UWAG – Training
RF Characteristics

By Ian Stout

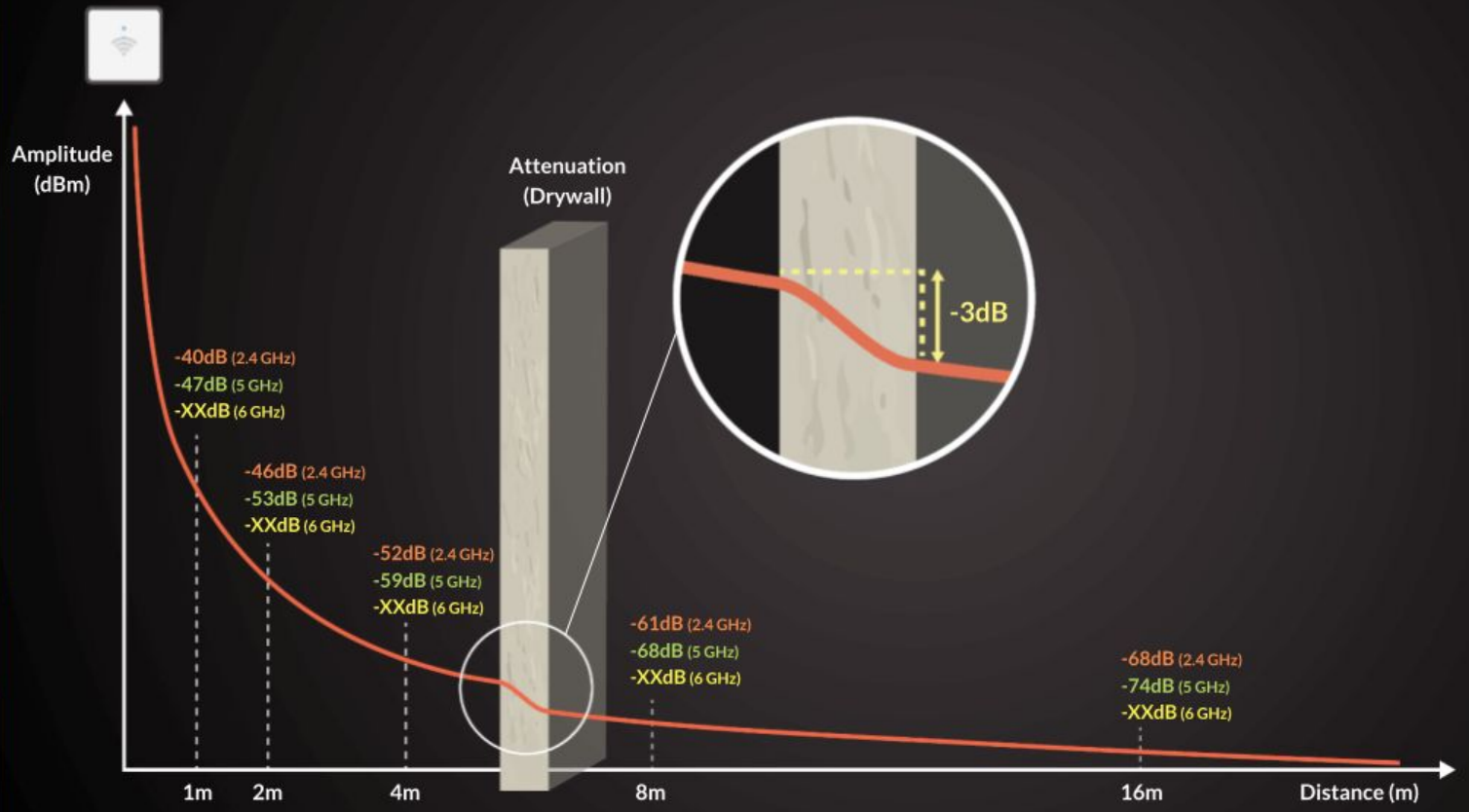
Attenuation

The decrease of amplitude or signal strength. A signal may lose strength when transmitted on a wire or in the air.

