TECHNICAL COLUMNS

Official archives of articles and columns written by Ron Hranac for Communications Technology and some of its sister publications, published by Access Intelligence, LLC. Reprinted with permission of the author.

By **Ron Hranac**, former ***Senior Technology Editor,*** **Access Intelligence** and ***Communications Technology*** **Magazine**

Originally appeared in the **May 2009** issue of *Communications Technology*.

SIGNAL LEAKAGE IN AN ALL-DIGITAL NETWORK: THE CONTINUING STORY

By RON HRANAC

Judging from the feedback to my February column on leakage issues in all-digital networks, this is a topic that's clearly quite important to the industry. One point made by many of those who shared their comments had to do with keeping ingress under control, given what is believed to be the reduced likelihood that a leaking quadrature amplitude modulation (QAM) signal will interfere with an over-the-air service.

I recently teamed up with a few colleagues to see what happens when a QAM signal leaks into the over-the-air environment. As expected, traditional signal leakage detection gear cannot detect a noise-like QAM signal at typical field strengths. Even with very high level leaks, the detectors still show it as noise. High-level QAM channel leaks can cause problems with radio communications under the right conditions - my apology to neighborhood hams for any interference you may have heard during the testing. Bottom line? Using currently available leakage detector technology, about the only way cable operators can monitor their networks in order to maintain compliance with existing FCC signal leakage rules is with a dedicated continuous wave (CW) or similar carrier, or perhaps an analog TV channel's visual carrier.

Analog

Managing ingress when the cable network's payload consists of analog TV channels is pretty straightforward. First, discrete carrier-type ingress from paging transmitters, two-way radios, and the like tends to show up as lines in the picture of the affected cable channel. Ingress from an over-the-air analog TV channel may manifest itself as a leading-edge ghost if the over-the-air channel is the same frequency and video content as the channel being interfered with. (Analog TV ingress on phaselocked channels also shows up as ghosting, but the ghost image may be different than the cable channel's video, depending on the cable channel source video.) If the interfering over-the-air TV channel has a slightly different frequency than the cable channel, beats may appear in the picture. Over the years, we've learned to use leakage detectors, spectrum analyzers, and other tools to troubleshoot downstream ingress.

All-digital

How can we sort out ingress problems when the cable network is all-digital?

It depends.

Among the "it depends" factors is the type of over-the-air signal that is making its way into the plant. Let's first look at discrete carriers from the previously mentioned paging transmitters or two-way radios. When a discrete interfering carrier falls in a QAM channel, it can degrade modulation error ratio (MER), bit error rate (BER), and possibly show up in the constellation as the so-called donut pattern. The interfering carrier may or may not appear higher than the QAM signal's haystack on a spectrum analyzer. Indeed, it may be covered up by the haystack!

Let's say a downstream QAM signal on cable Ch. 19 (150-156 MHz) is being affected by ingress from a two-way radio signal in the 151 MHz range. Some subscribers in the service area of a node in which the radio transmitter is located are complaining about intermittent tiling and other problems on all of the video streams carried on Ch. 19. No other channel is affected.

A little preliminary sleuthing indicates that Ch. 19 is fine in the headend and at the node's downstream test point. We now know where the problem is and where it isn't, so it's time to divide-and-conquer. Go to a point in the node's service area that is halfway between the node and where subs have reported problems. A quick check with a QAM analyzer tuned to Ch. 19 shows degraded BER and MER, while other QAM channels seem to be OK. This suggests that the ingress - or at least some of it - is getting in the plant between the node and this first halfway point. How can we be sure if ingress is causing the observed BER and MER degradation?

If your QAM analyzer supports measuring junk under the haystack, take advantage of that feature. At least two test equipment manufacturers I'm aware of offer this capability in some of their instruments: JDSU calls it QAM ingress, and Trilithic calls it QAM EVS (error vector spectrum).

In a nutshell, this function allows one to see a representation of the haystack's underlying noise floor. A discrete ingressor ought to be obvious. Be aware that you might also see what appears to be a small beat exactly at the center of the QAM channel near the noise floor. This is supposed to be there - it's the QAM signal's suppressed carrier. For our Ch. 19 example, the suppressed carrier is at 153 MHz.

If the affected channel is 64-QAM, the two-way radio signal may cause the QAM analyzer's constellation symbol landings to look like small donuts, depending in part on the amplitude of the ingressor relative to the haystack's amplitude. With 256-QAM, the donuts are harder to see because of the constellation's much smaller decision boundaries. By the time an ingressor is high enough amplitude to cause the donut pattern in a 256-QAM constellation, the channel is toast.

All right, we've confirmed that what we're seeing on the QAM analyzer indicates ingress. The next stop is a point halfway between the node and the first halfway point. If the interference is not present there, it's getting in somewhere between that second halfway point and the original halfway point. Keep dividing the plant into smaller and smaller half segments until the source or sources of ingress have been identified. Use your plant's dedicated leakage detection carrier and your leakage detector to try to nail down the leak locations, which likely will also be where ingress is getting in. Keep in mind that ingress often enters the plant via several low-level points, not a single high-level point.

DTV ingress

What if the ingressor is an over-the-air digital TV channel? How will a broadcaster's 8-VSB (vestigial sideband) signal affect the QAM signals in our plant? First, because 8-VSB is noiselike, the ingressing signal will have the same effect as reducing the carrier-to-noise ratio (CNR) on the affected cable channel(s). This will cause degraded MER and perhaps also poor BER. The constellation's symbol landings will be fuzzy.

If the over-the-air DTV channel is in the VHF low or high band, the 8-VSB signal probably will affect just the equivalent cable channel. If the ingressor is in the UHF band, the 2 MHz overlap between over-the-air UHF channels and cable channels means that one over-the-air channel may affect two adjacent cable channels! This is discussed in my January column at www.cable360.net/ct/operations/bestpractices/33177.html.

Tracking down the location(s) where DTV ingress is entering the plant may get a little tricky, although the divide-and-conquer technique is arguably the best approach. Look for degraded MER and/or BER on the affected cable channel(s) and also fuzzier than normal constellation symbol landings - sorry, no donut patterns with a noise-like ingressor - to discern potential DTV ingress. I've not tried to look for a culprit 8-VSB signal under the haystack with a QAM analyzer that supports this function, nor am I certain it would even work. Evaluating BER, MER, and the constellation display will be the best bet.

When troubleshooting potential downstream ingress of any kind, don't rule out checking the over-the-air spectrum to see if the suspected ingressor is present there.

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.