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CMTS UPSTREAM SNR REVISITED

By RON HRANAC

There was an interesting thread on the SCTE-List recently about cable modem termination system (CMTS) upstream signal-to-noise ratio (SNR). One cable operator reported having difficulty "obtaining upstream SNRs above the 25-26 dB range, even with plant that is node+1." He went on to ask, "Does anyone have any suggestions on how to move to the 28-30 dB level?" Someone else wondered whether there is some reliance one can place on anomalies being reported by the CMTS as faulty, using only the SNR reading. I jumped right in the middle of the discussion, and my SCTE-List comments serve as the basis for this month's column.

For background on this subject, I encourage you to take a look at the following Communications Technology columns:

"CNR vs. SNR"

www.ct-magazine.com/archives/ct/0303/0303_broadband.html

"Spectrum Analyzer CNR vs. CMTS SNR"

www.ct-magazine.com/archives/ct/0903/0903_broadband.html

"More on CMTS SNR"

www.ct-magazine.com/archives/ct/1003/1003_broadband.html

It's only an estimate

There is, unfortunately, way too much reliance put on a CMTS's upstream SNR estimate, which is really modulation error ratio (MER). One thing to remember is that this parameter is not the same as carrier-to-noise ratio (CNR) that one might measure with a spectrum analyzer.

The upstream burst receiver chips used in all CMTSs are capable of doing a variety of measurements such as SNR (I'm going to call it MER for the rest of this column), but those chips aren't the equivalent of a $90,000 vector signal analyzer. Upstream MER should be used in conjunction with other measured parameters—packet loss, bit error rate (BER), codeword error rate, the CMTS's flap list, uncorrectable vs. correctable forward error correction (FEC) errors, and even looking at the upstream on a spectrum analyzer from time to time—to characterize the health of the digitally modulated signal and the cable network. One cannot rely upon just the MER estimate.

What it tells, what it doesn't

Let's first assume that the upstream MER estimate provided by a CMTS is reasonably accurate. (There are several limitations to its accuracy, which I'll discuss in a moment.) Looking at the reported value for what it is—modulation error ratio—a low value might tell us that something is amiss.

What a low MER value doesn't tell us is what caused it to be low in the first place. This is true in the case of both upstream and downstream MER measurements. Low MER might be caused by low CNR, but it also might be caused by excessive phase noise in the data transmitter(s) at the other end; excessive nonlinear distortions in the transmission path (composite triple beat, composite second order, common path distortion, cross-modulation, etc.); in-channel ingress; excessive linear distortions in the transmission path (one or more micro-reflections, in-channel amplitude tilt or ripple—basically crummy frequency response, and/or group delay); and so forth.

As I've noted on a number of occasions, linear distortions cannot be seen on a conventional spectrum analyzer. It's not unusual to have low MER, yet the CNR and signal levels are just fine. Specialized test equipment is required to see if linear distortions are causing low MER.

For more on this, take a look at the two-part article that appeared in the July and August 2005 issues:

"Linear Distortions, Part 1"

www.ct-magazine.com/archives/ct/0705/0705_lineardistortions.htm

"Linear Distortions, Part 2"

www.ct-magazine.com/archives/ct/0805/0805_lineardistortions.htm

Chip limitations

A CMTS's upstream MER estimate may be low for reasons other than the previously described plant impairments. Considering the way a CMTS's upstream burst receiver chips make MER measurements, it's important to understand the limitations of those chips. Depending on chipset vendor and the design of the chip, the MER estimate's accuracy may be specified for an additive white Gaussian noise (AWGN) environment only, and then only when the actual CNR is within a defined range of values—say, 15 dB to 25 dB. Outside of the defined range of CNR values, the MER accuracy may or may not be affected. Linear distortions may or may not affect the CMTS's MER estimate, depending on the chip's design. Furthermore, the MER estimate may be dependent upon the number of modems connected to a CMTS upstream port and their actual data traffic. Heck, even the vintage of the upstream burst receiver chip may affect the MER accuracy. Newer chip designs tend to be more accurate.

The nature of MER

Since MER is a baseband measurement, anything that affects demodulation of the upstream digitally modulated signal also may affect the MER estimate. This includes data collisions, cable modem modulation profiles, and even the upstream combiner/splitter network's performance. Data collisions, for example, are part of the world of DOCSIS cable modems (during contention slots). Under certain traffic conditions with a lot of data collisions, the burst receiver chip's MER estimate may be affected. The plant and digital signal may be just fine, and cable modems and the CMTS may be OK, too, yet the MER appears to be low.

Because of the way MER is defined, transient impairments such as impulse or burst noise, sweep transmitter interference, etc., generally won't affect the measured value. This suggests that it's possible to have good MER, yet still have packet loss and degraded BER. For this reason, it's important to use upstream MER measurements in conjunction with other performance parameters (CMTS flap list, packet loss, uncorrectable vs. correctable FEC errors, etc.). I like to think of upstream MER as just one tool of many in the toolbox.

Rather than track absolute values of MER—assuming the value is above the unequalized MER failure threshold for the modulation type in use, of course—it's better to track relative trends. For instance, if a given CMTS upstream port's MER averages, say, 26 dB most of the time—and there are no packet loss, flap list,

uncorrectable vs. correctable FEC errors or similar problems—then the 26 dB value may be normal and acceptable for that upstream signal. But if we see that value change abruptly or perhaps over time, then we should find out why.

The bottom line, though, is that a CMTS's upstream MER estimate should not be the ONLY parameter measured. It simply doesn't tell the whole story.

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