After the RF signal is radiated into the air via the antenna, the signal will attenuate due to absorption, distance, or possibly the negative effects of multipath.

As an RF signal passes through different mediums, the signal can be absorbed into the medium, which in turn causes a loss of amplitude. Different materials typically yield different attenuation results.

What happens when a wall is introduced?



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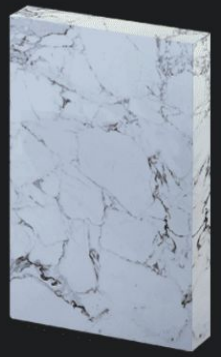
Common Wall Materials and their *Average Attenuations**

Drywall
3dB

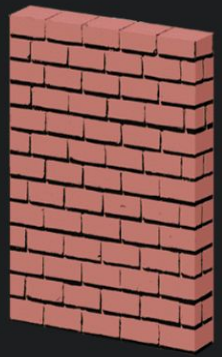
Bookshelf
2dB

Exterior Glass
3dB

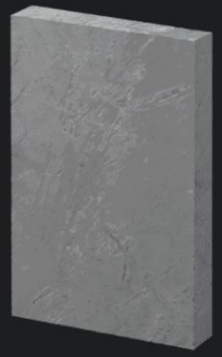
Solid Wood Door
6dB



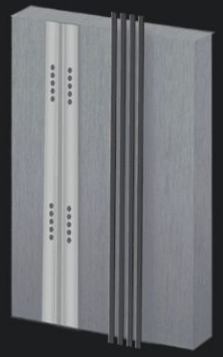
Marble
6dB



Brick
10dB



Concrete
12dB



Elevator Shaft
30dB

