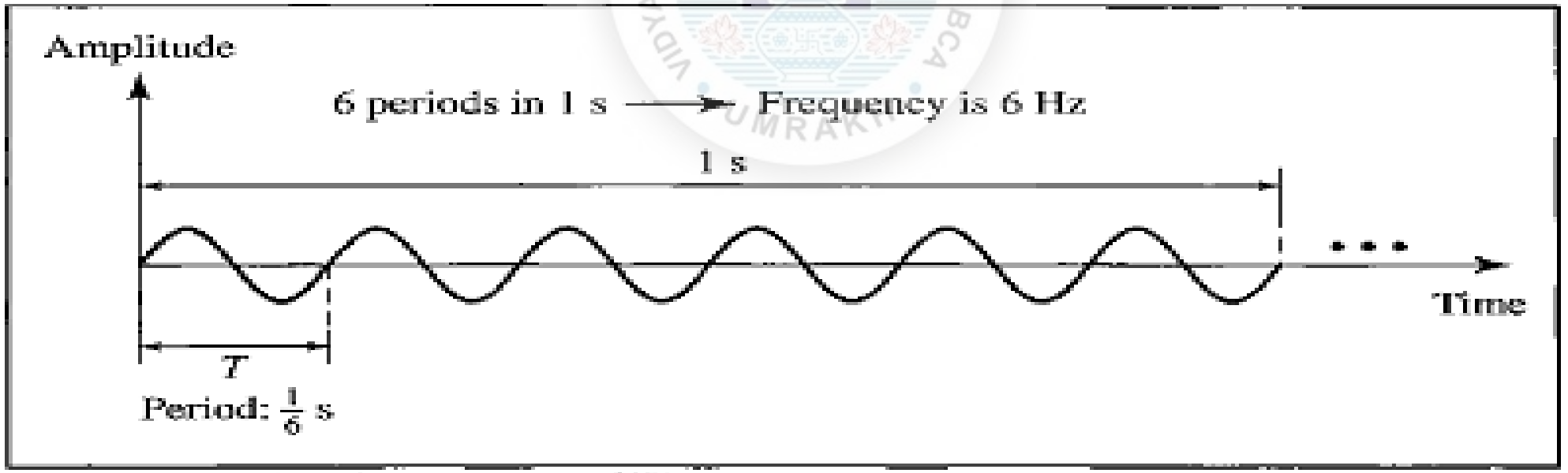
# NOTE

- Period refers to the amount of time, in a seconds, a signal need to complete 1 cycle.
- Frequency describes the number of waves that pass a fixed place in a given amount of time.
- So if the time it takes for a wave to pass is is 1/2 second, the frequency is 2 per second. If it takes 1/100 of an hour, the frequency is 100 per hour.
- Usually frequency is measured in the hertz unit
- Frequency and period are inverse of each other.

$$f = \frac{1}{T} \text{ and } T = \frac{1}{f}$$




**a. A signal with a frequency of 12 Hz**




**b. A signal with a frequency of 6 Hz**

# NOTE

- In telecommunication, a band - sometimes called a frequency band - is a specific range of frequencies in the radio frequency (RF) spectrum, which is divided among ranges from very low frequencies (vlf) to extremely high frequencies (ehf). Each band has a defined upper and lower frequency limit.

# Rediowave Transmission

- It is a technique where data is transmitted using radio waves and therefore energy travels through the air rather than copper or glass.
- Electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz are normally called radio waves.
- Conceptually, radio, TV, cellular phones etc. uses radio transmission in one form or another.
- The radio waves can travel through walls and through an entire building.
- Depending upon the frequency, they can travel long distance or short distance.
- Satellite relay is the one example of long distance communication.
- It is very useful for multicasting in which one sender and multiple receiver.

