

WECU Surveillance

Wireless Clear Line of Sight Defined

LOCATIONS-Understanding Radio Line of Sight

Radio transmission requires a clear path between antennas known as radio line of sight. It is necessary to understand the requirements for radio line of sight when designing a network.

Line of sight is the direct free-space path that exists between two points. Using binoculars on a clear day, it is easy to determine if visual line of sight exists between two points that are miles apart. To have a clear line of sight there must be no obstructions between the two locations. Often this means that the observation points must be high enough to allow the viewer to see over any ground-based obstructions.

The following obstructions might obscure a visual link:

- Topographic features, such as mountains
- The curvature of the Earth
- Buildings and other man-made objects
- Trees
- Aircraft parking spots

If any of these obstructions rise high enough to block the view from end to end, there is no visual line of sight.



Obstructions that can interfere with visual line of sight can also interfere with radio line of sight. But one must also consider the Fresnel effect. If a hard object, such as a mountain ridge or building, is too close to the signal path, it can damage the radio signal or reduce its strength. This happens even though the obstacle does not obscure the direct, visual line of sight.

The Fresnel zone for a radio beam is an elliptical area immediately surrounding the visual path. It varies in thickness depending on the length of the signal path and the frequency of the signal.



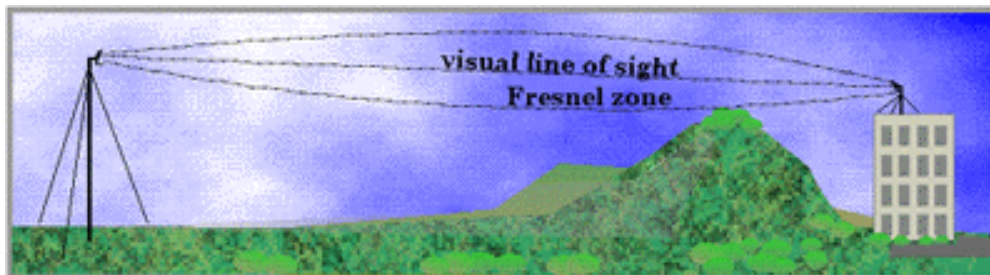
As shown in the picture above, when a hard object protrudes into the signal path within the Fresnel zone, knife-edge diffraction can deflect part of the signal and cause it to reach the receiving antenna slightly later than the direct signal. Since these deflected signals are out of phase with the direct signal, they can reduce its power or cancel it out altogether. If trees or other 'soft' objects protrude into the Fresnel zone,

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they can attenuate (reduced the strength of) a passing signal. In short, the fact that you can see a location does not mean that you can establish a quality radio link to that location.

There are several options to establish or improve the line of sight:

- Raise the antenna mounting point on the existing structure
- Build a new structure, i.e. radio tower, which is tall enough to mount the antenna
- Increase the height of an existing tower
- Locate a different mounting point, i.e. building or tower, for the antenna
- Cut down problem trees



Fresnel Radius

Below are several radius measurements at different distances and frequencies. When designing a wireless system there should be at least the Fresnel radius of free space all the way around the direct line of sight between two radios. Any obstruction encroachment into the Fresnel zone will reduce the signal strength between the radios and increase the reflected signal, both of which lower the chances of having a successful link.

Fresnel Radius at Distance verses Frequency

Distance	900Mhz	2.4Ghz	5.8Ghz
0.1 mile	12.01 feet	7.358 feet	4.733 feet
0.25 miles	19.00 feet	11.63 feet	7.484 feet
0.5 miles	26.87 feet	16.45 feet	10.58 feet
1 mile	38.00 feet	23.27 feet	14.96 feet
2 miles	53.74 feet	32.90 feet	21.16 feet
5 miles	84.97 feet	52.03 feet	33.47 feet
10 miles	120.1 feet	73.58 feet	47.33 feet

* NOTE: The curvature of the earth is not calculated into the table above.

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Survey Options

Offsite survey – The Offsite surveys is free of charge and is the first step in determining the wireless system design requirements. The offsite survey will only serve to provide basic guidance on the antenna gain needed and height the antennas need to be mounted assuming no foliage, man made changes to the earth or manmade obstructions. Off site surveys should not replace an onsite survey; it is only the first step. Offsite surveys do not all for or consider: frequency usage in a region, foliage, manmade obstacles or changes to the earth surface.

To conduct an offsite survey WECU Surveillance requires the latitude and longitude of the Access Point and all remote radio points. With this information WECU Surveillance can conduct its free offsite survey to determine the antenna gain and height of towers needed, assuming no man made obstacles are in the path. If man made obstacles are in the direct path, also include the latitude, longitude and height of those obstacles. Measure the height of the obstacles from its base.

Onsite survey – The Onsite survey is a paid service. The daily rate is \$1500(two day minimum), plus travel and lodging. WECU Surveillances' onsite survey and design services include measurements on:

1. Wireless survey
 1. Frequency usage measurements and scan
 2. Latitude and Longitude for each wireless point
 3. Recording of details on all potential obstacles
2. Solar survey (if solar is to be used)
 1. Measurements will be taken to validate the hours of direct sunlight available at each location.
3. Installation requirements will be discussed and a plan formulated with the installation company.
4. Equipment transportation considerations
5. Environmental considerations and how they may affect the system design and installation

A formal report and system design is provided with the onsite survey.