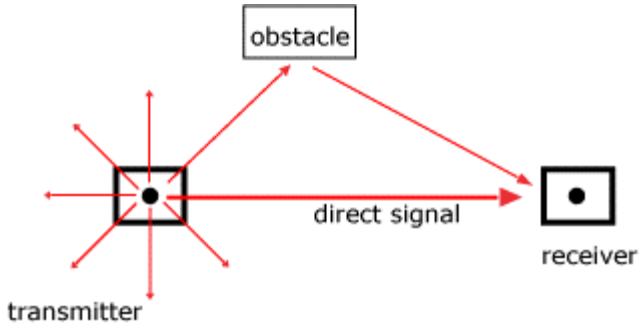
Wireless Communication

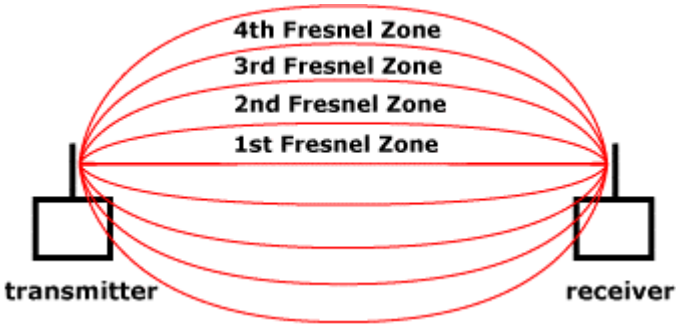
an overview of the wireless phenomena



Being able to see the receiving antenna (line-of-sight) does not guarantee the wireless link will establish and operate properly. Radio waves do not travel between the transmitter and the receiver in just a straight line. For standard 'Rubber Duckie' type omni-directional antennas, radio waves travel from the transmitter in every direction outward from the antenna.

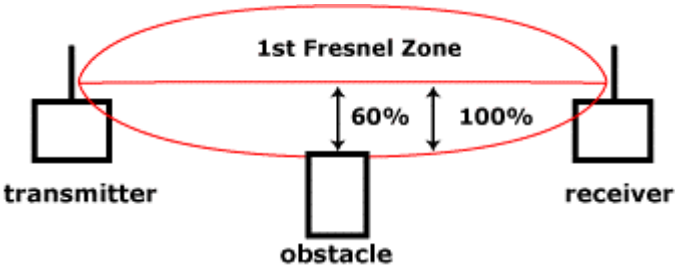
If the radio waves bump into an object, they may deflect back in the direction of the receiving antenna and arrive later than the direct path waves. The time differences between the signals being received create a shift in the phase of the deflected radio wave when compared to the direct path waves. When the receiving antenna receives the deflected path waves, the signal received from the direct path is reduced due to a Phase Canceling Effect. The magnitude of this Phase Canceling Effect is related to the signal strength of each signal and the phase difference between the signals.

Radio waves between a transmitter and a receiver follow a straight line but also form an ellipsoidal shape like a football or sausage, known as the Fresnel Zone. Monsieur Fresnel, a French physicist and mathematician, devised a method to determine the effect the Fresnel Zone has on wireless communications. The Fresnel zone is broken up into zones, each with a different phase and signal strength.



Signals received through the zones 1, 3, 5, etc. have more negative effects on the wireless communications while signals received from zone 2, 4, 6, etc. can actually have positive effect on the wireless connectivity. This is all due to the phase shift occurring at different 'angles' when compared to the direct line signal. If the receiver receives enough phase canceling signals, the total could cancel out the direct path signals resulting in signal loss.

