

## **Antenna Installation Considerations**

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### **Abstract**

This white paper outlines specific installation considerations when installing a WLAN antenna including Fresnel Zones, LOS, reflection, multipath etc.

## **Introduction**

When installing a wireless LAN antenna several factors must be considered before installation in order to obtain optimal wireless signal connectivity.

## **Indoor (in building) Wireless Networks**

When dealing with the installation and expansion of indoor wireless networks several factors must be considered. Most manufacturers of wireless access points and routers indicate a typical range that their equipment can provide. Usually these range estimates require line of sight which means you will need a clear unobstructed view of the antenna from the remote point in the link. In most cases there will be obstacles present in an indoor installation that could affect performance.

Signals generally will not penetrate metal or concrete walls. Other factors that will reduce range and affect coverage area include metal studs in walls, concrete fiberboard walls, aluminum siding, foil-backed insulation in the walls or under the siding, pipes and electrical wiring, furniture and sources of interference. Other sources include other wireless equipment, cordless phones, microwave ovens, radio transmitters and other electrical equipment. Due to the increased gain, installing range extender antennas in the presence of interference could actually yield equal or worse range.

In wireless transmissions, reflections (when wireless signals “bounce” off objects) and multipath (when wireless signals travel in multiple paths arriving at the receiver at different times) are as important as signal strength in determining the success of an installation. A signal will also exhibit peaks and nulls in its amplitude and alteration of its polarization (vertical or horizontal) when propagating through walls, ceilings and reflecting off metallic objects.

Wireless radios have special hardware and software to deal with multipath and signal level nulls, but if the antenna is in a poor location, the radio will not be able to communicate. When trying to get the best performance in a location with a lot of barriers or reflections, it is important to be able to move the antenna in all three axes in order to minimize the effects of multipath and optimize the signal strength.

## Outdoor Wireless Networks

Outdoor wireless network experience the same factors such as reflections and multipath as indoor networks. For outdoor wireless installations clear line of sight is optimal. Trees and leaves are obstructions to 802.11 frequencies so they will partially or entirely block the signal if not cleared.

Before deploying any wireless network a site survey is recommended. The site survey typically entails installing an access point at each location where user groups are located and then monitoring the wireless signal strength by walking varying distances away from the access points using a laptop with site survey software. The result will show you where you may need more access points to provide sufficient coverage or where you may need to move an access point for optimal wireless connectivity.

## Antenna Height

The correct installation height of an antenna depends on the factors outlined below.

**1) Distance between the sites:** The longer the link, the higher the antenna needs to be due to the earth's curvature. (This relation is not proportional) See table 1.

**2) The Fresnel Zone:** This is an electromagnetic phenomenon, where light or radio signals get diffracted or bent from solid objects near their path. See table 1 showing the 60% of Fresnel Zone values (accepted clearing on path). Add this to the earth curvature height.

**3) Objects in the path:** At a frequency of 2.4 GHz, you need a clear line of sight (LOS). Tree tops will reflect or ground the signal. The theory is that the height of the tallest object in the path of the signal should be added to the Fresnel Zone and earth curvature clearance heights. In your case, you should have to check the height of the trees, hills, buildings or any object on the link path and add this to the measurement for the total of the tower height.

The above three conditions make up the **Radio Line of Sight**. See Table 1.

Add these values to find the proper antenna height.

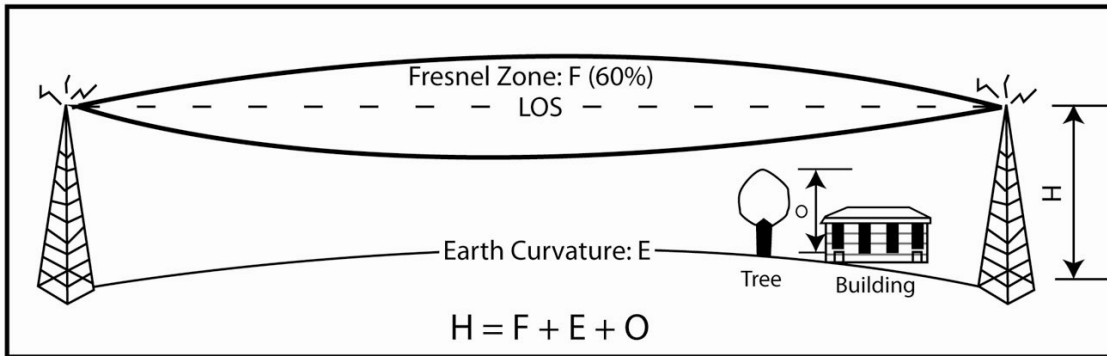


Table 1.

Wireless Link Distance (Miles)	Value Fresnel Zone F (60% at 2.4 GHz.) Approx. Value	Value E (Earth Curvature) Approx. Value	Antenna Height H Antenna Height No Obstruction
1	2	3	4
3	23	4	27
5	30	5	35
8	40	8	48
10	44	13	57
15	55	28	83
20	65	50	115
25	72	78	150

This is theoretical data and there are some cases of customers with working links, with line of sight (LOS) just a few feet over the top of obstacles on their path. We want to emphasize the need for clear line of sight. Trees should not be in the way. We recommend that the height of the tower should be the minimum of the earth curvature plus Fresnel Zone clearance height, making sure that this height is at least 10 feet above the top of any obstructing object before you start testing the link.

## **Conclusion**

To ensure optimal wireless connectivity several rules of installation must be followed. By not considering the factors outlined in this paper you may not receive signal on the receiving antenna end of the link.

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