EDUCATIONAL BRIEF

The Use of Circular Polarization (CP) Antennas in 802.11 Wi-Fi Network Applications

As wireless technology becomes more pervasive, antenna polarization is an important consideration when designing and installing a wireless network. Understanding polarization and how it can influence network performance is very important to optimize signal reach and network performance.

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Most communication systems use either Linear Polarization (vertical or horizontal) or Circular Polarization (CP) technologies. Largely due to cost considerations, Linear Polarization has emerged as the de facto standard in most wireless network implementations. On the other hand, with its superior signal propagation characteristics and traditionally higher costs, use of CP antennas has for the most part been limited to satellite communications. More recently, however, innovative design and production breakthroughs have made this superior technology affordable for use in more common applications.

ANTENNA POLARIZATION OVERVIEW

An antenna is a transducer that converts radio frequency (RF) electric current to electromagnetic waves that are then radiated into space. The electric field plane determines the polarization or orientation of the radio wave. In general, most antennas radiate either linear or circular polarization.

Linear Polarization: A linear polarized antenna radiates wholly in one plane containing the direction of propagation. An antenna is vertically linear polarized when its electric field is perpendicular to the Earth's surface. An example of a vertical antenna is a broadcast tower for AM radio or the whip antenna on an automobile. Horizontally linear polarized antennas have their electric field parallel to the Earth's surface. For example, television transmissions in the USA use horizontal polarization. Thus, TV antennas are horizontally-oriented.

Circular Polarization: In a circularly-polarized antenna, the plane of polarization rotates in a corkscrew pattern, making one complete revolution during each wavelength. A circular polarized wave radiates energy in both the horizontal and vertical planes and all planes in between. If the rotation is clockwise looking in the direction of propagation, the sense is called right-hand-circular (RHC). If the rotation is counterclockwise, the sense is called left-hand circular (LHC).

Due to the advanced signal propagation properties, CP antenna technology offers numerous performance advantages over traditional linear technologies.

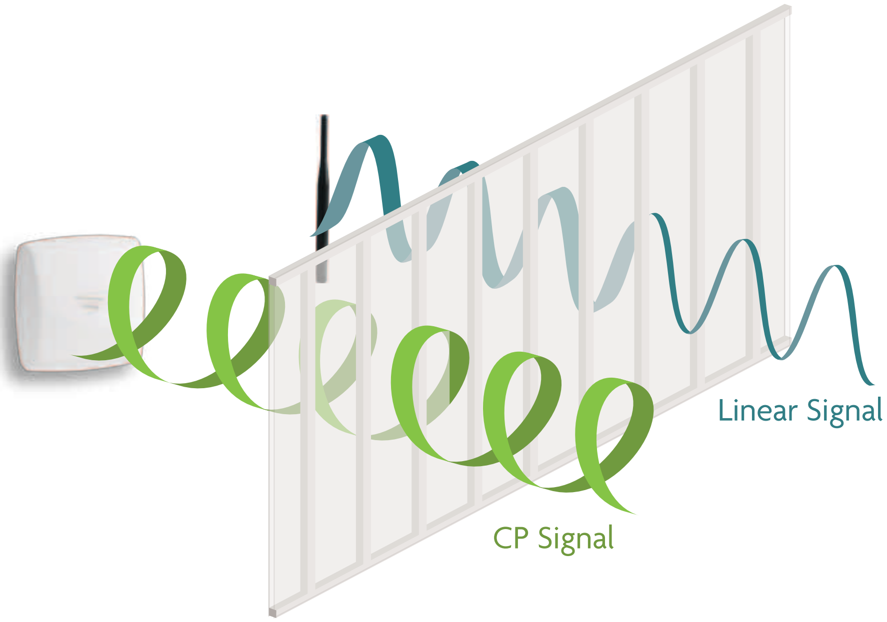

Image 1: Signal Penetration, CD vs, Linear

ADVANTAGES OF CIRCULAR POLARIZATION

Due to the advanced signal propagation properties, CP antenna technology offers numerous performance advantages over traditional linear technologies. When implemented as a central component within a Wi-Fi network, CP delivers better connectivity with both fixed and mobile devices and ultimately leads to a superior user experience. CP is ideal for addressing challenges associated with mobility, adverse weather conditions, and non-line-of- site applications, each of which is briefly discussed below:

