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UPSTREAM 64-QAM SUCCESS STORY

By RON HRANAC

My September 2002 CT column, "16-QAM Success Story," started out with the following introduction:

"It works great in the lab, but forget trying it in a real network."

"QPSK barely works in my system, so there's no way I can do 16-QAM."

"We tried 16-QAM, but the packet loss was unacceptable."

Do these comments sound familiar? The idea of switching from quadrature phase shift keying (QPSK) to 16-QAM (quadrature amplitude modulation) can be a daunting one ….

Fast forward to today, and substitute 64-QAM for 16-QAM in the above intro. Using 6.4 MHz channel bandwidth. Not in the lab, but in a system with paying subscribers.

Upstream 6.4 MHz bandwidth 64-QAM? Yep.

It's for real

I can already hear the wailing and gnashing of teeth. But it's real, and problem-free, in a half dozen nodes in one of a Midwestern cable operator's systems. The secret? Good ol' Cable 101. I had a lengthy chat with the company's senior RF engineer about their upstream 64-QAM deployment. Describing this particular top-25 MSO as a "quiet achiever," he asked me to not divulge names or specific locations, but said OK to sharing their success story. Fair enough.

The company's systems were built with a two-way 860 MHz HFC architecture. The average number of homes passed per fiber node is about 600, although in some cases - including those with upstream 64-QAM - node splits have resulted in around 400 homes passed per node. Subscriber drops are mostly tri-shield, with some quad-shield in problem areas. F-connectors are of the compression crimp variety. High-pass filters are not used. The upstream carrier-to-junk ratio is maintained in the 35 to 40 dB range over the roughly 18 to 42 MHz portion of the spectrum. The company has a comprehensive preventive maintenance program in place (more on this in a moment), and its cable modem service uses 256-QAM downstream and 16-QAM upstream digitally modulated signals in all of its systems. The exception to the latter is where upstream 64-QAM has been rolled out, of course.

5-45 MHz upstream spectrum screen capture from one of the nodes carrying a 6.4 MHZ wide 64-QAM signal. The 21.6 MHz "haystack" is near the center of the display. The tall carrier near 9 MHz is set-top box return, and the group of carriers centered near 33 MHz is for the system's circuit-switched telephony service.

What it takes

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To understand what it takes to make upstream 64-QAM work, we have to go back a few years to when a decision was made by this cable operator to get serious about preventive maintenance. The plan: Forward and reverse plant in all systems swept every 18 months; all nodes certified for proper operation and fiber link alignment every 18 months; ends-of-line checked; all power supplies visited at least every nine months; the corporate spec for signal leakage was set at 5 microvolts per meter, although the general rule-of-thumb was and is if any leak is found, fix it. Trilithic leakage detectors with the channel tag option are used, and the tagging helps minimize chasing noncable noise from "the traffic light two blocks away." JDSU's PathTrak is employed to monitor all full service nodes. And training. Lots of it. The result of all of this? After about the first two- to two-and-a-half years of the PM program, service calls dropped some 85 percent to 90 percent.

When it came time to move from QPSK to 16-QAM, the comprehensive maintenance practices and aggressive leakage monitoring and repair played a huge role in being able to do so. The company used Sunrise Telecom's upstream characterization toolkit to qualify the plant's ability to support upstream 16-QAM. All high transmit level modems (+55 dBmV and greater) were identified, and problems causing the high upstream levels were fixed. The cable modem termination systems (CMTSs) - equipped with DOCSIS 2.0 advanced physical layer (PHY) technology - can report a variety of parameters. These include Flap List, uncorrectable vs. correctable forward error correction (FEC) errors, upstream "SNR" (actually modulation error ratio, or MER), etc., all of which were monitored, problems identified and taken care of.

Back to the present: Downstream 256-QAM and upstream 16-QAM are working well. The occasional gremlin - ingress, crummy carrier-to-noise (CNR), whatever - that crops up is fixed as necessary.

Upstream 64-QAM

What about upstream 64-QAM? Since a substantial amount of work had already been done to make 16-QAM play nice, it didn't take a whole lot of additional effort for 64-QAM. Prior to rolling it out, each of the six nodes was driven out, and leaks greater than about 2 microvolts per meter eliminated. PathTrak was monitored closely and CMTS reported parameters double-checked. All modems in each of the six nodes were verified to be DOCSIS 2.0 versions, and any high transmit level modems, as before, were taken care of. When all seemed ready to go, the switch was flipped, and a 6.4 MHz wide 64-QAM signal centered at 21.6 MHz began transmitting upstream data from subscribers' modems. The screenshot above shows one of the upstreams with the 64-QAM signal. The cable operator's senior RF engineer told me that about 95 percent of the upstreams company-wide are this clean. The CMTSs' reported upstream MER for the six nodes averages 30 dB (unequalized).

To date, upstream 64-QAM operation in the six nodes has been problem-free, and pre-equalization has not been necessary. As of this writing, two additional nodes were pending a move from 16-QAM to 64-QAM.

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