# RCP INSTALLATION CONSIDERATIONS AND PRINCIPLES

ZCOMAX WIRELESS
Your Wireless Networking Connection

# Rural Connectivity Platform (RCP) - Installation Considerations

Installing a high-speed wireless link over a long distance might seem like a daunting task. However, with a basic understanding of the underlying principles involved and some proactive planning you can take many of the unknown and intimidating factors out of the equation.

This reference has been designed to assist you in testing a potential location for wireless viability and determining setup requirements when installing the RCP series.

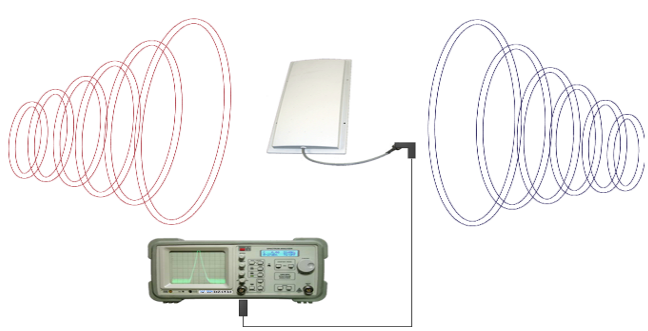
There are 3 primary factors that must be considered when installing any type of wireless link, including long distance links, they are:

- RF Interference
- Line of sight
- Fresnel Zone

## RF Interference

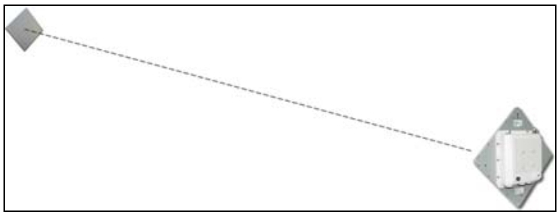
The purpose of this test is to determine the type of wireless activity that is present in a given location, particularly where you are considering installing a wireless device. Testing for RF interference involves having a frequency analyzer (such as a spectrum analyzer) and antenna setup that allows you to search the area for errant signals in the frequencies that you will be utilizing with the equipment that is intended to be installed there. A spectrum analyzer and antenna appropriate for the desired frequency range is the optimal equipment to sweep for signals that would interfere with the installation.

This type of survey is an intrinsic part of RF deployment and maintenance to ensure that a channel is selected that allows for the most stable and reliable connection possible.

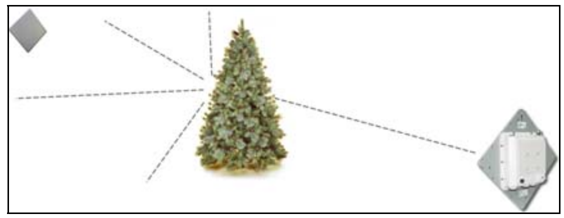


# Line Of Sight

Line of sight is a critical factor for any 2.4GHz and 5.8GHz wireless network. Line of sight means that the transmitting and receiving antennas need to have an unobstructed "view" of each other to ensure a reliable and stable signal. The imaginary line connecting one antenna to the other is considered the Radio Frequency Line of Sight (RF LoS).