Mobile Connectivity: In the modern world, mobile and handheld wireless devices are everywhere. These handheld devices typically use linear polarized antennas and thus the orientation of the signal is often random, depending on how the device is being held by the user. This naturally leads to out of phase issues. As described above, CP antennas address this issue by transmitting in all planes, making it more likely for a mobile client device to be able to establish a reliable signal link regardless of the antenna orientation of the device.

Inclement Weather: Rain and snow cause a microcosm of conditions that will be discussed below (i.e. reflectivity, absorption, phasing, multi-path and line of sight). The advanced signal propagation characteristics of CP, make it more resistant to signal degradation due to inclement weather conditions.

Line-of-Sight: When a line-of-sight path is impaired by light obstructions (i.e. foliage or small buildings), CP is much more effective than linear polarization for establishing and maintaining communication links. Once again, this is due to the CP signal being transmitted on all planes, providing an increased likelihood that the signal will not be adversely impacted by obstructions and other environmental conditions.

There are a number of technical and implementation challenges that are typically associated with an 802.11 Wi-Fi network installation. These challenges (described below) can largely be mitigated through the use of CP technology:

Reflectivity: RF signals are either reflected or absorbed, depending on the material with which they come in contact. Linear polarized antennas transmit in only one plane, so if the reflecting surface does not reflect the signal precisely in the same plane, signal strength will be lost. By comparison, since CP antennas transmit in all planes, the signal strength is not lost. Rather, it is transferred to and used in a different plane, increasing the likelihood of an available, usable signal.

Absorption: RF signals from different planes react and are absorbed differently depending on the type of material being struck. Because it transmits on all planes, a CP antenna has a higher probability of penetration to deliver a successful, stable link. As an example, in a commercial office environment, a linear polarized antenna will have difficulty penetrating walls containing metal stud. However, in such a scenario, the signal from a CP antenna will more effectively be propagated through the wall and achieve an overall better reach throughout the building.

Phasing Issues: In order to operate effectively, high-frequency systems (i.e. 2.4 GHz and higher) that use linear polarization typically require a clear line-of-sight path between the two points. Such systems have difficulty penetrating obstructions due to reflected signals, which weaken the propagating signal. Reflected

Image 2: CP Signal Alignment

Image 3: Linear Signal Misalignment

linear signals return to the propagating antenna in the opposite phase, thereby weakening the propagating signal. Conversely, CP based systems also incur reflected signals, but the reflected signal is returned in the opposite orientation, largely avoiding conflict with the propagating signal. The result is that CP signals are much better at penetrating obstructions and for use in non-line-of-site applications.

Multi-path: Multi-path is when the primary signal and the reflected signal reach a receiver at nearly the same time. This creates an "out of phase" problem. When this happens, the receiving radio must spend its resources to distinguish, sort out, and process the proper signal, thus degrading performance and speed. An out of phase radio can result in dead-spots, decreased distance and throughput, and reduced overall network performance. Linear polarized antennas are more susceptible to multi-path due to the increased possibility of reflection, while a CP antenna transmitting on all planes will have a lower likelihood of signal cancellation.

SUMMARY

While there is no perfect method for implementing a Wi-Fi network, the use of Circular Polarization (CP) can significantly increase the chance for success. CP technology can be used effectively in 802.11 Wi-Fi network deployments to deliver superior signal coverage when compared to traditional linear polarized antenna technologies. CP signals are farther reaching, less susceptible to harsh weather environments and obstructions, and more reliable when used in mobile networking applications.

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