Satellite & Mobile Communication Network

24.08.2020

1. The electromagnetic wave equation :
   E field :
   $$\vec{e}(t,\ x) = \vec{E}sin(2\pi ft + 2\pi x/\lambda)$$
   $$\vec{h}(t,\ x) = \vec{H}sin(2\pi ft + 2\pi x/\lambda)$$
   $\vec{E} =$ *amplitude of electric field*
   $f =$ *frequency*
   $\lambda =$ *wavelength*
   $\vec{H} =$ *amplitude of magnetic field*
2. $x =$ *amount of space the wave travels in time* "T"

   Also, $x =$ *distance between two consecutive points in space with the same phase*

   - 0 phase - 0 amplitude value
   - 90 phase - maximum amplitude value
3. $v = f\lambda$

   v = velocity of the wave
4. $Power \propto E^2$

   E = amplitude of electric field

Electromagnetic Spectrum :

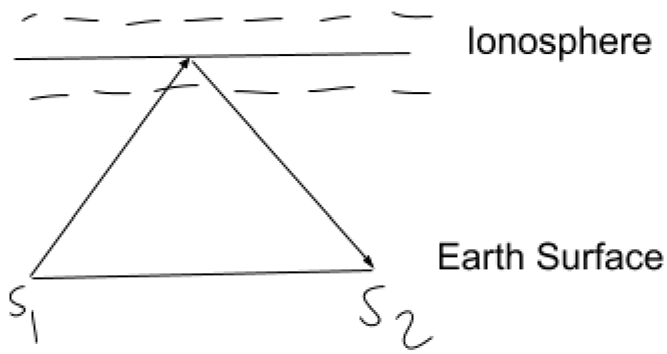
1. Medium Wave : 530 KHz - 1602 KHz

   Use :

   - Medium wave Radio
   - Hops along the surface of earth
2. Short Wave (HF Band) : 3MHz - 30MHz

   Use :

   - Short wave radio transmission for long distances



3. Very High Frequency (VHF) : 30MHz - 300MHz

   Use :

   - FM Radio
   - TV transmission

4. Ultra High Frequency (UHF) : 300MHz - 3000MHz (3GHz)

   Use :

   - TV broadcasting
   - Mobile Cellular Phone broadcasting

5. Microwave : 1GHz - 1000GHz

   Use :

   - WLAN
     - S band : (2.4GHz + 80MHz)
     - C band : (5GHz + 80MHz)

   L band : 1 - 2GHz

   S band : 2 - 4GHz

   C band : 4 - 8GHz

   X band : 8 - 12GHz

   Ku band : 12 - 18GHz

   K band : 18 - 26.5GHz

   Ka band : 26.5 - 40GHz

Properties of microwave:

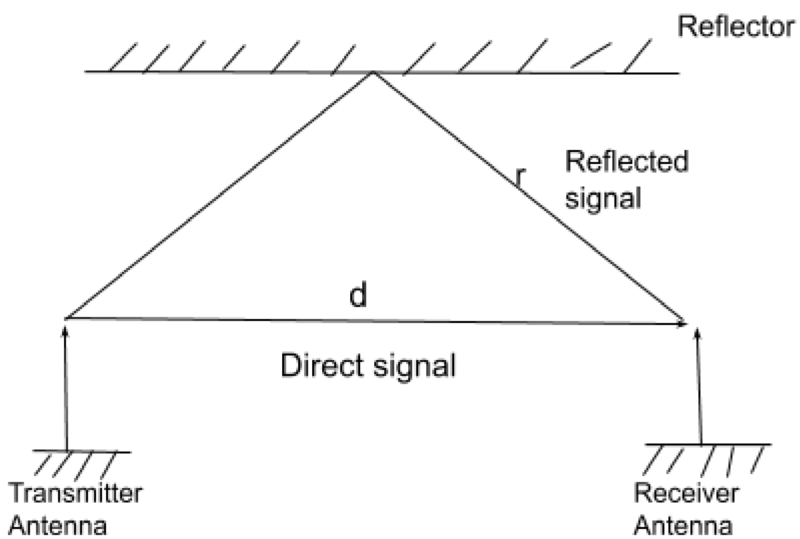
1. Line of sight propagation like light.
2. Absorbed by fog, vegetation, rain.

3. Signal strength in free space $\propto \frac{1}{x^2}$ (x = distance from transmitter antenna)
4. **Reflection:**
    - Full in metal
    - Partial in insulator

    Refraction:
    - 0 in metal
    - Partial in insulator

    i. Wave cannot travel through metal
    ii. Wave travels through insulator
5. Multipath finding starts from UHF

Multipath finding



Distance travelled by **direct signal** = d
Distance travelled by **reflected signal** = r

1. $e(t,\ x)\ =\ Esin(2\pi ft\ +\ \frac{2\pi}{\lambda}x)$
2. $e_d(t,\ d)\ =\ Esin(2\pi ft\ +\ \frac{2\pi}{\lambda}d)$
3. $e_r(t,\ r)\ =\ Esin(2\pi ft\ +\ \frac{2\pi}{\lambda}r)$
4. Effective signal at the receiver

$$e_e = e_d(t,\ d)\ +\ e_r(t,\ r)$$
$$=\ Esin(2\pi ft\ +\ \frac{2\pi}{\lambda}x)\ +\ Esin(2\pi ft\ +\ \frac{2\pi}{\lambda}r)$$

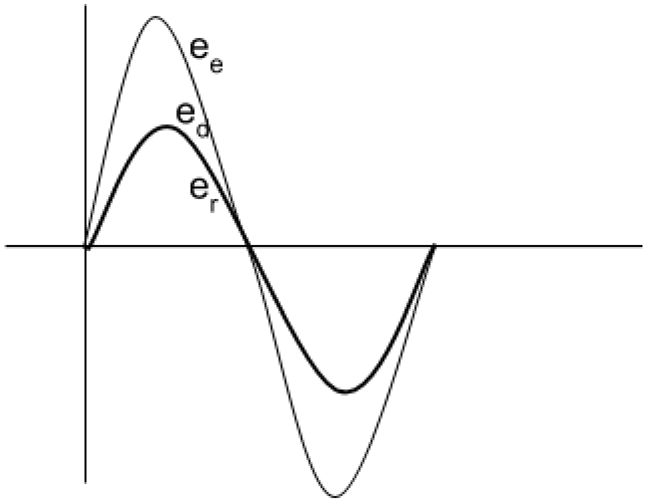
5. Let $r\ =\ d\ +\ \lambda$

$$e_e\ =\ Esin(2\pi ft\ +\ \frac{2\pi}{\lambda}x)\ +\ Esin(2\pi ft\ +\ \frac{2\pi}{\lambda}\ (d\ +\ \lambda))$$

$$= Esin(2\pi ft + \frac{2\pi}{\lambda}d) + Esin(2\pi ft + \frac{2\pi}{\lambda}\ d + 2\pi\lambda)$$
$$= 2Esin(2\pi ft + \frac{2\pi}{\lambda}d)$$

Signal strength doubles due to constructive interference

→ No multipath fading



6. $\lambda = d + \frac{\lambda}{2}$ Full fading