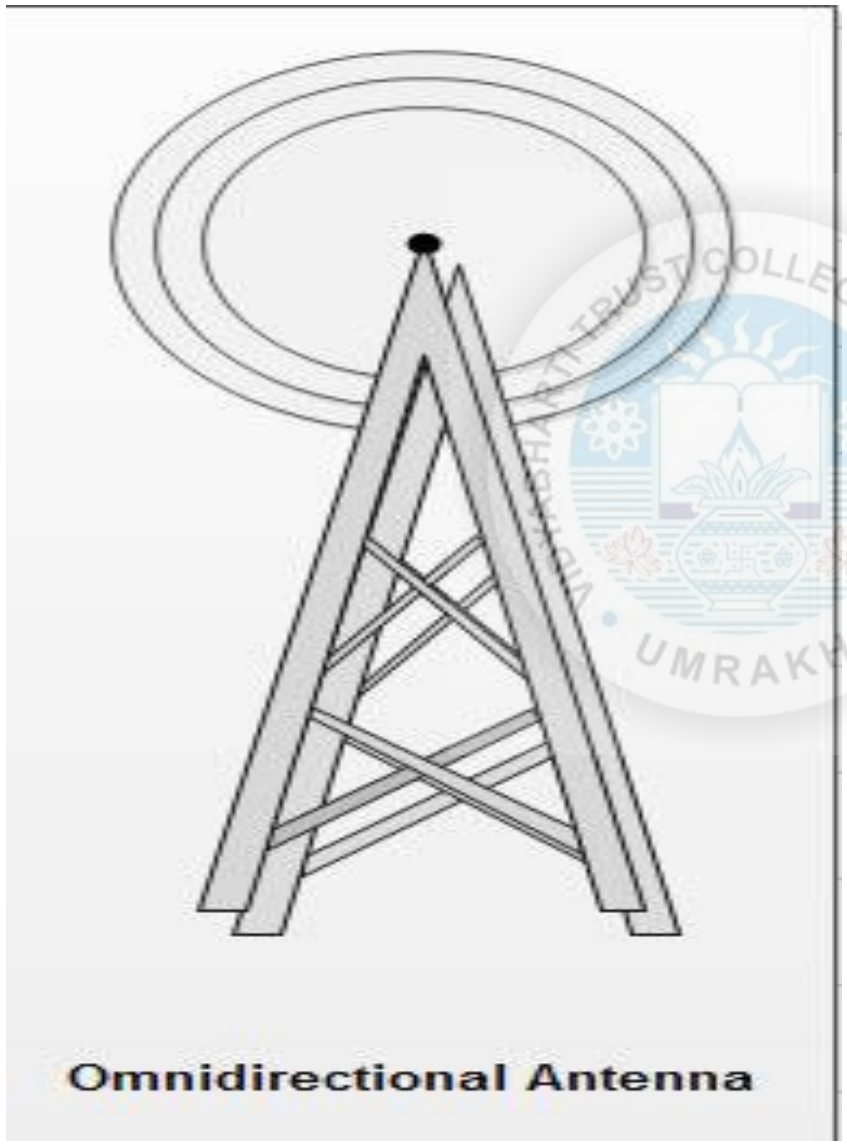
# Rediowave Transmission

- Radio waves can operate on a single or multiple frequency bands.
- Its frequency is between 10 kHz to 1GHz.
- It is simple to install and has high attenuation. These waves are used for multicast communications.

## Application

- Radiowaves are omni directional i.e. they travel in all the directions from the source. Because of this property, transmitter and receiver need not to be aligned.
- Radiowaves widely used for AM and FM radio, television, cordless telephone, cellular phones, paging and wireless LAN.

# Rediowave Transmission



# Microwave Transmission

- Electromagnetic waves ranging from 1 and 300 GHz are called Microwaves.
- They have a higher frequency than radio waves and therefore can handle larger amounts of data.
- They are unidirectional these means that the sending and receiving antennas need to be aligned.
- Microwave transmission is line of sight transmission means traveled in straight line.
- The transmit station must be in visible contact with the receive station. Generally placed at higher height.

# Microwave Transmission

## Characteristics

- It is line of sight . Since the towers with the mounted antennas need to be in direct sight of each other, towers that are far apart need to be very tall. Repeaters are need for long distance communication.
- Very high microwares cannot penetrate walls. This characteristics can be disadvantages if receivers are inside building.
- It is relatively wide so high date rate is possible.

## Application

- Due to their unidirectional properties, it is useful to one to one communication . It is used in cellular phones, satellite network and wireless LANs.

# Microwave Transmission

## Advantages

- They require no right of way acquisition between towers.
- They can carry high quantities of information due to their high operating frequencies.
- Low cost land purchase: each tower occupies only a small area.
- High frequency/short wavelength signals require small antennae.

## Disadvantages

- Attenuation by solid objects: birds, rain, snow and fog.
- Reflected from flat surfaces like water and metal.
- Diffracted (split) around solid objects.
- Refracted by atmosphere, thus causing beam to be projected away from receiver.

# Microwave Transmission

- It require unidirectional antennas that transmit singal only in one direction.
- Two such antennas are
  - Dish Antenna
  - Horn antenna.

