Lecture 09 Roadmap

Learn about the :

Unguided (Wireless) transmission media

- –Radio waves
- –Microwave
- –Infrared

Propagation Methods (Ground, Sky, Line of Sight)

Wireless Transmission

Unguided media

Transmission and reception via antenna

Configuration Types of Wireless media:

- **Directional**
  - **Focused beam**
  - **Careful alignment required**
- **Omni directional**
  - **Signal spreads in all directions**
  - **Can be received by many antennae**

Wireless Transmission Systems

- Radio waves
- Microwave
  - Terrestrial Microwave
  - Satellite Microwave
- Infrared

Three General Frequency Ranges

3KHz to 1GHz (**Radio**)

Omni-directional

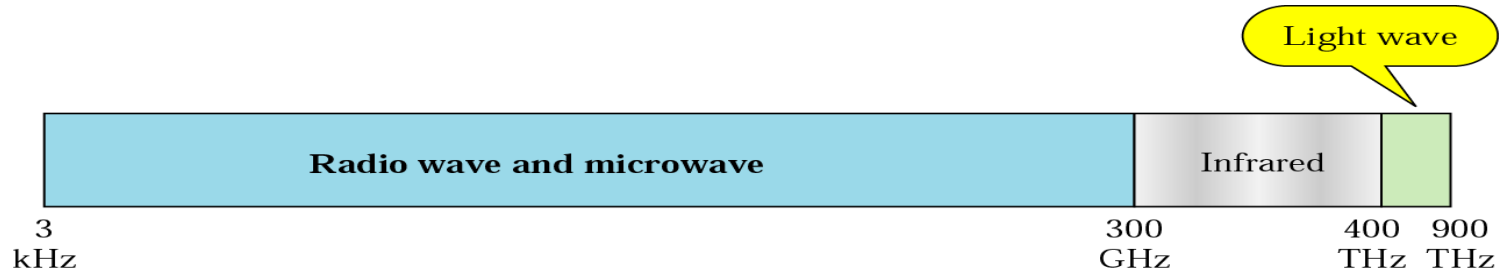
1GHz to 300GHz (**Microwave Frequencies**)

Highly directional, Point to point, Satellite

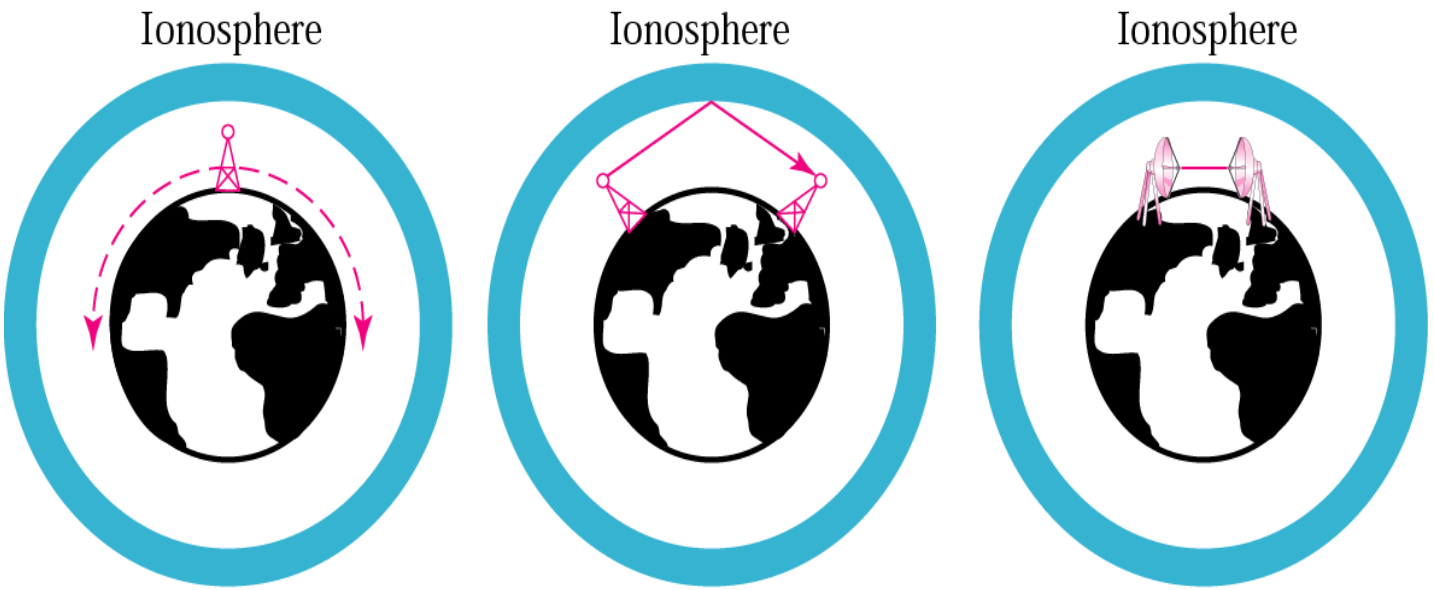
3×10^{11} to 2×10^{14} (**Infrared**)