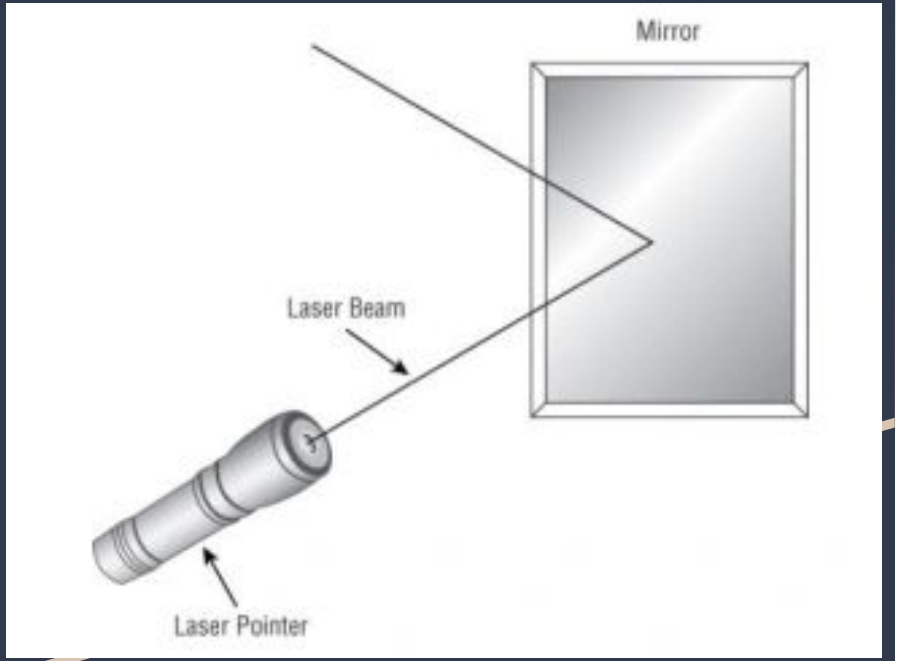
Reflection

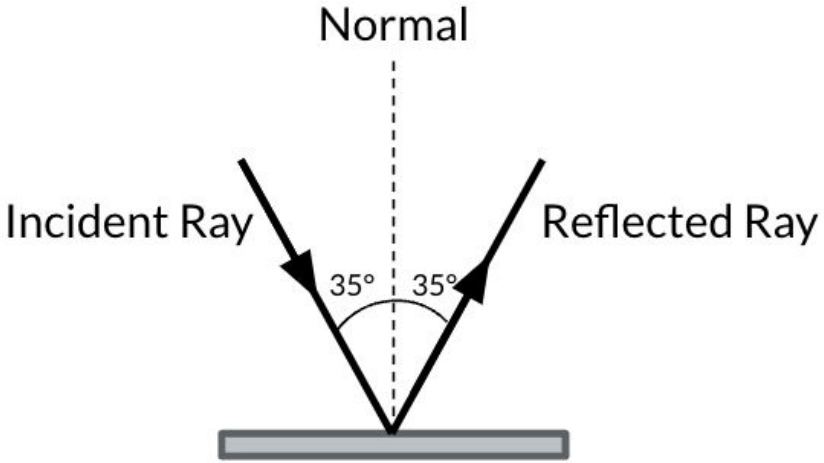
When a wave hits a smooth object that is larger than the wave itself, depending on the media the wave may bounce in another direction. This behavior is categorized as reflection.

a laser beam pointed at a single small mirror.

Depending on the angle of the mirror, the laser beam bounces or reflects off in a different direction. RF signals can reflect in the same manner, depending on the objects or materials the signals encounter.

Reflection


Mirror
Laser Beam
Laser Pointer


Normal
Incident Ray
Reflected Ray
35°
35°

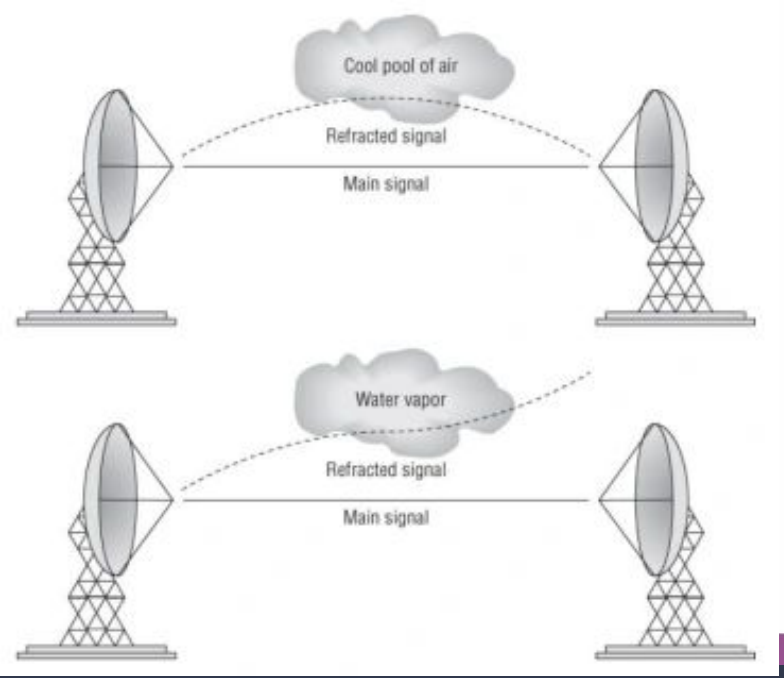
Refraction

A straightforward definition of refraction is the bending of an RF signal as it passes through a medium with a different density, thus causing the direction of the wave to change.

