Originally appeared in the **January 2005** issue of *Communications Technology*.

SIGNAL LEACKAGE AND THE VOIP

By RON HRANAC

One of the keys to ensuring reliable voice over Internet protocol (VoIP) deployments on the outside plant is a clean RF spectrum-that is, one free from over-the-air gremlins such as ingress and impulse noise. In theory, our networks are closed environments, which means that we can take advantage of something called frequency re-use.

Frequency re-use is the ability to use the RF spectrum inside of our cables for signals and applications that are quite different from how the over-the-air spectrum is allocated and used.

For example, we might carry an analog TV channel in the 144-150 MHz range, while in the over-the-air spectrum this same group of frequencies is used for two-way radio and similar services.

As long as our network is shielded properly, our signals won't leak out and interfere with over-the-air frequencies, and over-the-air signals won't leak in and interfere with cable frequencies.

But that's the perfect world.

Reality check

The reality is that despite our best efforts, our networks' shielding integrity is affected by weather, rodents, poor craftsmanship, things customers do inside their homes to the cable wiring and even poorly shielded cable-ready TV sets and VCRs connected directly to the drops.

This reality requires that we monitor the plant for leaks and fix those that exceed certain thresholds on an ongoing basis.

Federal Communications Commission rules mandate that we keep signal leakage below 20 microvolts per meter (V/m) when measured 3 meters from the plant. If your system just meets this threshold, you're in good shape as far as complying with the requirements in Part 76.

The bad news is that just meeting the 20 V/m leakage threshold isn't good enough for reliable two-way operation, and it's nowhere near close to what is necessary for reliable high-speed data and voice.

I've written in the past about cable operators that have set internal leakage limits that are tighter than the FCC's numbers. Typical values that I've seen are often in the 5-10 V/m range. I know of one cable operator whose leakage limit is 2 V/m. That's no typo-the threshold is 2 V/m, which is 20 dB lower than the FCC's limit!

In addition to regular leakage monitoring and repair, the FCC requires an annual ground-based ride-out to ensure that a calculated cumulative leakage index (CLI) based on measured leaks-basically a snapshot of leakage performance at a given point in time-does not exceed a defined value.

Alternatively, operators can conduct a flyover measurement, in which an aircraft flies at an altitude of 450 meters above the system's average terrain and measures leakage, which is not supposed to exceed 10 V/m.

If the flyover data are recorded digitally, the rules require that the 90th percentile level of points recorded over the cable system shall not exceed 10 V/m. With regard to flyovers, some operators target 98th or 99th percentile performance rather than the FCC's 90th percentile number.

Why worry about maintaining a cable system to stricter leakage limits than what the government says? The primary reason is that doing so helps manage ingress, especially upstream ingress. The argument is that where there's signal leakage, there's bound to be ingress.

Not enough

But complying with the FCC rules or even a tighter spec does not guarantee the system really is tight. I received the following comments from an engineer at one of the major MSOs after he read my October 2004 column.

"I enjoyed your article and was interested in the signal leakage correlation with VoIP reliability."

"Another issue we found with flyovers is that while the FCC requirement specifies that >90 percent of the readings be below the threshold of 10 V/m, nothing is said about what the absolute levels can be. We analyzed the data and put the readings into buckets indicating the intensity of the <10 v/m="">

"A system with a 95th percentile reading and 75 percent of the readings in the first bucket is not nearly as tight as another system with a 95th percentile reading and 75 percent of its readings in the lowest bucket. When we deployed cable modems, we found that the second system had fewer problems. [By itself] the 95th percentile score doesn't tell the whole story."

He went on to explain that his company has used Mar-Tech Engineering's www.martechengineering.net "enhanced flyover" to get an even better picture of leakage performance. I called Mar-Tech President Daryl Rosenberger to get the scoop on enhanced flyovers.

Rosenberger explained that an enhanced flyover involves using a dedicated test carrier with an audible tone to differentiate it from other signals on the system or in the over-the-air environment. The carrier is transmitted at a level that is 6 dB higher than other carriers on the plant, and then the flyover is performed. Doing this helps to find smaller leaks.

Data are tabulated and corrected to show flyover results as if the test carrier were at the same level as other signals on the network. The results from the higher level are included in the report and can be rather enlightening. Rosenberger noted that some operators are now doing semi-annual or even quarterly flyovers to get a better handle on leakage performance and keep it low enough to ensure more reliable two-way services.

The bottom line

The bottom line is that keeping leakage and ingress under control is critical to ensuring reliable data and voice service. Plain old high-speed data is pretty forgiving when it comes to impairments because data packets that don't make it through the first time will be retransmitted. Not so with voice-those packets have but one chance to make it.

Keep the plant tight-really tight-and you'll have one less headache to worry about.

Ron Hranac is technical leader, HFC Network Architectures, for Cisco Systems, and former senior

technology editor for *Communications Technology*. Reach him at rhranac@aol.com.