Local

Within confined area (single room)



Propagation methods



Ground propagation
(below 2 MHz)

Sky propagation
(2 - 30 MHz)

Line-of-sight propagation
(above 30 MHz)

Propagation methods

Ground propagation

In ground propagation, radio waves travel through the lowest portion of the atmosphere. These low frequency signals emanate in all directions from the transmitting antenna and follow the curvature of the planet.

Sky propagation

In sky propagation, higher frequency radio waves radiate upward in to the ionosphere where they are reflected back to the earth.

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

Bands

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

Radio Waves

Frequency Range generally used is 3 K Hz – 1GHz

Omni-directional

Does penetrate in walls

Same distance restrictions and attenuation rate as microwaves

FM radio

UHF and VHF television

Mobile Telephones

Suffers from multi-path interference

Reflections from buildings, airplanes, water, land, ionosphere etc

Radio Waves

Advantages

- **Not line of sight**
- **Can penetrate most solids and through walls**
- **Longer range**
- **Not light sensitive**

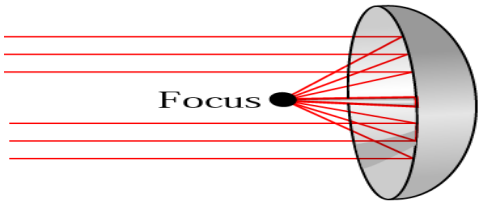
Disadvantages

- **Interference**
- **Lack of security**
- **Higher cost than infrared**
- **Federal Communications Commission(FCC) licenses required for some products**
- **Lower speed (** lower than wired and infrared transmission)

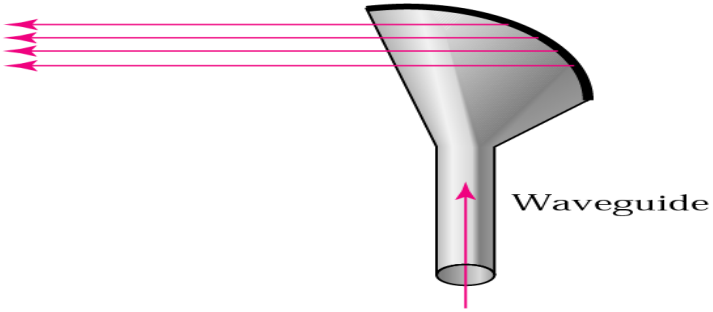
Microwaves

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

Frequency range is between 1and 300 GHZ.



a. Dish antenna



b. Horn antenna

Terrestrial Microwave

- Terrestrial Microwave transmission systems transmit tightly focused beams of radio frequencies from one ground-based microwave antenna to another .
- Antennas are usually located at substantial heights above the ground level.

Terrestrial Microwave

- Parabolic dish (typically 3m in diameter)
- Focused beam
- Line of sight
- Long haul telecommunications
- Higher frequencies give higher data rates
- Transmission Distance is limited by:
  - **Height of Antennas**
  - **Intervening Obstacles in the path of signals**

Terrestrial Microwave

- With no intervening obstacles, the maximum distance between two antennas can be:

D = 7.14 square root (Kh)

Where, D = distance in km
h = height of antenna
K = adjustment factor (usually 4/3)

Terrestrial Microwave

- Land-based, line-of-sight transmission
- Approximately 20-30 miles maximum between towers
- Transmits data at hundreds of millions of bits per second

Terrestrial Microwave Applications

- Long haul telecommunication services
- Short point-to-point links between buildings
- Links between LANs
- Links between different offices.