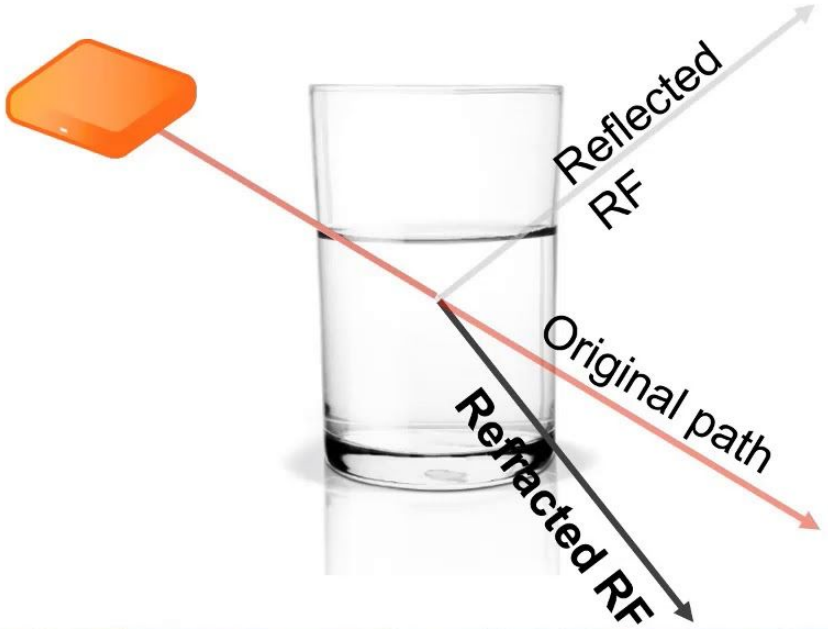
RF refraction most commonly occurs as a result of atmospheric conditions.

The three most common causes of refraction are water vapor, changes in air temperature, and changes in air pressure.

