TECHNOLOGY

Overview

Tsunami™ Wireless Ethernet Bridges: Understanding & Overcoming Radio Interference

When evaluating wireless technology, the possibility of radio frequency interference disturbing a wireless network link sometimes poses a concern. This paper provides background on interference, describes the licensed and license-exempt approaches towards interference, and explains how the right design and deployment, when combined with optimal technology, can overcome interference. Tsunami Wireless Ethernet Bridges provide reliable data transmission by minimizing the possibility of interference with a proven combination of well engineered deployment practices and robust wireless bridge technology.

The Interference Challenge

Radio interference results from unwanted radio frequency (RF) signals disrupting system communications. Typically these signals are at or near the same frequency as the receive frequency of an established system. The source of interference is usually very high power transmitters that are very close in frequency to the impacted system. Interference can affect all types of radio frequencies, although the topic is most frequently raised in the context of license-exempt systems.

Evaluating the Technology: License-exempt vs. Licensed

The terms "License-exempt" (also called "license-free" or "unlicensed") and "Licensed" refer to the radio frequency spectrum characteristics set by the U.S. Federal Communications Commission (FCC) or equivalent national government regulatory body. Licensed products require regulatory approval before deployment while license-exempt products can be deployed without any regulatory approval.

When a system is "license-exempt," it can be installed virtually anywhere within a given country without notifying regulatory authorities. Typically, manufacturers desiring license exempt certification must apply to the FCC or equivalent national authority for approval to operate a particular product in specific radio frequency bands. FCC rules encourage efficient use of RF bandwidth and harmonious co-existence of different systems using the same radio spectrum. The FCC (or equivalent authority outside of the US) process helps to isolate the opportunity for interference by requiring all license-exempt devices to conform to the same standards. Once a product adheres to specific national regulations and the manufacturer obtains certification by the appropriate governing authority, anyone can deploy that manufacturer's equipment anywhere in the country without further regulatory paperwork.

"Licensed" RF transmitters communicate using a specific transmit and receive frequency combination that is selected and assigned to the user (licensee). The frequency assignment is coordinated with other users of the same spectrum in that area. This process provides full disclosure of the frequency assignment and typically avoids interference from any existing licensee already assigned in the area. If licensed radios encounter interference, it is typically resolved with the assistance of the regulatory body. The application, assignment and coordination process with the FCC (or equivalent regulatory body) constitute the licensing process.

The licensing process can be time-consuming, resource-intensive and requires payment of fees to the FCC or equivalent authority. A "licensed" frequency band is often purchased, usually at auction, by a license holder. The license-holder "owns" a particular block of frequency spectrum in a given geographical area. While no one can use these licensed frequencies without the license-holder's consent, the license-holder is responsible for managing his/her own usage as well as any "sub-contracted" usage.

Some observers believe that licensed means that there will be no interference and that license-exempt means that the potential for interference is much higher. This is not necessarily the case. The primary difference between licensed and license-exempt systems is that licensed radio users have a regulatory body that will assist them in overcoming any interference issues that may arise, while license-exempt users must resolve interference issues without governmental assistance. Another difference between licensed and license-exempt lies in the process of coordination prior to deployment. Prior coordination is required for licensed radios to evaluate the neighboring spectrum users to minimize opportunity for interference. There is no government provided service for prior coordination of license-exempt systems – customers wishing to perform this must do so themselves.

Proxim provides both point-to-point licensed and license-exempt wireless products. The design and construction of the Tsunami license-exempt wireless bridge technology is not significantly different from that of the Tsunami licensed bridges. Depending on an organization's requirements, Proxim can help customers intelligently select and efficiently deploy the best technology to fit their needs.

Designing and Deploying an Optimal Wireless Link

Proper design and deployment are critical elements in avoiding potential interference. In fact, an appropriately configured license-exempt system deployed using a rigorous methodology can provide the same or better reliability than a licensed system, even in the face of potential interference.

