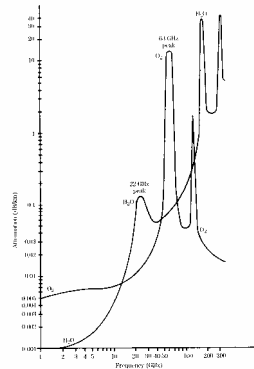


Propagation conclusion

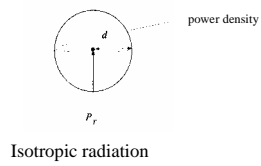
Atmospheric absorption

- Microwave communication above 10 GHz suffers from severe attenuation.
- Caused by water vapor and oxygen in the atmosphere.
- There are several strong attenuation peaks and these are resonance frequencies for molecules and atoms.

Attenuation

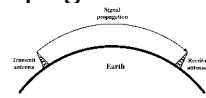


Free space attenuation

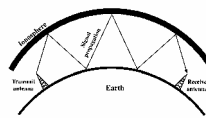


$$S_r = \frac{P_t}{4\pi r^2}$$

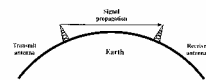
Propagation modes



(a) Ground wave propagation (below 2 MHz)



(b) Sky wave propagation (2 to 30 MHz)



(c) Line of sight (LOS) propagation (above 30 MHz)

Refraction

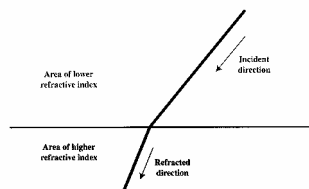


Figure 5.6 Refraction of an Electromagnetic Wave [PGOL98]

Radio Horizon

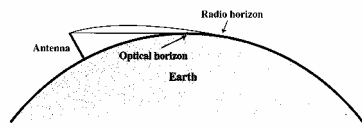
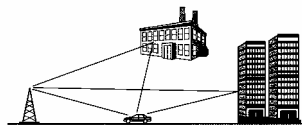


Figure 5.7 Optical and Radio Horizons

multipath



(a) Microwave line of sight



(b) Mobile radio

Figure 5.9 Examples of Multipath Interference

Propagation Phenomena's

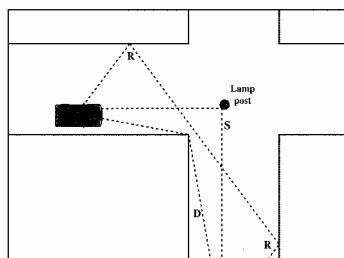


Figure 5.10 Sketch of Three Important Propagation Mechanisms: Reflection (R), Scattering (S), Diffraction (D) [ANDE95]

Multipath

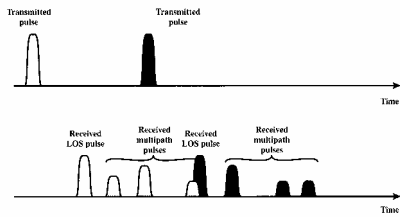


Figure 5.11 Two Pulses in Time-Variant Multipath

Typical fading in urban environment.

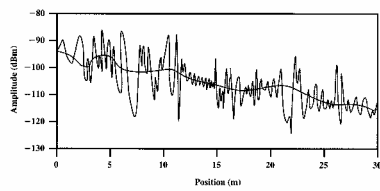


Figure 5.12 Typical Slow and Fast Fading in an Urban Mobile Environment