Refraction



Refraction

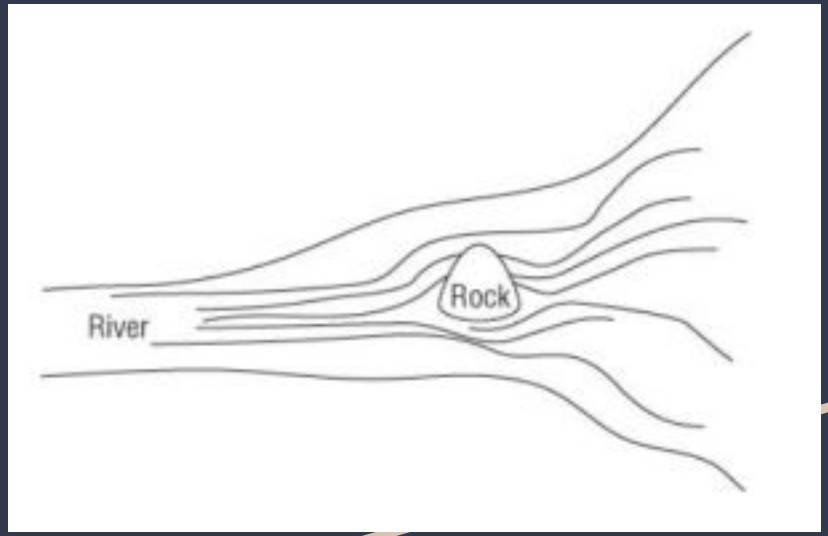


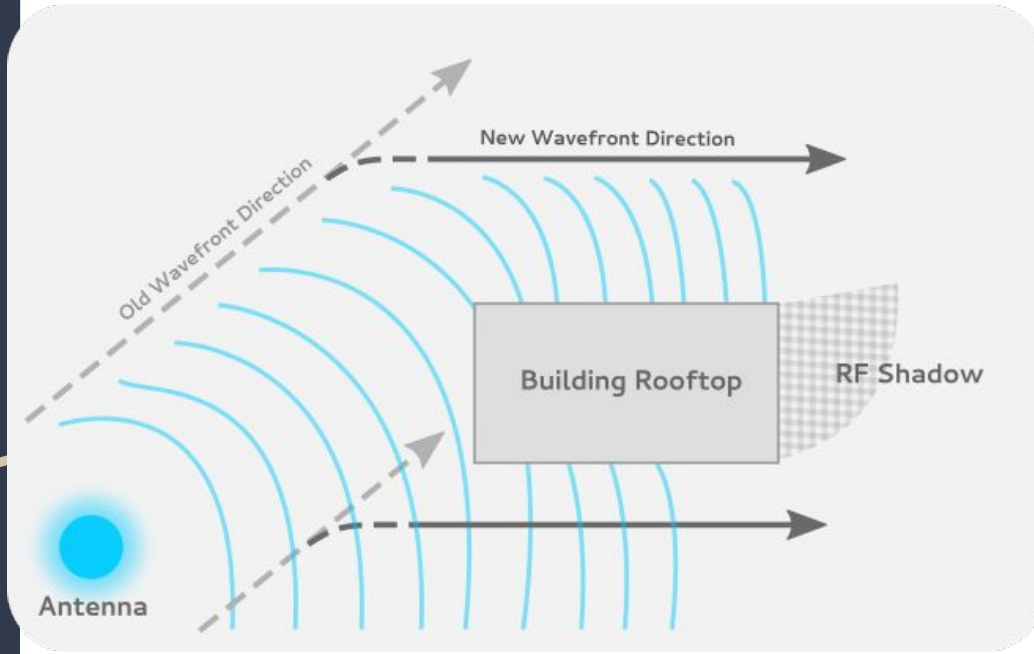
Diffraction

Diffraction is the bending of an RF signal around an object (whereas refraction, as you recall, is the bending of a signal as it passes through a medium). Diffraction is the bending and the spreading of an RF signal when it encounters an obstruction.

Typically, diffraction is caused by some sort of partial blockage of the RF signal, such as a small hill or a building that sits between a transmitting radio and a receiver. The waves that encounter the obstruction bend around the object, taking a longer and different path. The waves that did not encounter the object do not bend and maintain the shorter and original path

Diffraction



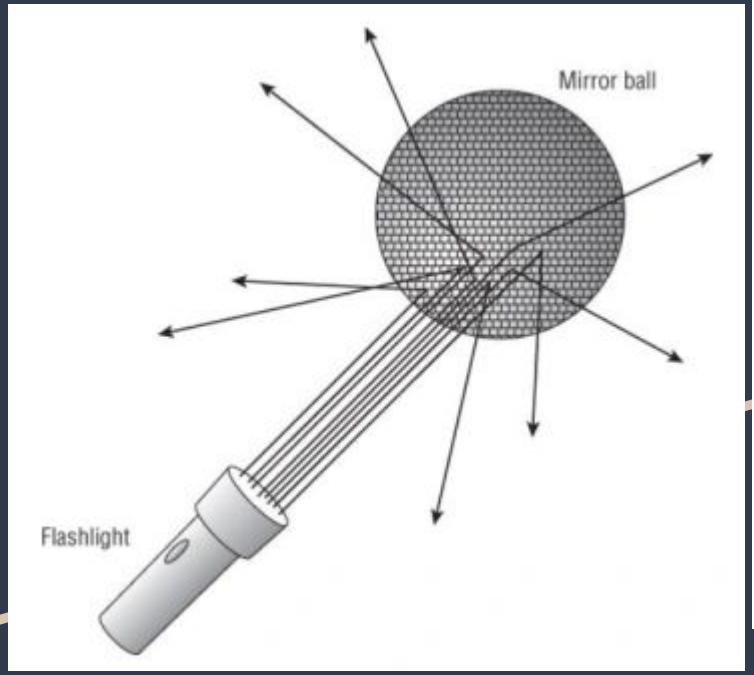


Scattering

Scattering can most easily be described as multiple reflections. These multiple reflections occur when the electromagnetic signal's wavelength is larger than pieces of whatever medium the signal is reflecting from or passing through. Scattering can happen in two ways.

Smog in our atmosphere and sandstorms in the desert can cause this type of scattering. Also when an RF signal encounters some type of uneven surface and is reflected into multiple directions. Chain link fences, wire mesh in stucco walls, tree foliage, and rocky terrain. When striking the uneven surface, the main signal dissipates into multiple reflected signals, which can cause substantial signal downgrade and may even cause a loss of the received signal.

