



RF Interference in VINE Networks

INTRODUCTION

Unlicensed Band Operation

Operation in unlicensed bands has advantages and disadvantages. The major advantage is that you can deploy a network quickly, with off-the-shelf equipment without having to wait for a license from a regulatory agency. However, since everybody else can do the same thing, you must take into account the potential for RF interference from other equipment.

The Wi-LAN *VIP 110-24* radio is the building block of the VINE network topology. This radio uses Direct Sequence Spread Spectrum (DSSS) modulation operating in the unlicensed 2.4 GHz band. The radio occupies a RF bandwidth of 18 MHz and can operate at speeds of up to 11 Mbps.

Frequency hoppers and other operators in the band can interfere with the successful operation of a DSSS system. The Wi-LAN VINE topology and MAC protocol includes several features that help reducing the effects of potential interferers. This Application Note address how the VINE architecture operates in the presence of potential interferers, and describes some specific *VIP 110-24* features that allow it to identify and avoid or overcome such interferers.

IDENTIFYING INTERFERENCE

Spectrum Analysis

A feature of the *VIP 110-24* is the ability to perform a “spectrum analysis” of the whole band as seen by either of its two antennas. The graphical output of this spectrum analysis quickly identifies which channels may be suffering potential interference and which ones are free, or “clean”. The spectrum analysis feature allows the user to specify the “channel dwell time”, or time spent measuring the signal at each channel, so that you can catch interferers that are bursty in nature.

Timing Analysis

The *VIP 110-24* also has a “time-analysis” command that monitors the activity in a specific channel over time, and displays the result graphically. This is useful for characterizing the interference source, or making sure that a channel that was perceived as free is indeed interference free over a long period of time.

AVOIDING INTERFERENCE

Directional protection

In the VINE network every link includes a narrow beam (high gain) antenna pointing “upstream” and a wide beam antenna pointing “downstream”. The narrow beam antenna protects the radio receiver against interference (except for interferers in the link path). The wide-beam antenna leaves the upstream radio receiver more exposed to interferers. There are three mitigating aspects with regard to this exposure:

1. In typical internet access applications there is much less upstream traffic than downstream. The interference exposure at the wider beam antenna only affects the upstream traffic.
2. Most installations do not need an omnidirectional antenna to service downstream nodes. In many cases the repeater node is at the top of a mountain serving subscribers down in a valley. In this and similar situations, a sector antenna covering as narrow a sector as possible can be used. Many different sector antennas exist with beam widths of 60, 90 or 120 degrees.
3. Sector antennas are available with horizontal polarization. If the interferer is vertically polarized, (the most common configuration), using the horizontally polarized antennas at both ends of the link can provide isolation in excess of 20 dB.

Frequency avoidance

With the spectrum and timing analysis tools you can characterize the sources of interference as seen by each radio. Once they are identified, the *VIP 110-24* provides the following features to avoid the interference.

Fine channel granularity: Even though the RF bandwidth of the *VIP 110-24* is 18 MHz, channels are spaced in 2 MHz intervals. Therefore almost any 18 MHz gap in the band can be used for successful operation.

Independent transmit and receive frequencies: In the *VIP 110-24*, the transmit and receive channels can be set to different values. This means that if there is

interference obstructing different channels at the two ends of a link, you are not restricted to using the same frequency in both directions. In fact, in a VINE network you always select the preferred receive frequency for each radio, based on the local environment. The VINE protocol insures that that selection is communicated to the other side of the link so that it transmits in the desired channel.

Overcoming Interference

RF Transmit Power: The VINE protocol allows the transmit power to be set independently for each link. For short links the transmit power is typically reduced to avoid causing interference in VINE nodes further away. However, a localized interferer can be overcome by increasing the RF power for that individual link, without affecting transmissions to other neighbors that are not suffering interference.

The *VIP 110-24* output power can be configured in 1 dB steps from 0 to 23 dBm. In addition, the radio's outdoor enclosure allows mounting the radio in close proximity to the antenna. This results in negligible cable losses and therefore all the available output power will be used to overcome the interfering source.

Programmable Modulation: The *VIP 110-24* modulation can be set at four different values resulting in RF speeds of 11, 5.5, 2, and 1 Mbps. As the speed is lowered the link margin (and therefore immunity against interference) improves as shown in the table below:

Speed:	11	5.5	2	1
Link Improvement:	0	3 dB	5 dB	8 dB

As with the power, the radio speed can be set independently for each link. For example, a node with many "children" may communicate at different speeds with each child. Additionally the speed can be different for each direction of the link. Since interference may be more prevalent in the upstream direction (due to the wide-beam antenna at the receiver), a network in a noisy environment could end up with the upstream link running at a lower speed than the downstream link. Since there is typically less upstream traffic, the impact of running the upstream link at lower speed is smaller.

CONCLUSION

The VINE technology used in the *VIP 110-24* has several features and tools to help mitigate the effect of interference. These features should enable the user to deploy reliable VINE networks in the unlicensed band, even in the presence of other unlicensed operators.

If there are any questions concerning the use of this procedure, contact your local sales distributor or Wi-LAN Technologies Inc.