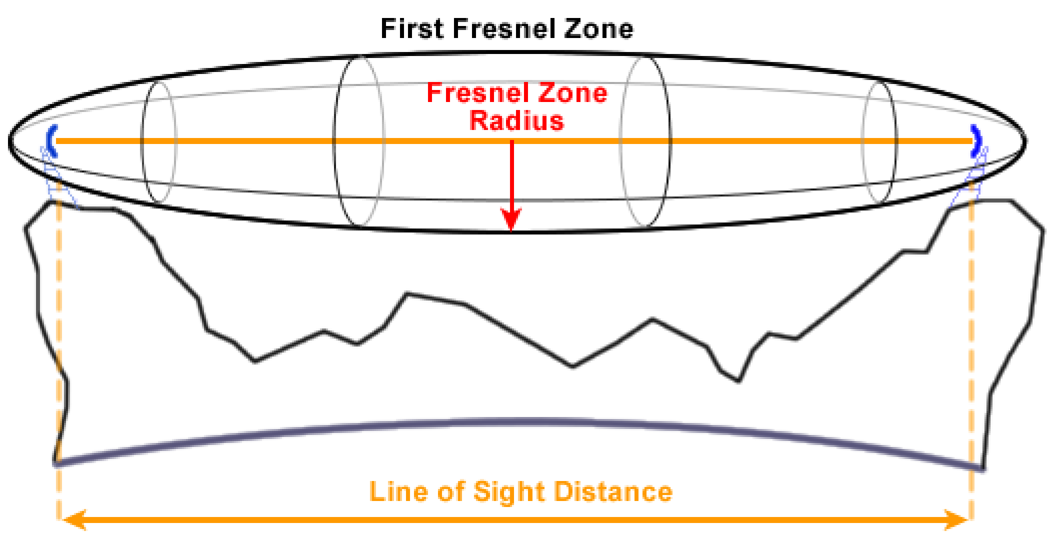
**Line of Sight**



**No Line of Sight**

# Fresnel Zone

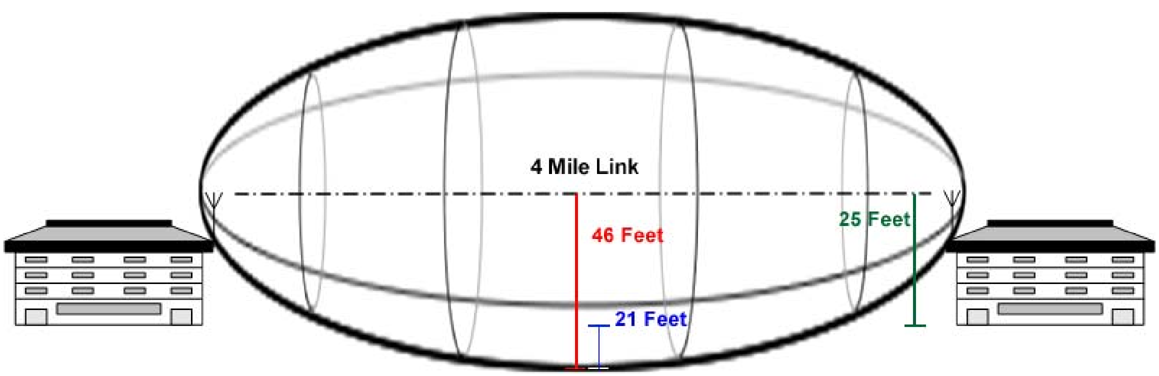
While line of sight is a crucial part of how well 2 points can connect wirelessly, an often overlooked component is the Fresnel Zone. The first Fresnel Zone is the area directly around the RF LoS, and the radius we are most concerned with, and can be determined mathematically. Interference and obstruction within the Fresnel Zone can, possibly, have damaging effects on network performance, so a solid understanding of the principles involved is invaluable when determining setup of any wireless equipment.



