Knowing the quality of our digital signals is very important.

Diagram 7, shows the theoretical bit error rate before and after the set-top boxes' forward error correction system.

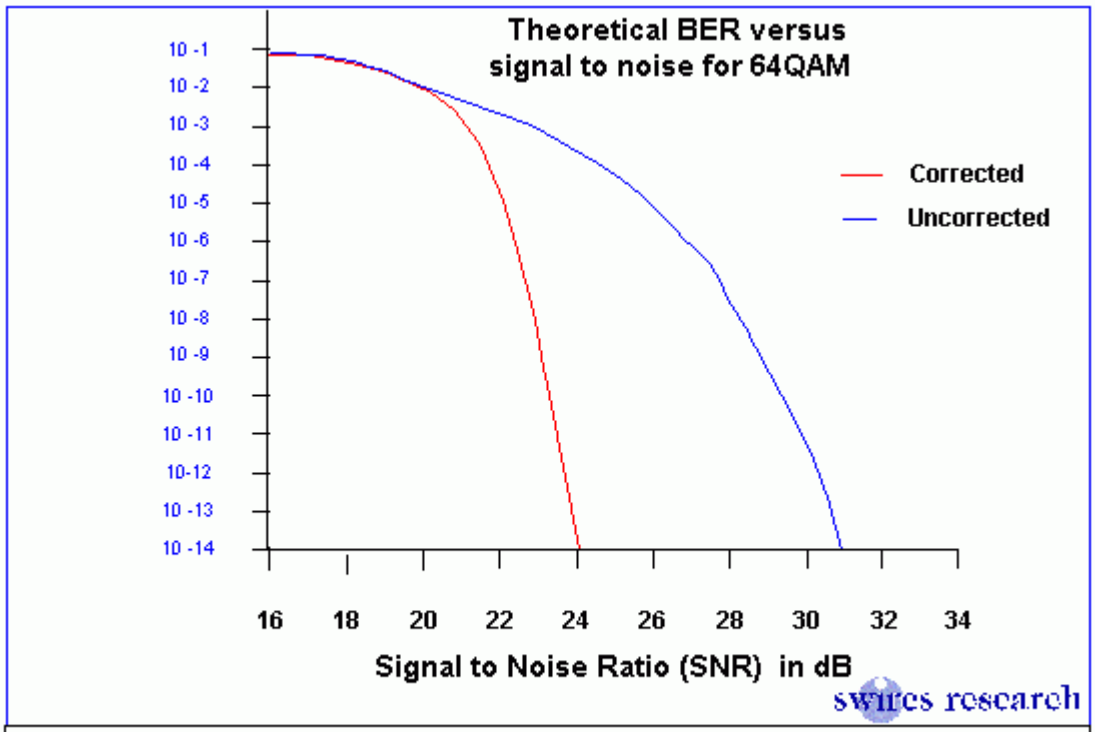

Diagram 7: Signal to Noise Ratio versus Bit Error Rate

It is well known that the digital signal does not degrade gracefully - At one moment it can be almost perfect and then fail totally without warning. This point of system failure has been accurately determined as the second half of the world cup final! Scientifically it occurs when the uncorrected Bit Error Rate (BER) falls below 1 x 10-4.

To remedy this each field instruments could be equipped with a QAM demodulator to indicate bit error rate. Though the demodulator would have to be of a very high quality with very low phase noise, if it is to be of value as a measuring tool, and adding a demodulator adds to the cost, power consumption and weight of the instrument.

If measurements were also to be made of terrestrial COFDM and satellite QPSK digital signals, separate demodulators would also have to be added for each of the standards.

As an alternative to BER, Signal to Noise Ratio (SNR) measurements can be made. By far the greatest cause of degradation of BER of a digital signal passing through a network is noise degradation.

Measuring the SNR has the advantage of showing the quality of the cable network rather than the quality of the digital signal itself. Should the digital signal contain degradation due to a problem in the head-end this would show in the BER measurement taken down the network even though the network is operating perfectly.

A caution should be inserted at this point. Many analogue signal level meters have a carrier to noise or signal to noise button. When this automated measurement is used it makes a correction for the bandwidth of the TV signal. This correction is not required for digital signals as noise to noise signals are being measured and the bandwidth effectively cancels out. A wrong reading will result if an instrument with an in-built signal to noise measurement system designed for analogue TV use is employed for digital signal to noise measurements.