Scattering



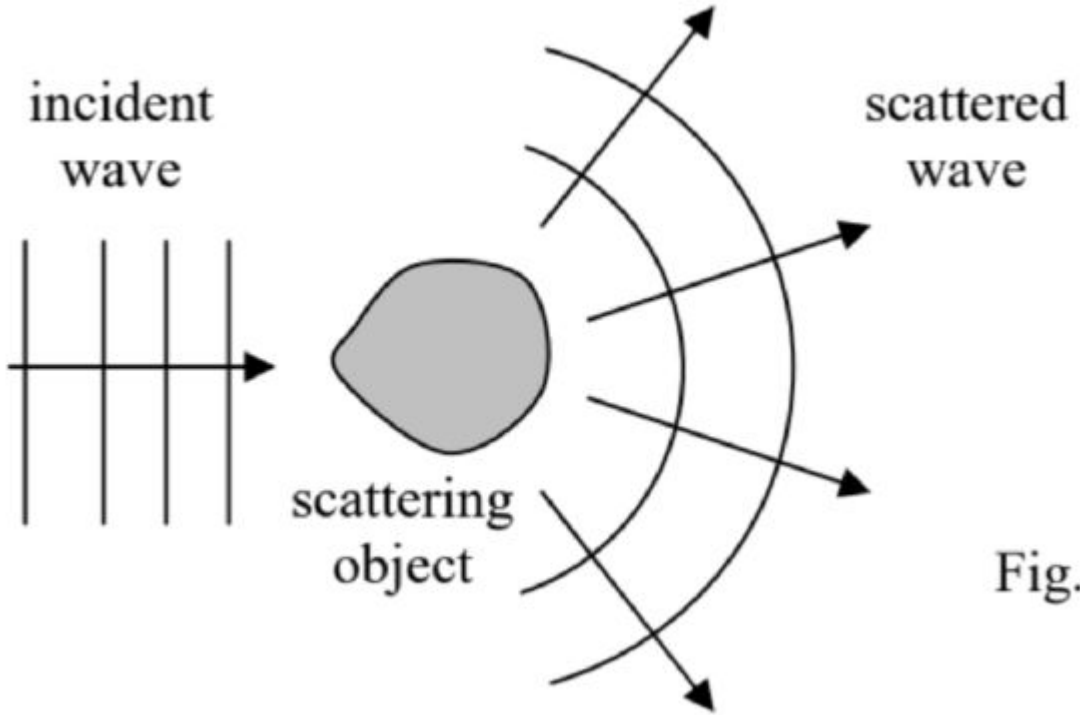
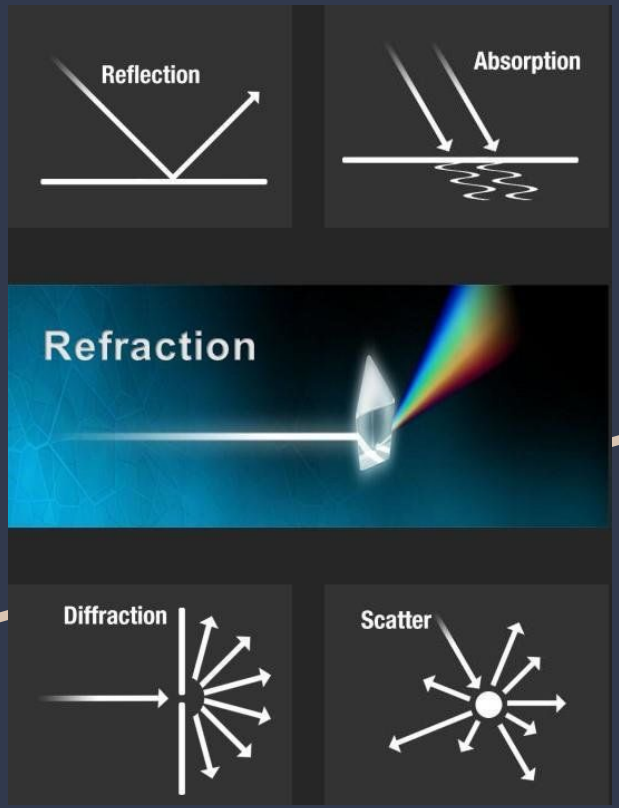


Fig.

Multipath



A propagation phenomenon that results in two or more paths of a signal arriving at a receiving antenna at the same time or within nanoseconds of each other.

When a signal encounters an object, it may reflect, scatter, refract, or diffract. These propagation behaviors can all result in multiple paths of the same signal.

Why would Multipath be Beneficial?

Questions?