There are two key factors in deploying a successful wireless network: 1) achieving a strong received signal level (RSL) and 2) minimizing the receiving antenna's beamwidth. The higher the received signal level of the intended transmission, the less likely a system will be affected by interference. A stronger signal is more able to cut its way though the clutter of interference and make itself heard at the receiving end of the link. Higher received signals are obtained by optimizing a wireless link using robust radio technology, optimal antennas, and transmission cabling providing low signal loss between the Tsunami bridges and the antennas.

Selecting the right antenna

Antennas frequently play a key role in mitigating the potential for interference. Antennas come in a variety of sizes and shapes that have different performance characteristics in the area of "gain" and directionality. In radio parlance, gain refers to the ability of an antenna to increase the strength of the transmitted and received signal while directionality refers to the antenna's ability to focus on a specific aperture for transmitting and receiving signals. Antennas can transmit/receive in all directions (omni-directional) or transmit/receive in one specific direction (directional). Tsunami Wireless Ethernet Bridges use directional antennas that transmit and receive a focused beam of radio energy for optimal performance between two points. Directional antennas come in flat panel and parabolic designs, both of which offer considerable gain and directionality. Deploying a high-gain antenna results in improved RSL and consequently improved signal reception. Larger antennas generally offer more gain.

Focusing the received RF beamwidth reduces the likelihood that surrounding RF clutter might interfere with a systems reception. Antennas vary in the aperture to which they can "see" signals. Larger size antennas provide narrower beamwidths and can diminish interference from nearby transmitters because of the focused RF energy at the intended destination. A narrower beamwidth increases the desired energy of the signal while reducing the power of interfering sources not directly aligned to the antenna.

While smaller antennas may be aesthetically preferable, larger antennas offer a number of benefits including:

- Increased strength of the transmitted signal
- Increased strength of the received signal that is aimed directly at the antenna
- Decreased area of transmitted energy
- Delivery of more focused RF signals (narrower beamwidth)
- Improved selectivity of desired signal in the face of signals from slightly different bearings

For example, an 8-foot antenna can boost a signal by over 375% over a 2-foot antenna. In addition to the improved RSL, larger antennas offer a narrower beamwidth that can focus on the incoming signal and avoid extraneous transmissions. A 2-foot antenna may have a 6.1 degree beamwidth while an 8-foot antenna has a 1.6 degree beamwidth – nearly four times smaller (see Figure 1). Where a 2-foot antenna might encounter interference, an 8-foot antenna will reduce the incoming level of interference substantially and may not "hear" an interfering signal unless it was within the 1.6 degree target area. If the interfering signal is outside the 1.6 degree target area, it is diminished. A narrower antenna beamwidth reduces the interfering signal while increasing the desired signal.

