AXTIR calculations for discussion:

Following the methodology of *Diminico_1_0104.pdf:*

• Shannon capacity is a useful figure of merit for 10GBASE-T channels
• For 10GBASE-T available channel capacity can be approximated by a ratio of insertion loss (IL) to alien crosstalk (AXTIR).
• Other impairments (echo, NEXT, FEXT, etc) are cancelable to such an extent that they are negligable.

Therefore:

10GBASE-T Channel Capacity

$$Pair\_Capacity = \int_{f_{MIN}}^{f_{MAX}} \log_2(1 + SNR(f))df$$

Where ***SNR(f)*** is absolute magnitude ratio (V/V)
Where ***SNR(f) = AXTIR(f) = IL_Channel – PSANEXT_Channel***

• 18 Gb/s minimum target capacity for 10GBASE-T on four-pair cable

Table 1. Class E PSANEXT Calculations

15 dB slope			
Length	PSANEXT	BW	shcap
55	49.6	625	18
100	64.6	625	18

Table 2. Class F(IL) PSANEXT Calculations

15 dB slope			
Length	PSANEXT	BW	shcap
55	48.1	625	18
100	62.4	625	18

However, there are other considerations in terms of the capacity calculation. From Larry Cohen's presentation to TIA TR42.7 in February[1] the capacity is bounded by the receiver SNR .

[1] TR42.7-04-02-012-10GBT-Deployment-release_Cohen.pdf

- Most important figure of merit for **real systems** is minimum receiver SNR
- Required channel capacity varies with channel length, line code, and AXTIR shape for constant receiver SNR constraint.[2]

The following chart from slide 9 of Cohen shows a calculation of the required PSANEXT Versus Channel length for three line code options.

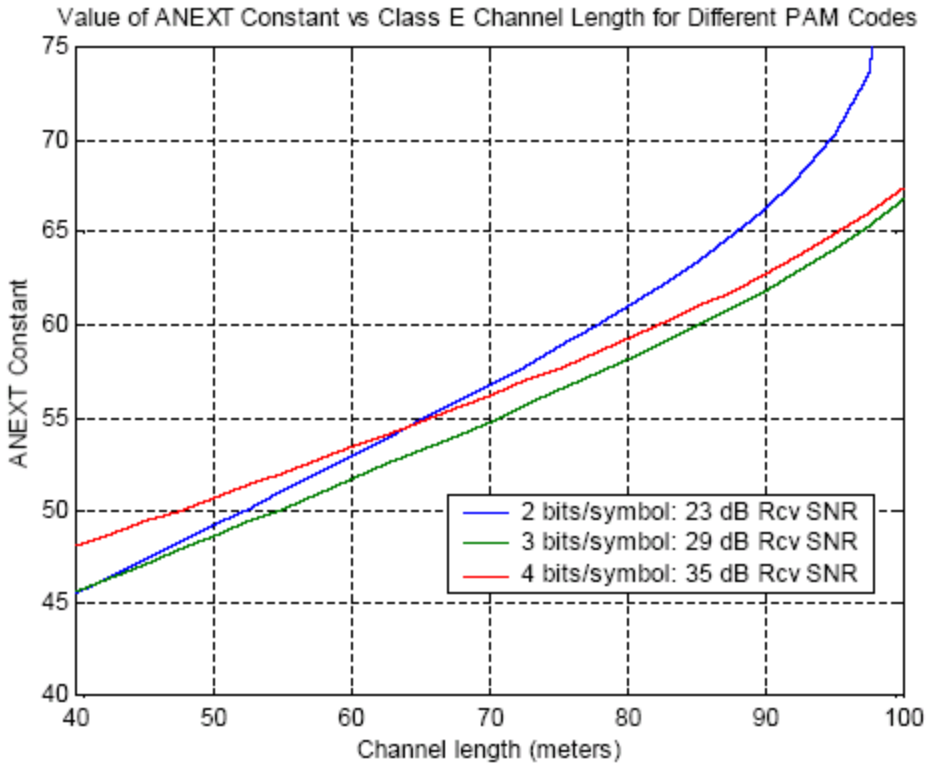

Figure 1. Value of ANEXT Coupling Constant (Y) with Constant SNR Constraint (from Cohen slide 9)

- ANEXT = Y +15*log10(f/100),
where Y is adjusted to produce target receive SNR
- Target SNR includes:
- BER = 10e-12
- 5.5 dB coding gain
- 3 dB margin
- Impairments:
- Echo = 55 dB
- NEXT = 40 dB
- FEXT = 25 dB
- Noise = -150 dBm/Hz
- Transmit power = 8 dBm

[2] TR42.7-04-02-012-10GBT-Deployment-release_Cohen.pdf

Based upon the above calculation of PSANEXT level needed for 4 bit per symbol and 3 bit per symbol encoding, the equivalent shannon capacity can be predicted by the simplified calculation.