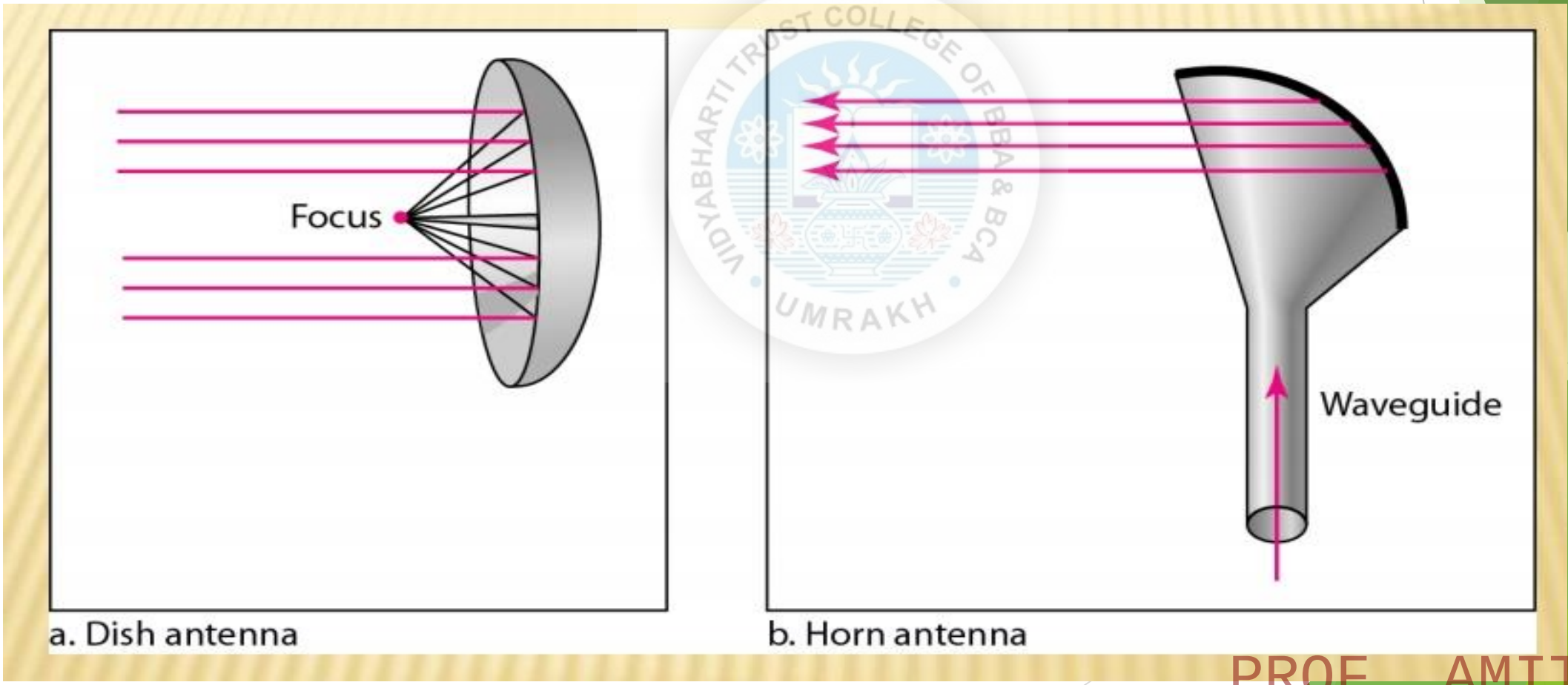
## Dish Antenna

- A dish antenna works based on the geometry of parabola. All the lines parallel to the line of sight when hit the parabola, they are reflected by the parabola curve at angles such that they converge at a common point called the focus.
- The dish parabola catches many waves and directs them on the focus.

# Microwave Transmission

## Horn Antenna

- In horn antenna, outgoing transmission is send through a stem and as it hits the curved head, the transmission is deflect outward as series of parallel beams.



# Infrared Transmission

- Infrared waves, with frequencies from 300 GHz to 400 THz.
- It is used for short range communication.
- It has high frequencies so cannot penetrate walls. So it prevent interference between one system and another. So a short range communication system in one room cannot be affected by another system in the next room.
- When we use our infrared remote control we don't interfere with the use of the remote by our neighbour.

Application

- Used for short range communication in a closed area using line of sight propagation.

# Satellite Communication

- A satellite is a body that revolves around the earth just in same way earth revolves around the sun.
- Satellites are widely being used for communication purposes as they cover maximum area on the earth for a particular transmission.
- Satellites process microwaves with bi-directional antennas (line-of-sight). A communication satellite acts as a big microwave repeater in the sky.

