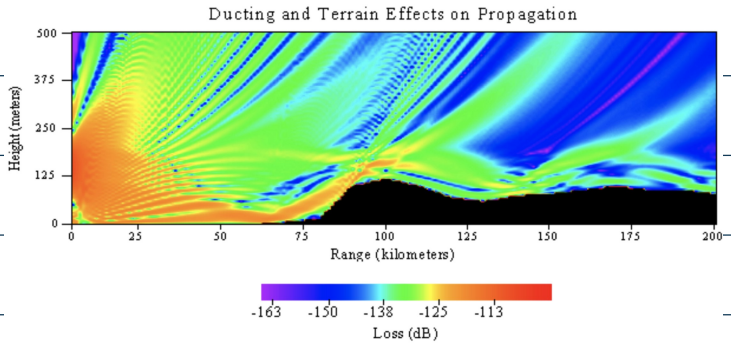
Electromagnetic Propagation

Friday, August 21, 2020 12:46 PM



Example propagation loss calculation shown as a vertical radial slice
- terrain blocking & reflection
- ducting due to atmospheric conditions

CHAPTER 2: Basic Guide to RF Propagation & Models

- Solve RF propagation problems
  1. Radio comms
  2. Sensor
  3. Jamming
  4. RADAR analysis

Propagation of Electromagnetic Energy

- energy = waves @ c (speed of light in vacuum)

$$f\,(\text{MHz}) = \frac{300}{\lambda\,(\text{meters})}$$

- object in path of an EM wave is often described by its "electrical size", which is

its electrical size, which is its dimension measured in wavelength. Thus, an object's electrical size is related to the frequency of the EM energy incident upon it.

- electrically small objects have little effect on the propagation of EM energy

many terms to define attenuation of RF signal; ITU definitions

- Total Loss (of a radio link)
  - ratio of the power supplied by the transmitter to the power available to the corresponding receiver
- System Loss
  - ratio of the power input to the transmitting antenna terminal to the power available at the terminals of the receiving antenna
- Transmission Loss (of a radio link)
  - the ratio of the power radiated by the transmitting antenna to the power available @ the receiving antenna if there were no loss in the radio frequency circuits

receiving antenna ... in the radio frequency circuits

☆ What is computed ☆

- Basic Transmission Loss (of a radio link)
  - the transmission loss that would occur if the antennas were replaced by isotropic antennas

- Free Space Transmission Loss
  - the basic loss that would occur if the antennas were located in a perfectly dielectric, homogeneous, isotropic & unlimited environment

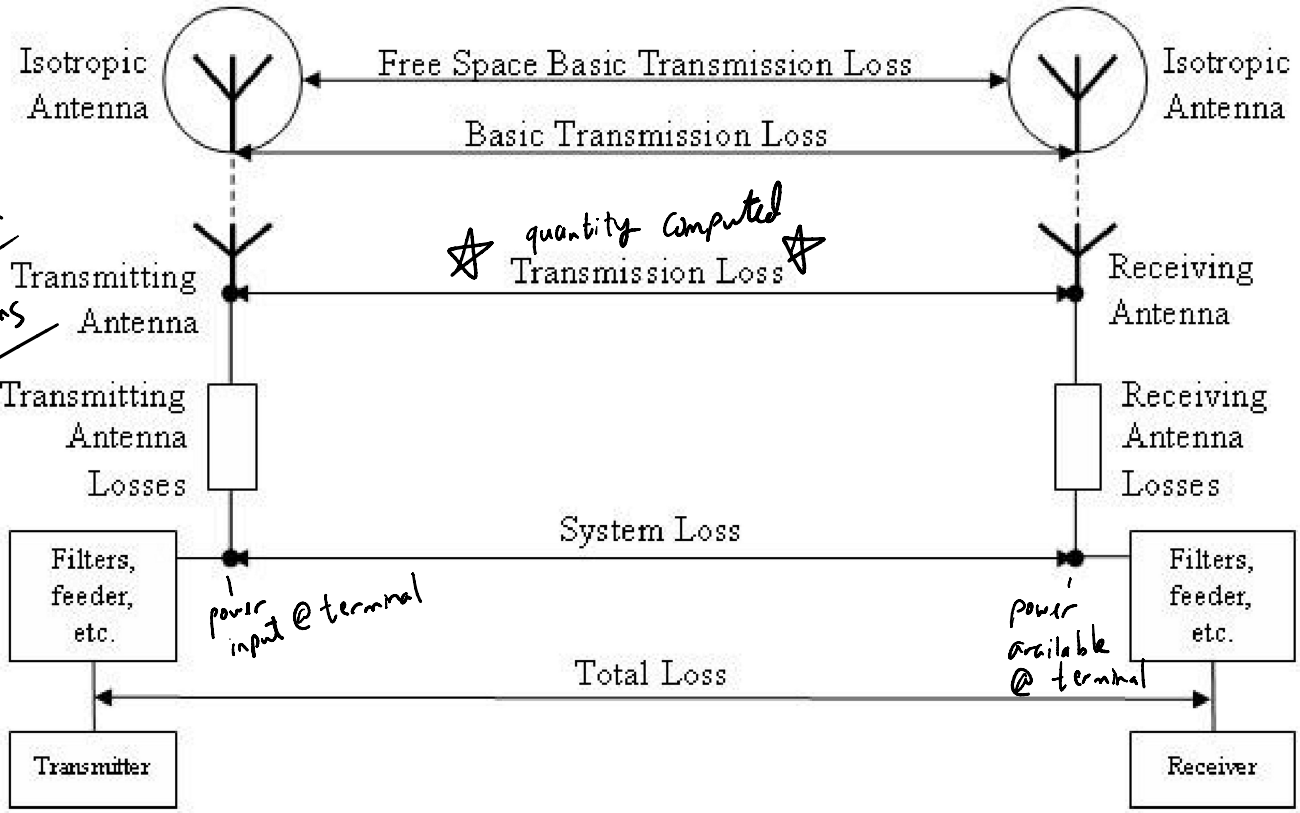
- Ray Path Transmission Loss
  - the basic transmission loss for a particular ray propagation path