Terrestrial Microwave

- Attenuation is the main transmission impairment
- Higher microwave frequencies are used for short point-to-point links between buildings.
- Higher frequencies are less useful for longer distances. WHY?

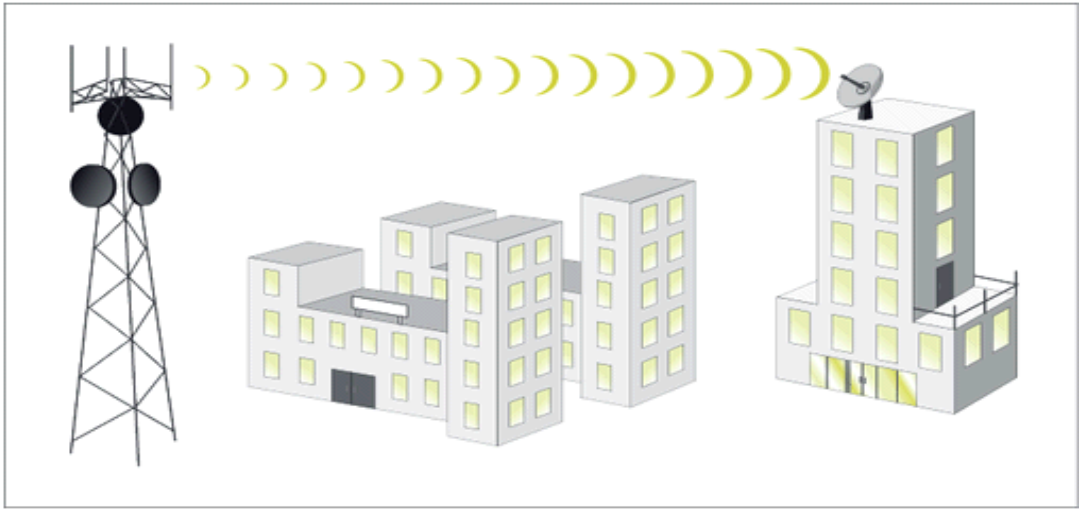
Terrestrial Microwave

- Advantages
  - High data rates
  - Low cost land purchase for towers
  - High freq /short wavelengths require short distant antennas
- Disadvantages
  - Attenuation
  - Reflected from flat surfaces, metal etc
  - Line of sight is required

Microwave Tower

Figure 3-11
A typical microwave tower and antenna

Figure 3-12
A microwave antenna on top of a free-standing tower transmitting to another antenna on the top of a building

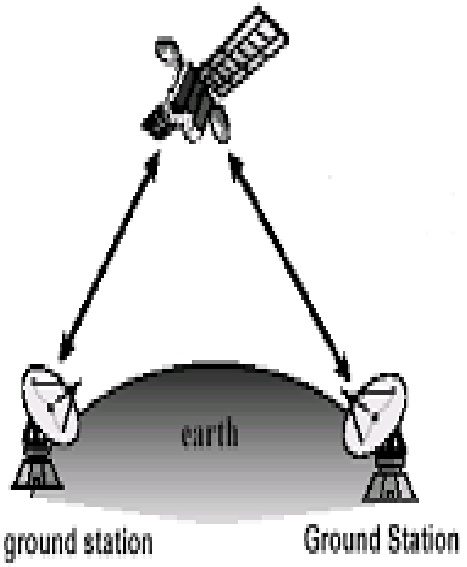


Satellite Microwave

- In Satellite Microwave, the signals are transmitted from a ground station to a satellite and then after amplifying, from the satellite to some other ground station.
- It covers large geographical areas than terrestrial microwaves

Satellite Microwave

- Uplink
  - Transmitting signals from a ground station to a satellite
- Downlink
  - Receiving signals from a satel
    to a ground station
- Transponders
  - A satellite operates on a number of frequencies bands called transponder channels



Principal Satellite Transmission Bands

- 4 GHz (downlink) – 6 GHz (uplink)
  (first to be designed)
- 12 GHz (downlink) – 14 GHz (uplink)(rain interference is major problem)
- 19 GHz (downlink) – 29 GHz (uplink)(equipment to use this band is still very expensive)

Satellite Microwave

- Satellite is relay station
- Requires geo-stationary orbit
  - Height of 35,784km
  - To remain stationary, the satellite must have a period of rotation equal to earth's rotation period.