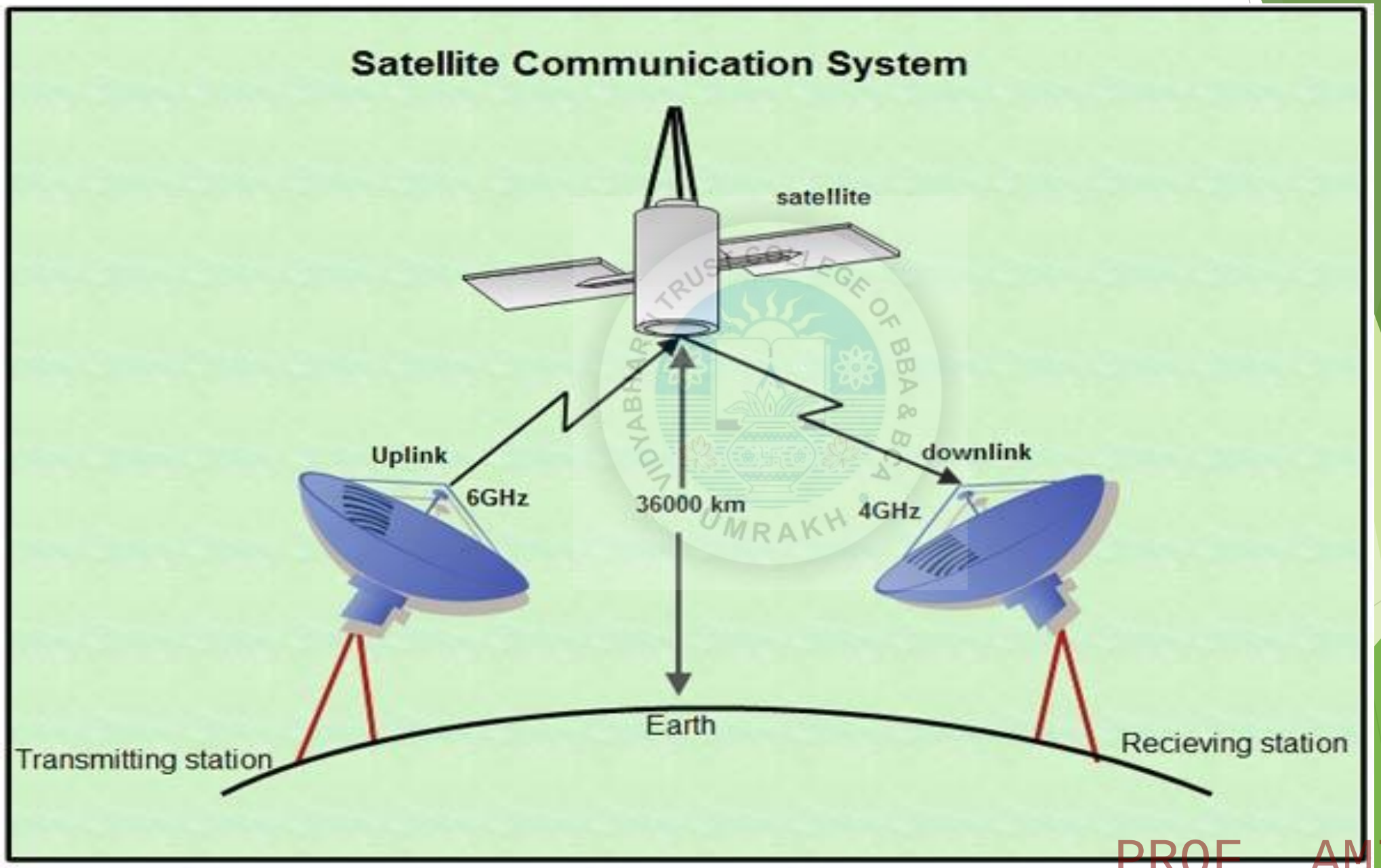
Why Required?