- Loss Relative to Free Space
  - the ratio b/w the basic transmission loss & the free space basic transmission loss

Loss represented in decibels (dB). to convert to dB:

$$\text{loss in dB} = 10 \log_{10} (\text{loss})$$

loss in dB = $10 \log_{10}$ (loss)



Propagation Models

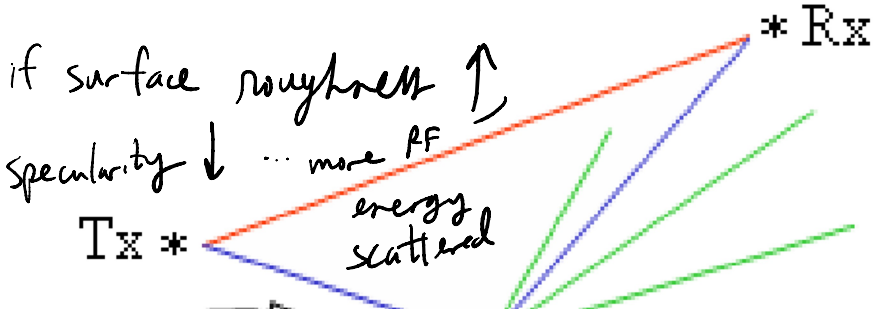
When energy travels from a transmitting antenna to a receiving antenna, the manner in which it travels is called the propagation mode

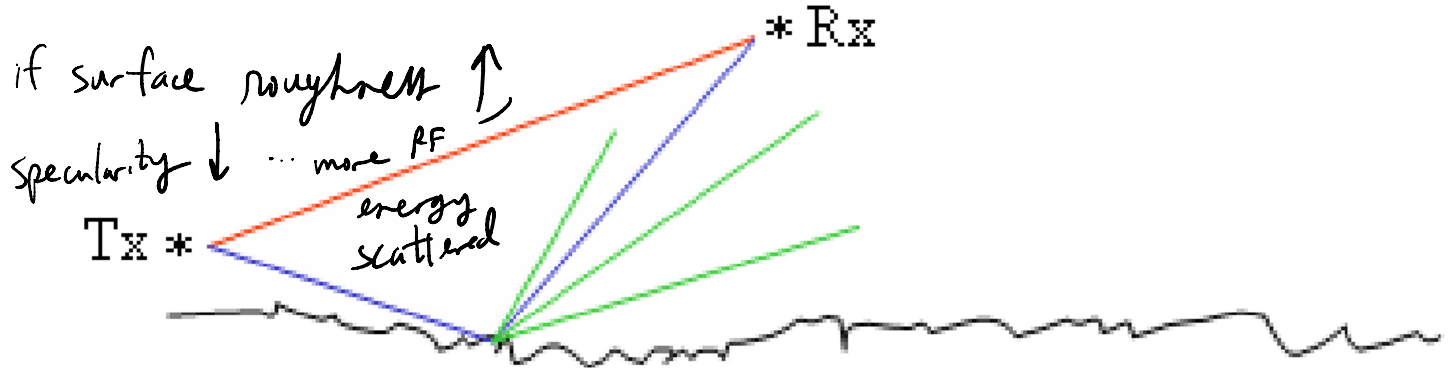
- Reflection
  - think of RF energy travelling along ray paths
    - under most circumstances - small # of ray paths
    - LOS (line-of-sight): directly connects w/out any obstacle

- LOS (line of sight) - directly connects w/out any obstacle
- in addition to LOS, could reflect off ground

- smooth surface reflection -- specular reflection
  - reflected wave is only attenuated (diminished) by <u>reflection co-efficient</u>
    - ↳ function of frequency & ground's dielectric properties (i.e. conductivity (σ), relative permittivity (ε_r))
    - ↳ siemens/meter : conductivity units
    - ↳ permittivity : unitless
    - ↳ dependence of reflection coefficient on the ground dielectrics is <u>often unnoticeable</u>, soil moisture levels & sea salinity affect σ & ε_r the most

- rigid surface - roughness described by Δh
  - Rayleigh criterion determines whether surface considered rough: $\Delta h < \frac{\lambda}{16} \sin\psi$, then surface smooth
    - -- ψ is grazing angle - angle b/w reflected ray & ground




if surface roughness ↑
specularity ↓ ... more RF
energy scattered
Tx *
* Rx