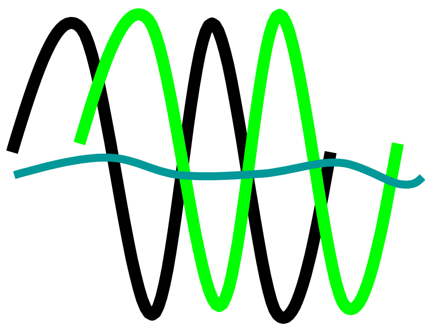
RADIO WAVE PROPAGATION

Radio Propagation:

What is Radio?

Radio is a Transmitter or a Receiver. The Radio Transmitter induces electric and magnetic fields. The electrostatic field Components is µ 1/d3, induction field components is µ 1/d2 and radiation field components is µ 1/d. The radiation field has E and B Component. Surface area of sphere centered at transmitter, the field strength at distance d = E×B µ 1/d2.

Two main factors affect signal at the Receiver. One is distance (or delay) that results in path attenuation, second is multipath that results in Phase differences



Green signal travels 1/2λ farther than Black to reach receiver, who sees Blue. For 2.4 GHz, λ (wavelength) =12.5cm.

Your ability to work with radio is based on 4 factors:

1. Your skill as a radio operator (knowing your regions, etc.)
2. Your equipment and how you use it
3. The antennas you use
4. Understanding radio wave propagation.

Antennas:

The antennas are the transducers. The transmitting antenna changes the electrical energy into electromagnetic energy or waves. The receiving antenna changes the electromagnetic energy back into electrical energy. These electromagnetic waves propagate at rates ranging from 150 kHz to 300GHz.

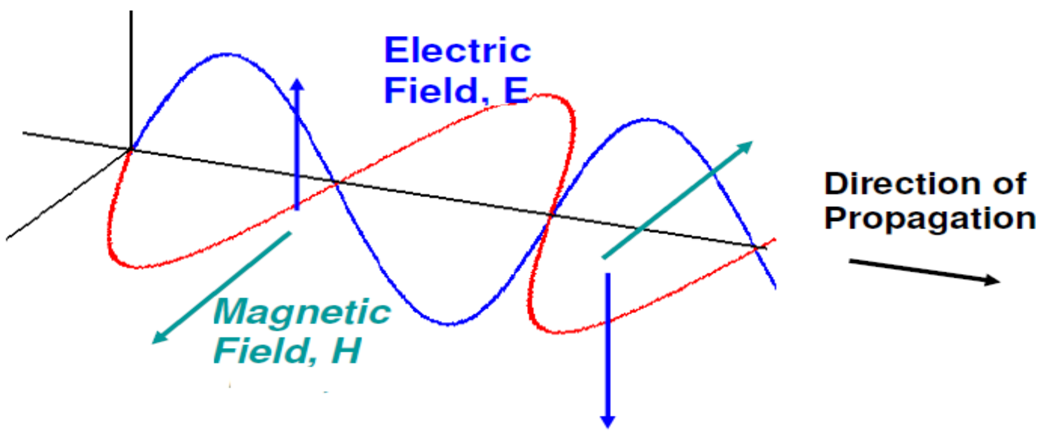
Polarization:

The polarization of an antenna is the orientation of the electric field with respect to the Earth's surface and is determined by the physical structure of the antenna and by its orientation. Radio waves from a vertical antenna will usually be vertically polarized and that from a horizontal antenna are usually horizontally polarized.

Propagation:

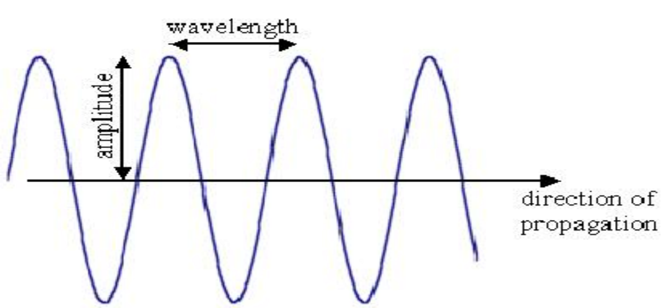
Propagation means how radio waves travel from one point A to another point B. What are the events that occur in the transmission path and how they affect the communications between the points?

Electromagnetic Waves (EM waves) are produced when the electrons in a conductor i.e., antenna wire are made to oscillate back and forth. These waves radiate outwards from the source at the speed of light (300 million meters per second). Electromagnetic Waves are of two types (i) Light Waves (waves we see) (ii) Radio Waves (waves we hear).Both of these EM Waves differ only in frequency and wavelength. EM waves travel in straight lines, unless acted upon by some outside force. They travel faster through a vacuum than through any other medium. As EM waves spread out from the point of origin, they decrease in strength in what is described as an inverse square relationship.