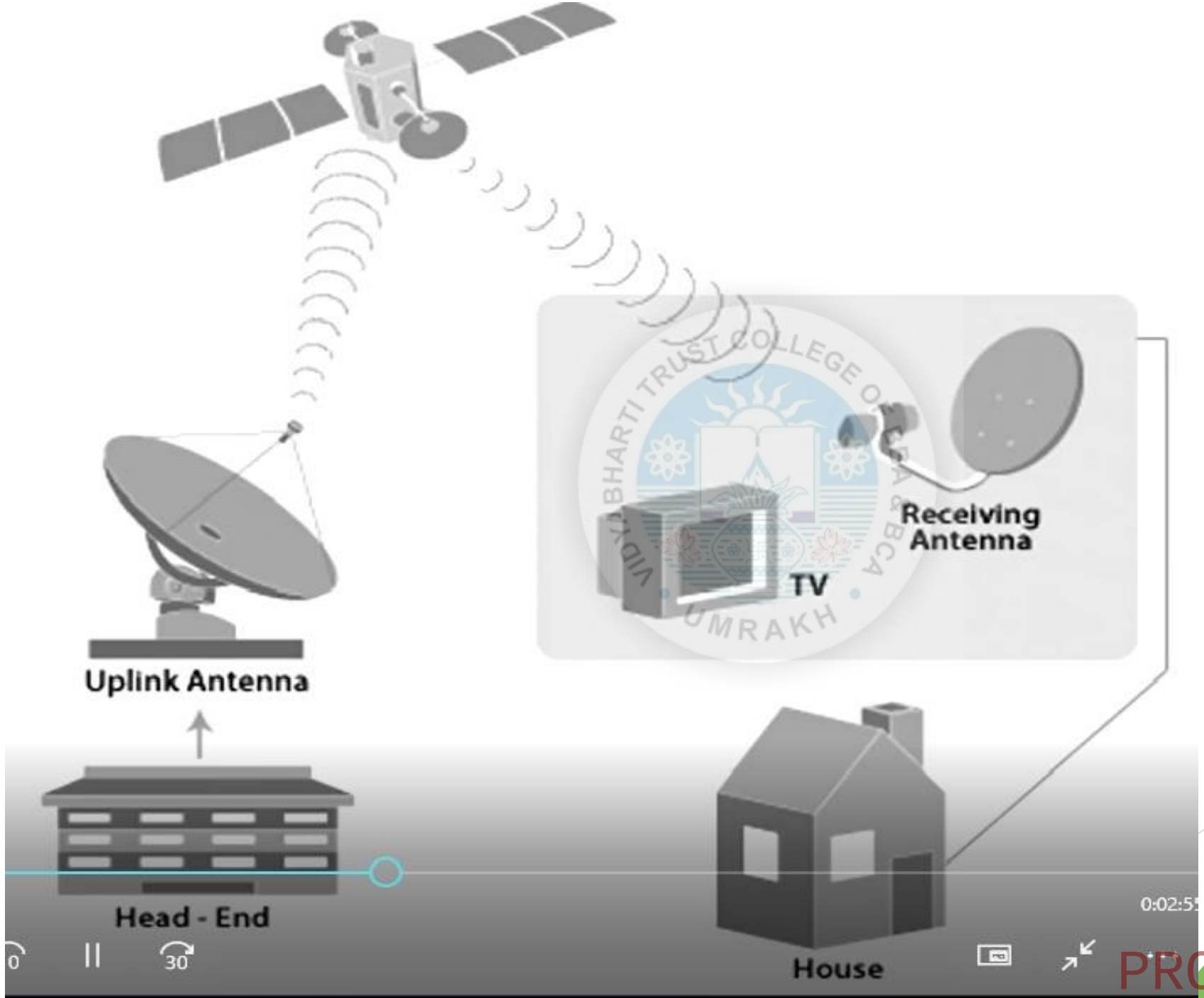
- The main problem with microware communication is that the curvature of the earth, mountain and other structure often block the line of sight.
- Instead of antenna, Satellite can be used to transmit microwave messages from one location to another.