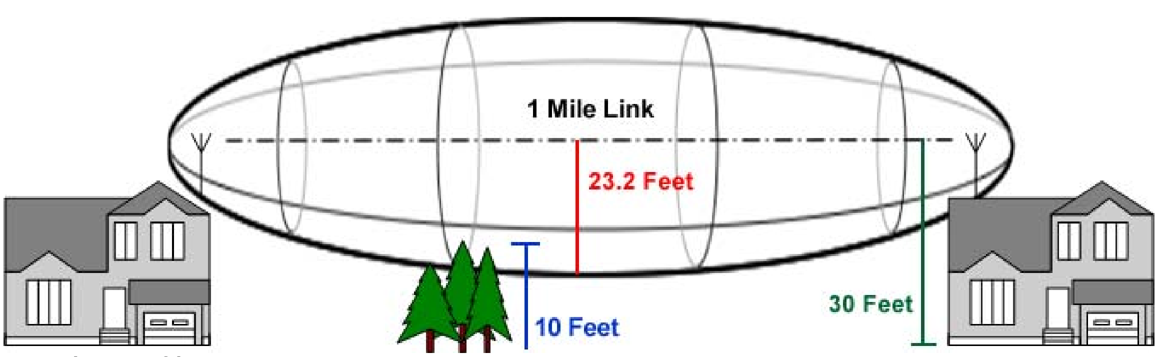
Radio waves travel in multiple paths from the transmitting antenna to the receiving antenna and obstructions between the antennas will reflect the waves onto different paths. This event is called multi-path. The effects of multi-path are that the reflected signals will arrive out of phase, to varying degrees, in relation to the main transmission signal. If the reflected signals arrive out of phase, the power is effectively reduced, degrading performance.

Calculating the Fresnel zone can help determine what obstacles will be a detriment to the network and so steps can be taken to avoid them or circumvent them The first Fresnel zone is the most critical as this has the most direct bearing on the performance of the wireless connection so that is the one that this document focuses on.

Ideally, nothing should obstruct the first Fresnel zone but that is rarely possible in real world applications. A general rule of thumb is to try and shoot for ≤ 20% infringement with no more than 40% infringement of the first zone. The infringement can be anything within the Fresnel zone. This is a key factor when considering that the area encompassed by the Fresnel zone is largest in the middle, between the two endpoints. Infringement can be caused by anything including the ground/curvature by the earth, hills/mountains, trees, buildings, etc.




**Fresnel Zone Infringement By The Ground**




**Fresnel Zone Infringement By Trees**

To calculate the widest (center) part of the Fresnel zone, use either of these 2 calculations:

For radius in feet:

$$r = 72.05\sqrt{\frac{D}{4f}}$$

where
r = Radius in feet
D = Distance between endpoints, in miles
f = Frequency in Gigahertz

or

For radius in meters:

$$r = 17.32\sqrt{\frac{D}{4f}}$$

where
r = Radius in meters
D = Distance between endpoints, in Kilometers
f = Frequency in Gigahertz

The obstruction is rarely going to be right in the middle of the connection so it may be necessary to calculate the radius at a given distance from either endpoint. There are a couple different calculations to figure the Fresnel radius at any point along the line of sight, we'll just demonstrate 2 here.

To determine the radius, in meters, of a given Fresnel zone at any point between the transmitter and receiver:

$$F_n = \sqrt{\frac{n\lambda d_1 d_2}{d_1 + d_2}}$$

where
$F_n$ = The $n^{th}$ Fresnel Zone radius at point *x*
$d_1$ = The distance from one endpoint to the object
$d_2$ = The distance from the other endpoint to the object
$\lambda$ = The wavelength* of the signal in meters

To determine the radius of the first Fresnel zone, in feet, at any point between the transmitter and receiver:

$$x = 72.05\sqrt{\frac{d_1 d_2}{f d_t}}$$

where
$d_1$ = The distance from one endpoint to the object in miles
$d_2$ = The distance from the other endpoint to the object in miles
f = The frequency of the signal in gigahertz
$d_t$ = The total distance between endpoints

* To calculate wavelength ($\lambda$) in meters/feet/etc. use the following equation:

$$\lambda = \frac{c}{v}$$

where
$\lambda$ = wavelength
c = speed of light in desired units (meters/feet/etc.) per second#
v = frequency in hertz°

# The speed of light equals:

299,792,458 meters/second
≈ 300,000 kilometers/second
≈ 3542880000000 feet/second
≈ 671,000,000 miles/second

o To convert frequency to hertz use the following multiplier:

Megahertz to hertz = frequency x 1,000,000
Gigahertz to hertz = frequency x 1,000,000,000