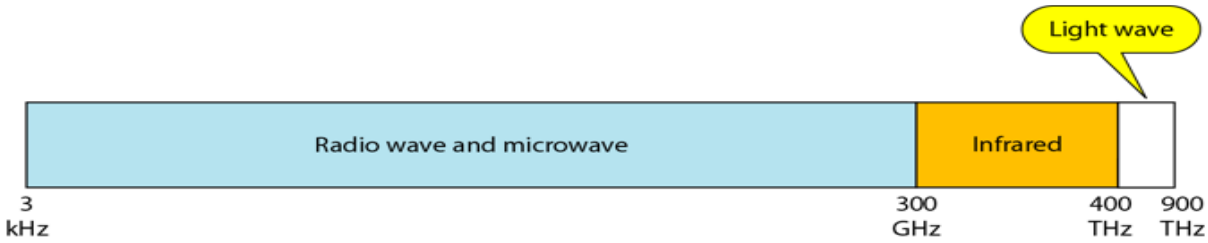
Module 3

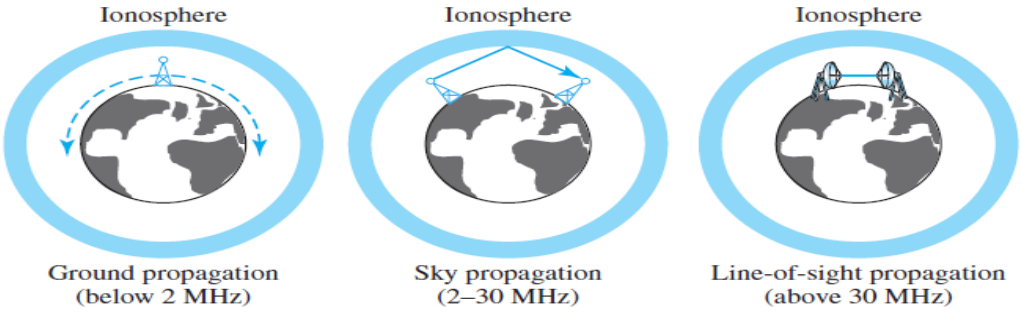
UNGUIDED MEDIA: WIRELESS

- It transports electromagnetic waves without using a physical conductor.
- This type of communication is often referred to as ***wireless communication.***
- Signals are normally broadcast through free space and thus are available to anyone who has a device capable of receiving them.
- Figure shows the part of the electromagnetic spectrum, ranging from 3 kHz to 900 THz, used for wireless communication.



- Unguided signals can travel from the source to the destination in several ways:
    1. Ground propagation
    2. Sky propagation
    3. Line-of-sight propagation

Propagation Methods



1) Ground propagation

- In **ground propagation,** radio waves travel through the lowest portion of the atmosphere, hugging the earth.
- These low-frequency 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: The greater the power, the greater the distance.

2) Sky propagation

- In **sky propagation,** higher-frequency radio waves radiate upward into the ionosphere (the layer of atmosphere where particles

exist as ions) where they are reflected back to earth.

- This type of transmission allows for greater distances with lower output power.

3) <u>Line-of-sight propagation</u>

- In **line-of-sight propagation,** very high-frequency signals are transmitted in straight lines 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.

<u>Bands</u>

- The electromagnetic spectrum defined as radio waves and microwaves is divided into eight ranges, called ***bands***.
- These bands are rated from *very low frequency (VLF) to extremely high frequency (EHF).*

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

1) Radio Waves

- Electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz are normally called radio waves.
- Radio waves are omnidirectional.
- When an antenna transmits radio waves, they are propagated in all directions. This means that the sending and receiving antennas do not have to be aligned. A sending antenna sends waves that can be received by any receiving antenna.
- **Disadvantage** of omnidirectional
    - The radio waves transmitted by one antenna are susceptible to interference by another antenna that may send signals using the same frequency or band.
- Radio waves, particularly those waves that propagate in the sky mode, can travel long distances.
- Radio waves are used for long-distance broadcasting such as **AM radio**.

- **<u>Omnidirectional Antenna</u>**

Radio waves use omnidirectional antennas that send out signals in all directions.

➢ ***Applications***

- AM and FM radio,
- Television,
- Maritime radio
- Cordless phones

2) Microwaves

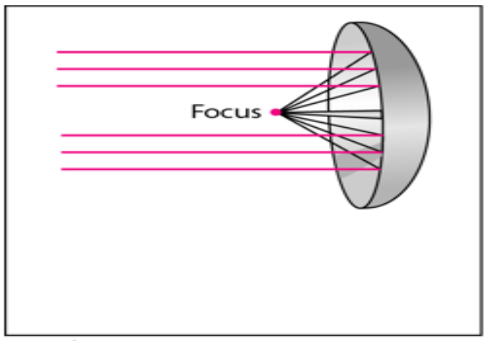
- Electromagnetic waves having frequencies between 1 and 300 GHz are called microwaves.
- Microwaves are **unidirectional**.
- When an antenna transmits microwaves, they can be narrowly focused. This means that the sending and receiving antennas need to be aligned.

Characteristics of microwave propagation:

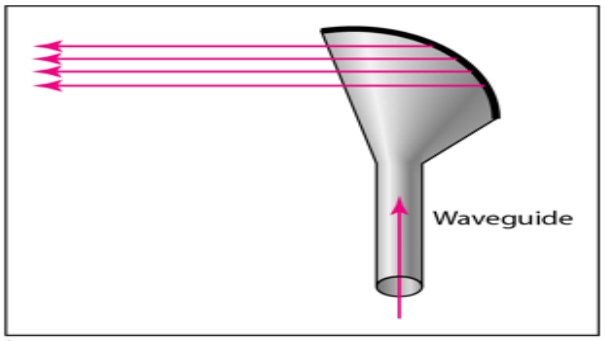
- Microwave propagation is line-of-sight.
- Very high-frequency microwaves cannot penetrate walls. This characteristic can be a disadvantage if receivers are inside buildings.
- The microwave band is relatively wide, almost 299 GHz. Therefore wider sub bands can be assigned, and a high data rate is possible.
- Use of certain portions of the band requires permission from authorities.

➢ ***Unidirectional Antenna***

- Microwaves need unidirectional antennas that send out signals in one direction.
- Two types of antennas are used for microwave communications:
  a) The parabolic dish
  b) The horn.



a. Dish antenna



b. Horn antenna

a) <u>parabolic dish antenna</u>

- It is based on the geometry of a parabola: Every line parallel to the line of symmetry (line of sight) reflects off the curve at angles such that all the lines intersect in a common point called the **focus**.
- The parabolic dish works as a **funnel**, catching a wide range of waves and directing them to a common point.

b) Horn antenna

- A horn antenna looks like a gigantic scoop.
- Outgoing transmissions are broadcast up a stem (resembling a handle) and deflected outward in a series of narrow parallel beams by the curved head.

- Received transmissions are collected by the scooped shape of the horn.

Application

- cellular phones
- satellite networks
- wireless LANs

3) Infrared

- Infrared waves, with frequencies from 300 GHz to 400 THz (wavelengths from 1 mm to 770 nm), can be used for short-range communication.
- Infrared waves, having high frequencies, cannot penetrate walls.
- This advantageous characteristic prevents interference between one system and another; 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 do not interfere with the use of the remote by our neighbors.

- In addition, we cannot use infrared waves outside a building because the sun’s rays contain infrared waves that can interfere with the communication.

  Application

  - TV Remote
  - Night Vision Cameras
  - Medical Field