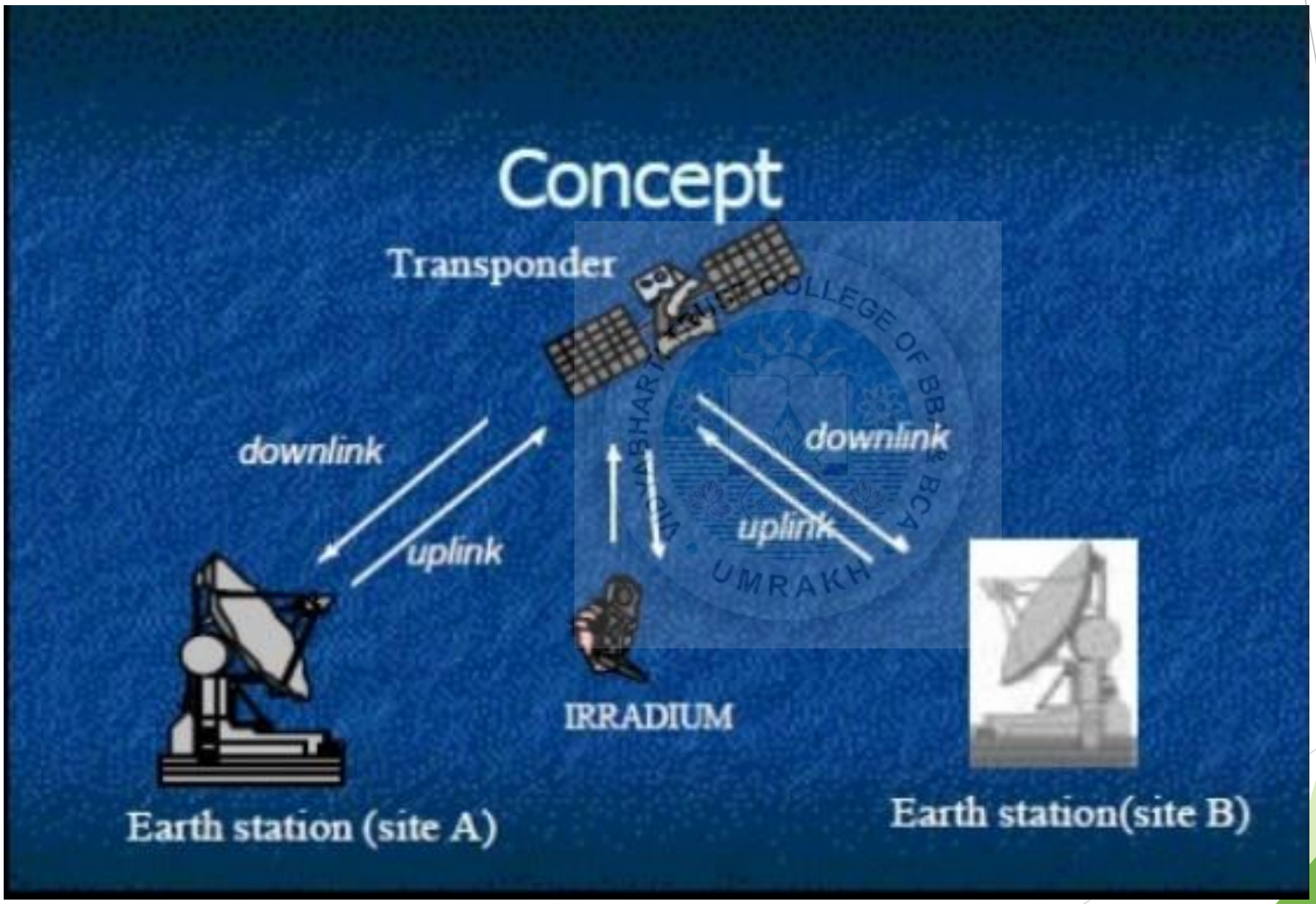
# Satellite Communication

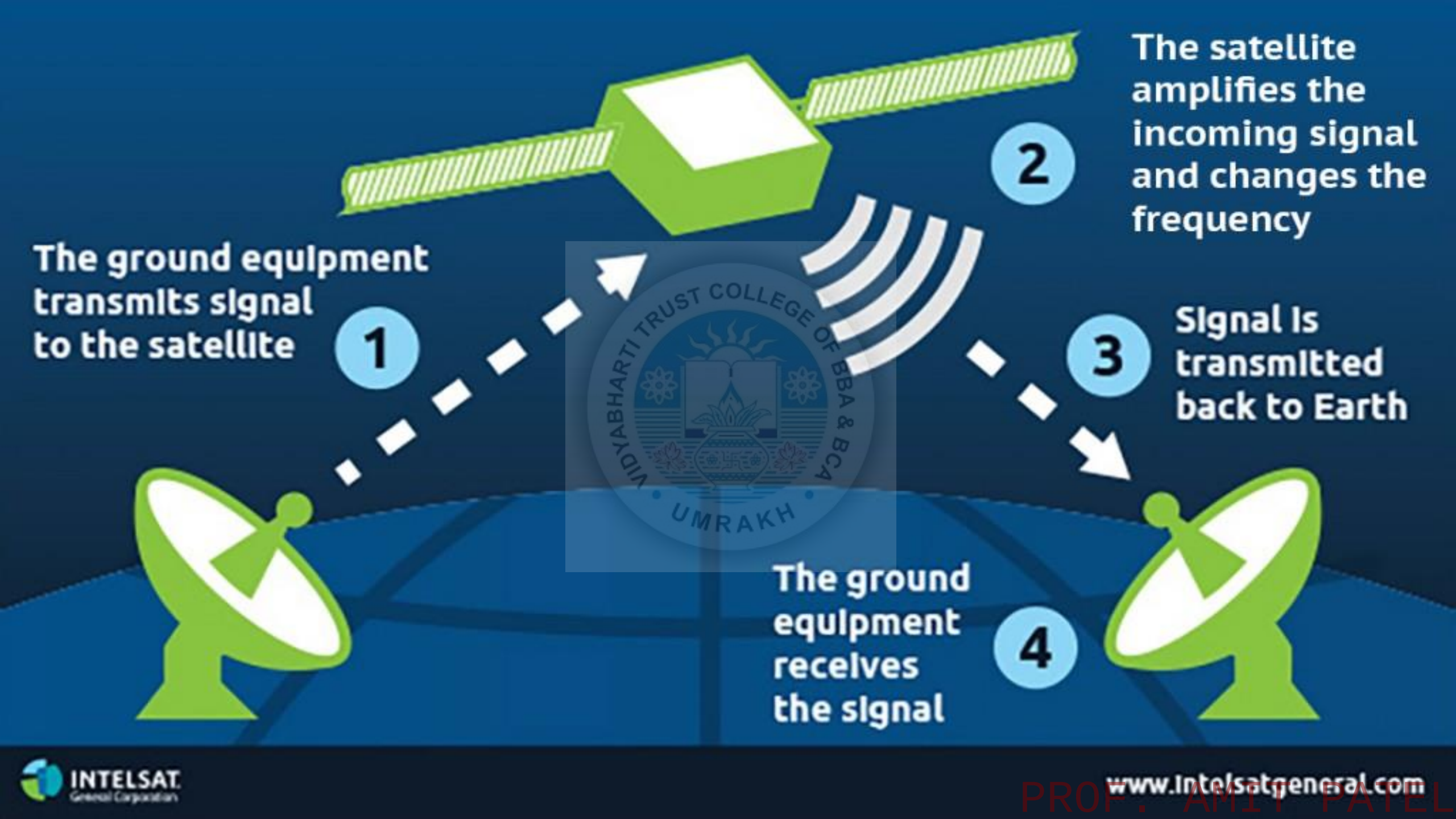
- A satellite links two or more ground based (earth) station that transmit or receive microwaves.
- Man-made satellites are highly specialized wireless receiver transmitters that are launched by a rocket and placed in orbit around the earth.
- Satellite rotate approximately 23300 miles above the earth in precise location.
- The paths in which satellites move are called orbits. The orbit can be equatorial, inclined or polar.
- Satellite transmission station that can send and receive message are known as earth station.

# Satellite Communication






Concept
Transponder
downlink
uplink
downlink
uplink
IRRADIUM
Earth station (site A)
Earth station(site B)



# Satellite Communication

- The signal from a satellite is normally aimed at a specific area called the footprint. The area shadowed by the satellite, in which the information or data can be transmitted and received is called the footprint.
- The signal power at the center of footprint is maximum. The power decreases as we move out from the footprint center.
- The signal which is being transmitted upwards to the satellite is called as the uplink. Thus uplink frequency is the frequency used to transmit signal from earth station to satellite.
- The signal which is being transmitted back to the receiving earth station is called as the downlink. Thus, downlink frequency is the frequency used to transmit the signal from satellite to earth station.