BER is not easy to relate to the margins that are required on a cable system, the numbers are cumbersome and 1.0 * 10-9 does not intuitively indicate a network margin.

Even the best quality demodulators will only enable measurements down to 1.0 * 10-10. This represents a signal to noise ratio of only 29 dB and at a 25 dB SNR the decoder may fail (a margin of only 5 dB.) So if a network has a SNR of 29 dB or 40 dB the bit error rate reading will show 1.0 * 10-10.

Back

The time required to make significant BER measurements

The number of bit errors per second can be readily computed:

Errors per second = data rate * bit error rate.

At a bit error rate of 1.0 E-4 the generally agreed quasi error free point (just before it all falls over);

= 38.15 E 6 * 1.0 E-4 = 3,815 errors per second.

N.B. 38.15 E6 bits per second has been taken as a typical QAM data rate

However at a bit error rate of 1.0 E-10

= 38.15 E 6 * 1.0 E-10 = 0.0038 errors per second or 13 errors per hour.

To get a statistical significant number an error count of at least 50 errors is needed.

With a BER of 1.0 E-9 there are 2.28 errors per minute, so about 20 minutes to

collect significant data is needed, or 3.8 hours with a BER of 1.0 E-10.

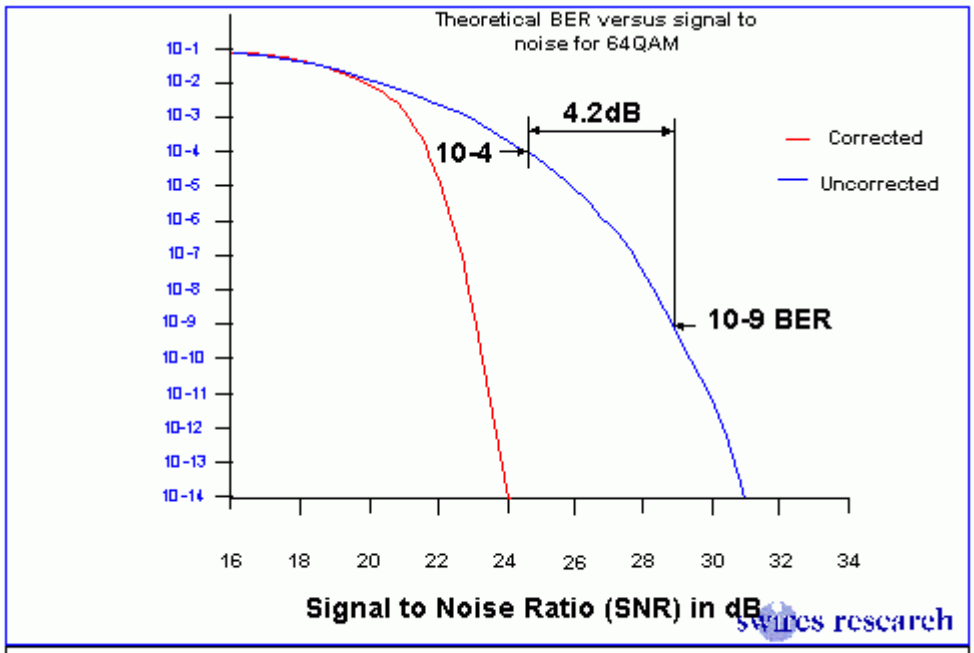

Diagram 8: Signal to Noise Ratio versus Bit Error Rate

Diagram 8 shows that the difference in signal to noise ratio between the maximum error rate of 1.0 E 10-4 and 1.0 E 10-9 is only a signal to noise ratio difference of 4.2 dB. So all that is known from the 20 minute wait for a BER reading is that the noise margin on our system is better than 4.2 dB. No matter how good the system, the margin is not known.

Clearly, although BER is a valuable method in the lab or at the headend where equipment can be set up for several hours if necessary, it does not tell us enough about the system margin down the network to enable preventative maintenance.

A great deal of research has shown that by far the primary cause of degradation of BER is due to noise and that the relationship between SNR and BER is reliable.