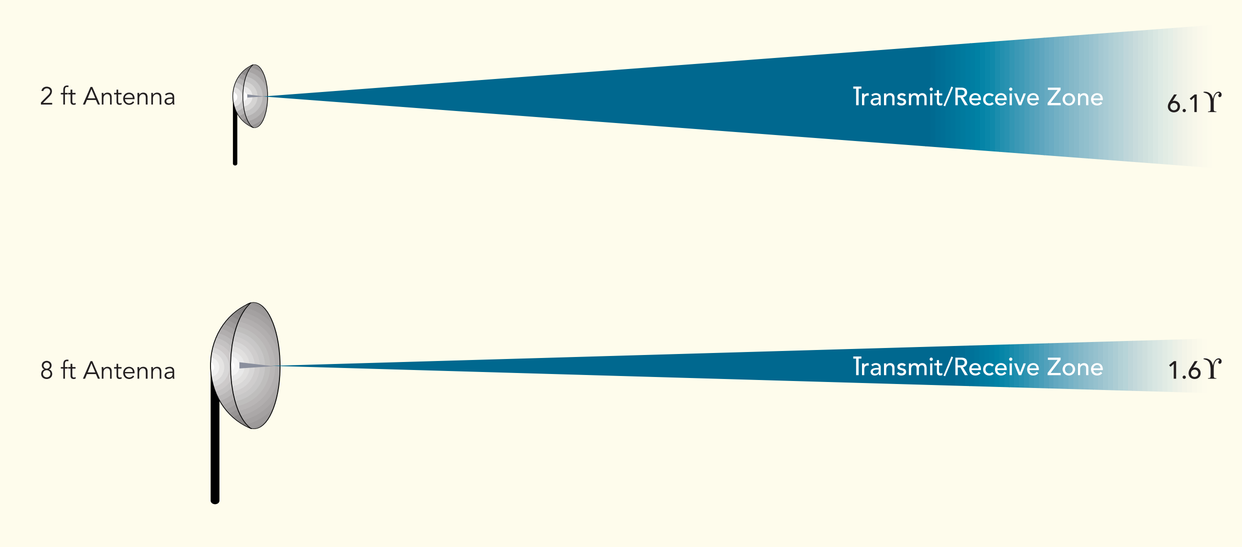

Figure 1: 2 foot vs 8 foot antenna radio frequency (RF) beamwidth

A good deployment practice is to "scan" the antenna locations for potential interference prior to deployment. A spectrum analyzer and antenna can be used to determine if there are any interfering signals that might need to be "steered around," and gather information on the interfering signal direction, strength, frequencies and polarization. This is roughly equivalent to the prior coordination that is performed for licensed radio designs. This tactic is not always necessary because frequency changes frequently can be made during deployment, however, it is a good step to take in system design. Such scanning can be particularly useful in dense metropolitan areas where one is more likely to encounter interference.

When Tsunami Wireless Ethernet Bridges are combined with appropriately sized, directional antennas and optimal transmission cabling between antennas and the Tsunami Bridge that minimize signal loss, interference is rare and reliability of these wireless systems is maintained at the highest levels.

Tsunami Wireless Ethernet Bridge Technology: Designed to Deliver

While good deployment practices reduce or eliminate the potential for interference, a well designed core transceiver system can result in easier deployment and provide an increased degree of tolerance to interference. A key Tsunami strength is the radio technology engineered by Proxim. Tsunami Wireless Ethernet Bridges offer one of the highest output power levels in the industry. High output power raises the RSL and consequently reduces the potential for interference since any interfering signal source would have to be stronger to interrupt the signal.

Another way to reduce interference is changing the frequency channel of the system. In cases where interference is encountered, many Tsunami models allow the transmit and receive frequency band or channel to be changed so as to avoid interference. Tsunami also provides the same data capacity (eg. 10 Mbps, 45 Mbps, 100 Mbps, etc) in multiple frequency bands. This allows movement completely out of the RF band which may be subject to interference. For example, if one encounters an interfering signal with a 2.4 GHz bridge, one can use a 5.8 GHz model to avoid the interference.

Interference: The Myth and Reality of First Come, First Served

Interference typically impacts both the "interferee" and the "interferer." An established system encountering interference may be interrupted, but the new system causing the interference will often not be able to fully function. This dynamic favors established systems since the new system cannot displace the established system. Once a system is operational, future systems will have to "steer around" this existing signal so that both systems can live in harmony.

When one encounters interference while deploying a new system, it is frequently possible for the established system and the new systems to arrive at some sort of mutual accommodation enabling both systems to coexist while avoiding interference. This can be done through tactics such as reducing the transmitting power of one link so it does not interfere with the other link.

The Proxim Experience

Proxim has successfully installed more than 45,000 nodes worldwide. Many Proxim customers select wireless, license-exempt systems so that they may deploy them quickly and inexpensively without compromising reliability. The rapid growth and long-term success of these wireless networked installations is achieved through the use of the methodology and practices described in this paper to minimize interference and optimize overall system performance and availability.

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