# Satellite Communication

- Uplink and downlink frequencies are always different so as to avoid interference between them. Once a satellite receives any signal on a frequency(uplink) , it repeats or amplifies that signal and sends it back to earth on a separate frequency (downlink).
- A satellite contains several transponders. The transponder receives signal from one earth station, amplifies it and sends the signal back to other earth stations.
- A typical satellite has 12-20 transponders each with 36-50 GHz bandwidth.
- In case of satellite communication two different frequencies are used as carrier frequencies to avoid interference between incoming and outgoing signals.
- There are three different bands of frequencies where satellites can operate:
  - C band, also called 6/4 GHz band, is one of the oldest and most widely in use.
  - Ku band, also called 11/14 GHz band.
  - Ka band, called 20/30 GHz band.

# Advantage Of Satellite Communication

- A large volume of data can be transmitted at a very high speed.
- Transmission and reception cost are independent of the distance between 2 points. It means cost to send data to the person who live in your building and send same data to person who live in other country are same. So data transmission cost is not depend on distance.
- Different communication satellite are used to carry different kind of information. Some satellite used for internet communication, telephone communication or for TV broadcasting, weather forcasting.

# Disadvantage Of Satellite Communication

- The bad weather can affect the quality of transmission.
- It cause the security problems because it is easy to intercept the transmission travel through the air.
- Cost of transmission is very high.
- Satellite delay is present in all our satellite communication.

