Technician License Course
Chapter 4

Lesson Plan Module 8 – Propagation

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Radio Wave Propagation: Getting from Point A to Point B

- Radio waves *propagate* in many ways depending on…
  - Frequency of the wave
  - Characteristics of the environment
- We will discuss three basic ways:
  - Line of sight
  - Ground wave
  - Sky wave

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Line-of-Sight

- Radio energy can travel in a straight line from a transmitting antenna to a receiving antenna – called the *direct path*
  - There is some attenuation of the signal as the radio wave travels due to spreading out
- This is the primary propagation mode for VHF and UHF signals.

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Ground Wave

- At lower HF frequencies radio waves can follow the Earth's surface as they travel.
- These waves will travel beyond the range of line-of-sight.
- Range of a few hundred miles on bands used by amateurs.

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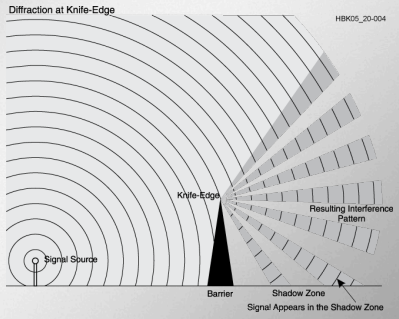
Reflect, Refract, Diffract

- Radio waves are reflected by any conductive surface
  - Ground, water, buildings
- *Refraction* or bending occurs when waves encounter a medium having a different speed of light, such as water or an electrical feed line.

Reflect, Refract, Diffract

- *Diffraction* occurs when a wave encounters a sharp edge (*knife-edge propagation)* or corner



VHF and UHF Propagation

- Range is slightly better than visual line of sight due to gradual refraction (bending), creating the *radio horizon*.
- UHF signals penetrate buildings better than HF/VHF because of the shorter wavelength.
- Buildings may block line of sight, but reflected and diffracted waves can get around obstructions.
- *Multi-path* results from reflected signals arriving at the receiver by different paths and interfering with each other.
  - *Picket-fencing* is the rapid fluttering sound of multi-path from a moving transmitter

"Tropo" - Tropospheric Propagation

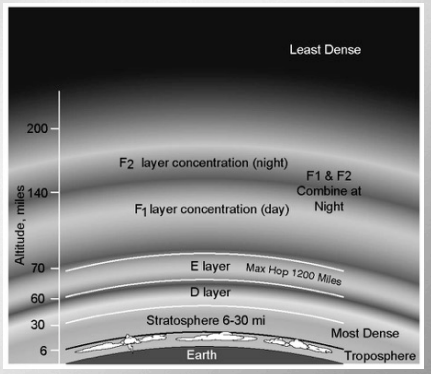
- The troposphere is the lower levels of the atmosphere – to about 30 miles high
- Radio waves can be reflected or *scattered* by clouds, rain, and density variations in the troposphere – range up to about 300 miles
- Temperature inversions and weather fronts can form *ducts* that trap and conduct VHF and UHF radio waves for hundreds of miles

The Ionosphere

- A region from 30 to 260 miles above the surface of the Earth
- Atmosphere thin enough for atoms to be ionized by solar ultraviolet radiation
- Ions are electrically conductive

Ionospheric Levels

- Because of varying density, the ionosphere forms layers with different amounts of ionization
- Ionization varies with solar illumination (hour to hour) and intensity of solar radiation
- Higher ionization refracts or bends radio waves more strongly



Sunspot Cycle

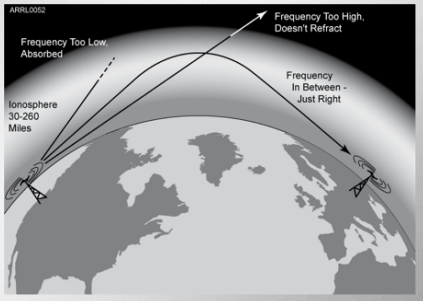
- The level of ionization depends on the intensity of radiation from the Sun.
- Radiation from the Sun varies with the number of sunspots on the Sun's surface.
  - High number of sunspots results in high levels of ionizing radiation emitted from the Sun.
- Sunspot activity follows an 11-year cycle.

The Ionosphere – An RF Mirror

- The ionosphere can refract (bend) radio waves back to Earth – acts like reflection
- Most refraction of amateur frequencies occurs in the F layer

The Ionosphere – An RF Mirror

- Reflection depends on frequency and angle of incidence.
- Too high a frequency or angle and the waves are lost to space.



The Ionosphere – An RF Mirror

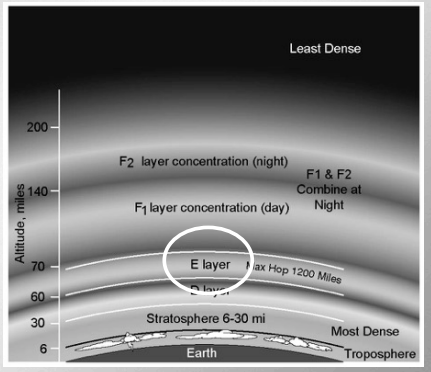
- Sky-wave or skip propagation is responsible for most over-the-horizon propagation on HF and low VHF (10 and 6 meters) during peaks of the sunspot cycle.
- Skip is very rare on the 144 MHz and higher UHF bands.
- Each ground-to-sky-to-ground trip is called a *hop*.

The Ionosphere – An RF Mirror

- Signals can take many paths through the ionosphere.
- Randomly combining at the receiving antenna, signals can partially cancel, creating irregular fading as the ionosphere changes.
  - The resulting echo and flutter distort speech and CW.
  - Fading causes data errors for digital signals.

Sporadic E (Es) and Aurora

- Highly ionized patches of the E layer can reflect HF and VHF signals – best on 10, 6, and 2 meters.
- Aurora near the north and south poles can also reflect VHF and UHF waves with a distinctive distorted sound.



Meteor Scatter

- Thousands of meteors enter the Earth's atmosphere every day – most quite small.
- Meteors leave trails of highly ionized gas that last for several seconds.
- Trails can reflect radio waves – called *meteor scatter.* The best band for this is 6 meters.
- Mostly in the E layer, meteor scatter and sporadic E supports contacts up to about 1500 miles.