The two fields are at right-angles to each other and the direction of propagation is at right-angles to both fields. The Plane of the Electric Field defines the polarization of the wave.

The radio waves can further be classified as Transverse and longitudinal. The Transverse Waves Vibrates from side to side, i.e, at right angles to the direction in which they travel for eg: A guitar string vibrates with transverse motion. EM waves are always transverse.



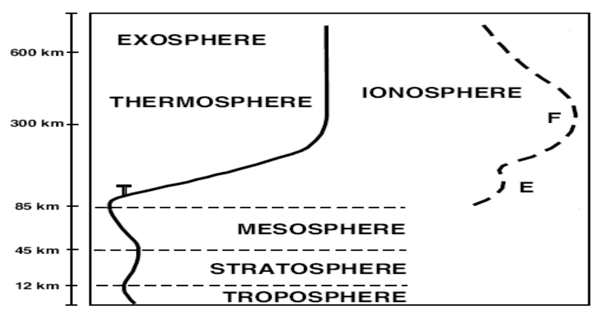
For Longitudinal radio waves vibrations are parallel to the direction of propagation. Sound and pressure waves are longitudinal and oscillate back and forth as vibrations are along or parallel to their direction of travel.

Factors affecting the propagation of radio wave are:

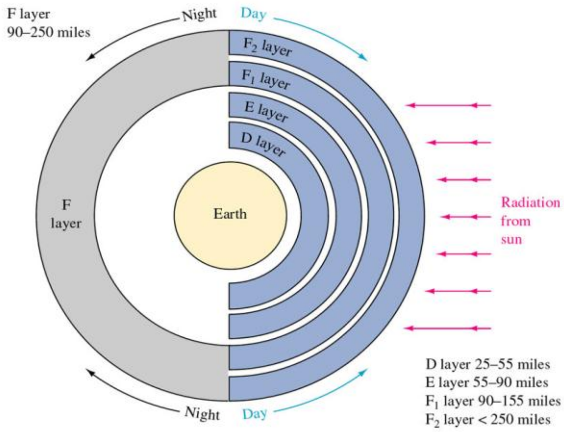
1. Spherical shape of the earth:-For Free Space RW travel in straight line. But communication on the earth surface is limited by distance to horizon and requires change in propagation.
2. Atmosphere-Height of about 600km.Is divided into layers. RW near the surface is affected by troposphere. Higher up RW is influenced by ionosphere.
3. Interaction with the objects.

Atmosphere:

Is divided into Troposphere(earth's surface to about6.5mi),Stratosphere(extends from the troposphere upwards for about 23 mi), Ionosphere(extends from the stratosphere upwards for about 250mi) Beyond this layer is Free Space.



The ionosphere is the uppermost part of the atmosphere and is ionized by solar radiation. Ionization is the conversion of atoms or molecules into an ion by light (heating up or charging) from the sun on the upper atmosphere. Ionization also creates a horizontal set of stratum (layer) where each has a peak density and a definable width or profile that influences radio propagation. The ionosphere is divided into layers.



About 120 km to 400 km above the surface of the Earth is the F layer. It is the top most layer of the ionosphere. Here extreme ultraviolet (UV) (10-100 nm) solar radiation ionizes atomic oxygen (O). The F region is the most important part of the ionosphere in terms of HF communications. The F layer combines into one layer at night, and in the presence of sunlight (during daytime), it divides into two layers, the F1 and F2.The F layers are responsible for most sky wave propagation of radio waves, and are thickest and most reflective of radio on the side of the Earth facing the sun**.** The E layer is the middle layer, 90 km to 120 km above the surface of the Earth. This layer can only reflect radio waves having frequencies less than about 10MHz. It has a negative effect on frequencies above 10 MHz due to its partial absorption of these waves. At night the E layer begins to disappear because the primary source of ionization is no longer present. The increase in the height of the E layer maximum increases the range to which radio waves can travel by reflection from the layer. The D layer is the innermost layer, 50 km to 90 km above the surface of the Earth when the sun is active with 50 or more sunspots. During the night cosmic rays produce a residual amount of ionization as a result high-frequency (HF) radio waves aren't reflected by the D layer. The D layer is mainly responsible for absorption of HF radio waves, particularly at 10 MHz and below, with progressively smaller absorption as the frequency gets higher. The absorption is small at night and greatest about midday. The layer reduces greatly after sunset. A common example of the D layer in action is the disappearance of distant AM broadcast band stations in the daytime.

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