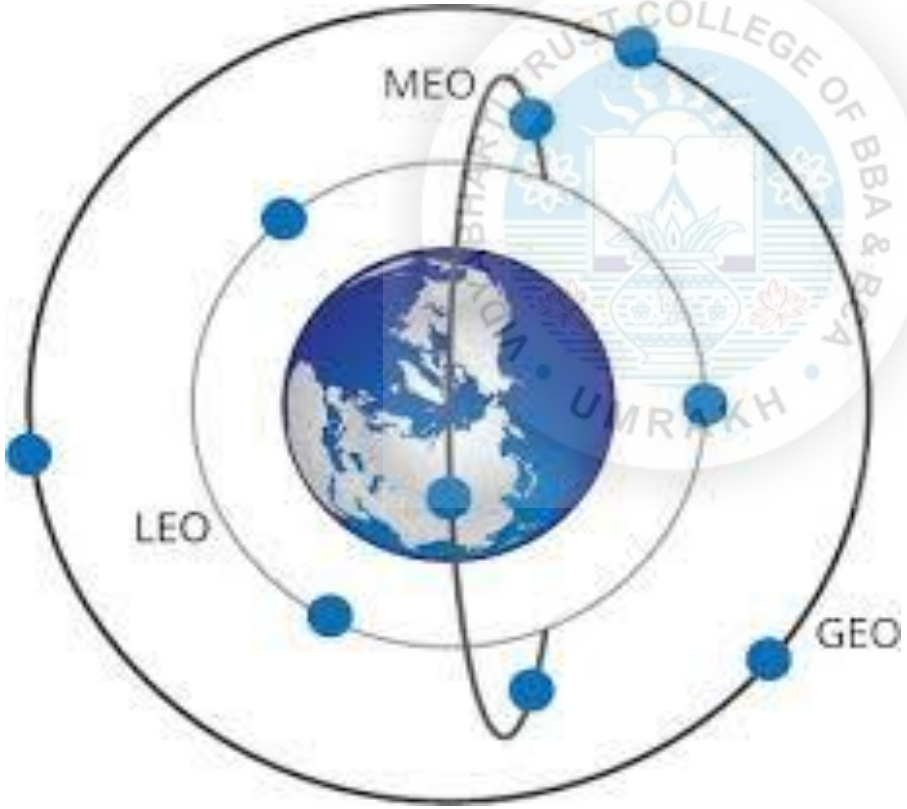
## Application

- Major application of satellite communication are long distance telephone transmission, weather forecasting, global positioning, remote sensing,television and many more.

# Satellite Communication

- Orbit: An orbit is the path that a satellite follows as it revolves around the earth.

  Basically there are three main orbits as shown in figure below:



# Satellite Communication

## Category

- There are 3 category

1. GEO (Geo-Stationary Earth Orbit)
2. MEO(Low Earth Orbit)
3. LEO (Middle Earth Orbit)

# Satellite Communication

## GEO (Geo-Stationary Earth Orbit)

- GEO satellites are usually at 35,800 km above the earth's surface.
- GEO satellites move around the earth at same speed as earth moves around the sun. Such a satellite is called geo-stationary.
- Weather forcasting, agriculture related satellite is place in GEO Also communication satellite is also put in GEO.

# Satellite Communication

## MEO

- MEO satellites are located at attitudes between 5,000 and 15,000 km.
- MEO satellites take approximately 6-8 hours to circle the earth.
- As they are at lower attitudes than GEOs, they have smaller footprint on the ground and require less powerful transmitters to reach them.
- Example of MEO satellites is Global Positioning System (GPS).

# Satellite Communication

## LEO

- LEO satellites are normally below an attitude of 2000 km.
- The speed of LEO satellite is 20,000 to 25,000 km/h.
- The footprint has a diameter of 8000 km/h
- As these satellites are very close to it the ground stations do not need much power and the round trip propagation delay is less than 20 ms.
- Used for scanning and imaging of earth .

# Difference

| Guided Media | Unguided Media |
| --- | --- |
| Signal is transmitted by establishing a physical path between the source and destination. | No physical path is established between the source and destination ; signal are propagated through air. |
| Guided media are well suited for point to point communication. | Unguided media are well suited for broadcast communication. |
| Example is twisted pair cable, coaxial cable and fiber optic cables. | Example are microware satellite, infrared waves and radio waves. |

# Satellite Communication

https://books.google.co.in/books?id=1ydNcyFiomUC&pg=PA46&dq=data+communication+and+networking+satellite+communication&hl=en&sa=X&ved=0ahUKEwiQz_DElp7JAhUBU44KHV8LBkkQ6AEISzAF#v=onepage&q=data%20communication%20and%20networking%20satellite%20communication&f=false

https://www.youtube.com/watch?v=hLB8WctUcTg

https://www.youtube.com/watch?v=BmXFidSbs6M

# Attenuation

- It is the loss of power due to absorption of energy in space and power density goes on descreasing t