Since decreasing the negative zones and increasing the positive zones in not easily accomplished, maximizing the direct signal strength helps increase connectivity between the two wireless units. To maximize the direct signals, minimize the possibility of the more direct signals bumping into anything and being deflected or reflected away from the receiving unit

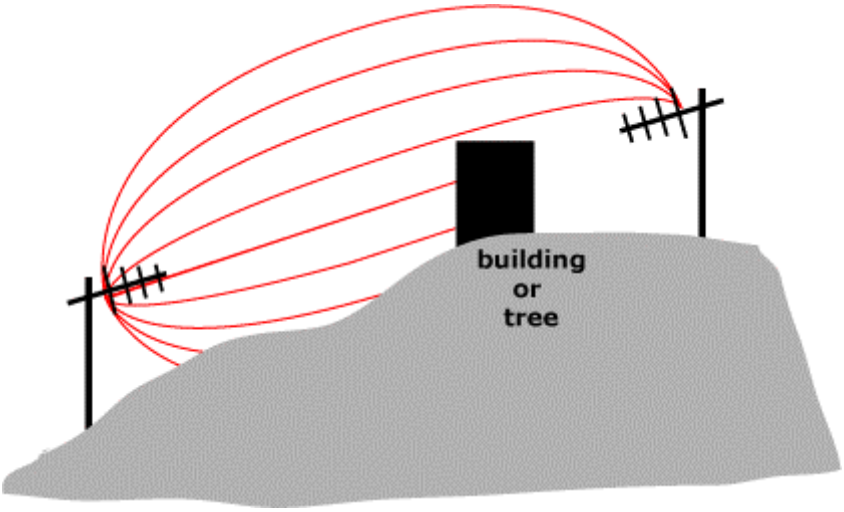


Since the 1st Fresnel Zone is closest to the direct path signal, the general 'rule of thumb' is to maximize 60% of the 1st Fresnel Zone by avoiding obstacles between the transmitter and receiver. Raising the antennas can increase the amount of the direct signal received by decreasing the amount of good signal blocked by an obstacle in the 1st Fresnel Zone.

Moving the antenna locations can also affect the amount of positive and negative signals deflected by obstacles between the transmitter and receiver. Additionally, water tends to absorb radio waves and plants are full of water, therefore, trees and leaves have a negative effect on the amount of signal energy reaching the receiver.

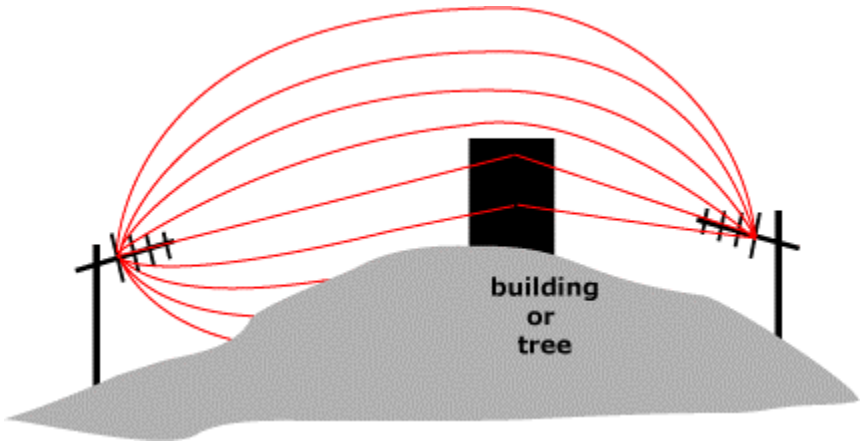
APPLICATION TO THE REAL WORLD

So let's consider a real world racing application for wireless communications over the side of a hill in non-line-of-sight installation.



A pair of Yagi type antennas installed at the bottom and top of a hill is used to focus the radio waves. Raising the antennas may not be all that it takes since obstacles like buildings and trees may block the direct path signals leaving only the other Fresnel Zones to establish a link between antennas. This may require more transmitter power than the direct path signals but it will work

Aiming the antennas at a nearby structure to reflect the direct path signals may help or hinder depending upon the mixture of signals received from positive Fresnel Zones versus the amount of signal received from the negative Fresnel Zones.



Because of the combination of signals being received and the angle of phase shift between them, the antenna position may need to be adjusted. In this application of a wireless link, the direction the receiving antenna is aimed may not relate to the location of the transmitting antenna, but more relates to reception of the 'best combination' of reflected Fresnel Zone signals.

With all the possibilities to consider for good wireless communication over distances, it is a good idea to install the wireless equipment before an event to establish how the antennas should be positioned as well as the antenna gain and transmitter power required.