Geostationary Satellite

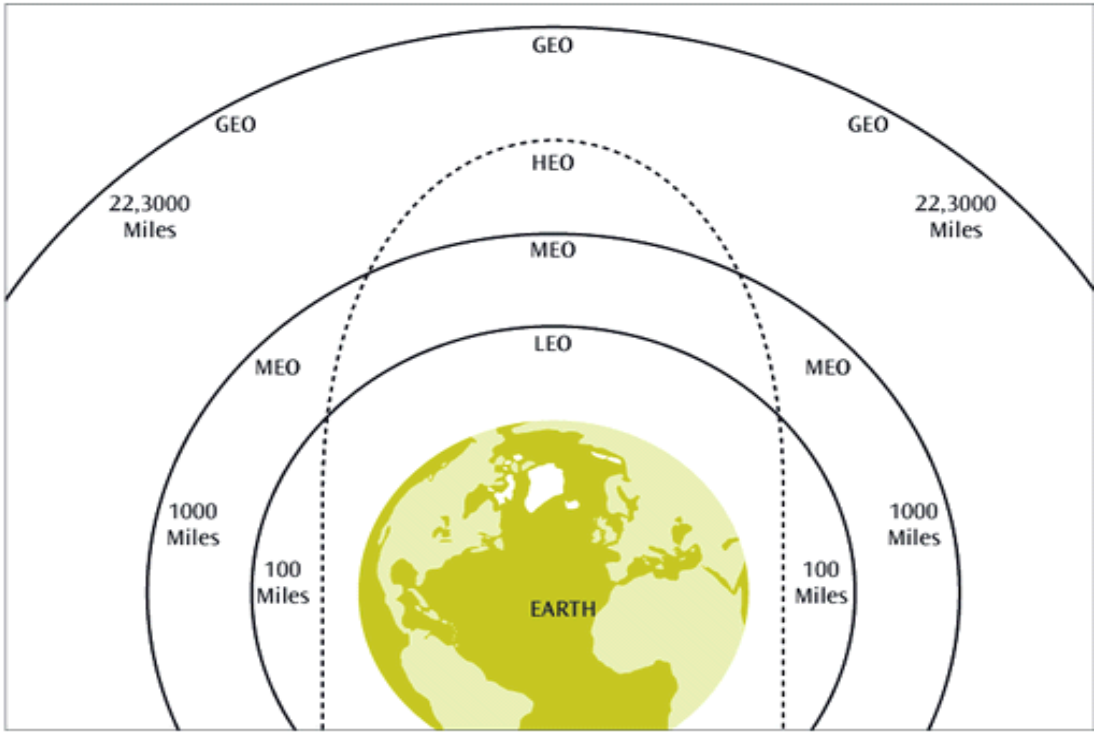
- For communication satellite to function effectively, it is generally required that it remains stationary with respect to its position over the earth. Otherwise, it would not be within the line-of-sight of its earth station at all the time.

Satellite Microwave

- LEO - Low Earth Orbit - 100 miles to 1000 miles. Used for wireless e-mail, special mobile telephones, videoconferencing.
- MEO - Middle Earth Orbit - 1000 to 22,300 miles. Used by government.
- GEO - Geosynchronous Orbit - 22,300 miles. Used for weather, television, and government operations.

Earth Orbits

Figure 3-13
The earth and the four earth orbits: LEO, MEO, GEO, and HEO



Applications of Satellite Microwave

- Television
- Long distance telephone
- Private business networks

Infrared

Special transmissions that use a focused ray of light in the infrared frequency range

Line of sight (or reflection)

Blocked by walls

Typical data rates are up to 4 Mbps

Infrared radiation is the region of the electromagnetic spectrum between microwaves and visible light.

In infrared communication an LED transmits the infrared signal as bursts of non-visible light.

At the receiving end a photodiode or photoreceptor detects and captures the light pulses, which are then processed to retrieve the information they contain.

Infrared Applications

TVs, VCRs, CD players, stereos, In portable computers Car locking systems Headphones Home security systems Toys

Infrared signals can be used for short-range communication in a closed area using line-of-sight propagation.

Advantages

- Low power requirements (ideal for laptops, PDAs)
- Higher security
- High noise immunity
- No License is required

Disadvantages

- Line of sight, Short Range, Blocked by solid materials
- Light, weather sensitive

Factors to Select the Media

- Cost
- Data Rate and Bandwidth
- Distance
- Security
- Environment