Table 3. Equivalent Capacity bounded by receiver SNR

Length	PSANEXT 4b/s	AXTIR Capacity	Model Capacity	PSANEXT 3b/s	AXTIR Capacity	Model Capacity
55	52.0	19.8	19.6	50	18.3	18.1
100	67.5	19.6	16.6	66.8	19.3	16.4

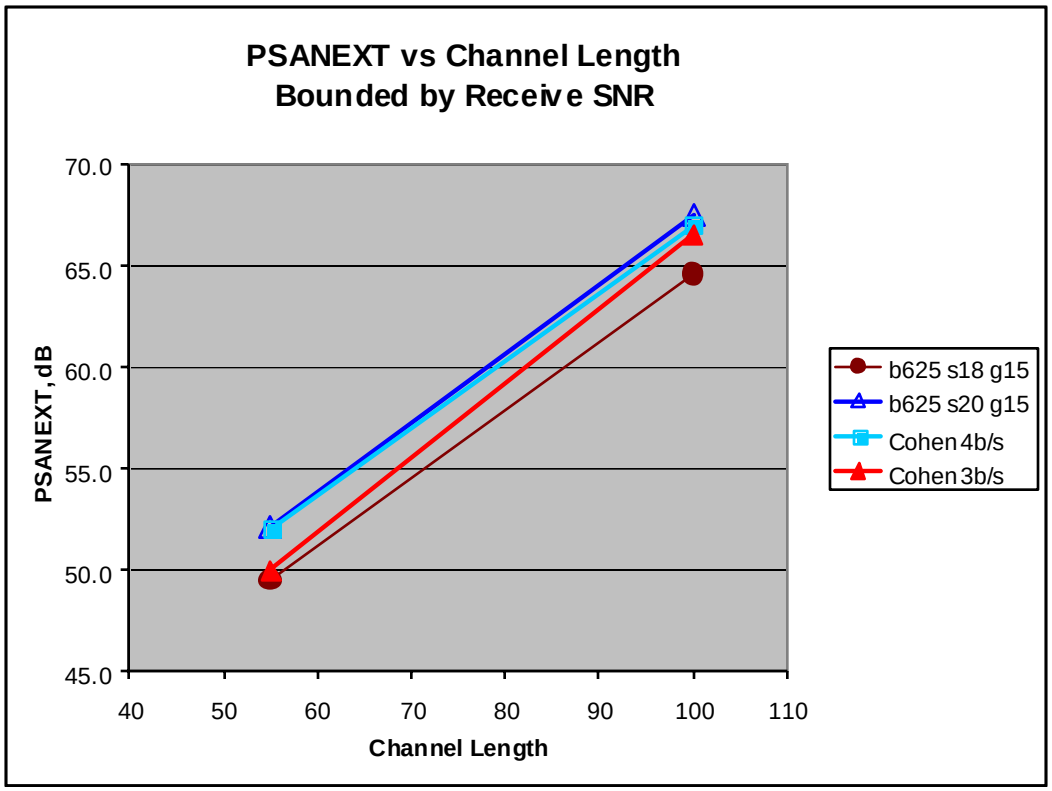

Figure 2. PSANEXT Calculations for 55 and 100m Bounded by Reciver SNR

Combining the results from the receiver bounded SNR caluculations and the AXTIR based capacity calculations shows that the basic calculation using 625 MHz bandwidth, 15 dB PSANEXT slope and 20 Gb capacity tracks the 4 b/s SNR bounded calculation quite well, while the calculation based upon 18 Gb capacity falls below the 4 b/s result at both 55 and 100 meters and below the 3 b/s result at 100 meters. Also from Table 3, we can see that the AXTIR based capacity calculation is a relatively good predictor at 55 meters, but over estimates the capacity by approximately 3 Gb/s at 100 meter lengths. It is probably more realistic then to use SNR bounded capacity esimate rather than 18 for the simplified calculation based upon AXTIR at 100 meters. Since the 3 b/s coding results in slightly lower ANEXT requirements, I will focus on that solution.

Table 4. Class E PSANEXT Calculations SNR bound 3b/s

Length	PSANEXT	BW	AXTIR capacity
55	50.0	625	18.3
100	66.5	625	19.3

Table 5. Class F(IL) PSANEXT Calculations SNR bound 3b/s

Length	PSANEXT	BW	AXTIR capacity
55	48.5	625	18.3
100	64.2	625	19.3

For establishing limits, the metric proposed by Trent Hayes (SYSTIMAX) may be used, which derates the above values by 2.5 dB. When testing, the PSANEXT peak values must be below the derated limit. Therefore Tables 1, 2, 4, and 5 become:

Table 8. Class E PSANEXT SNR bound 3b/s

Length	PSANEXT	BW	AXTIR capacity
55	47.5	625	18.3
100	64.0	625	19.3

Table 9. Class F (IL) PSANEXT SNR bound 3b/s

Length	PSANEXT	BW	AXTIR capacity
55	46	625	18.3
100	61.7	625	19.3

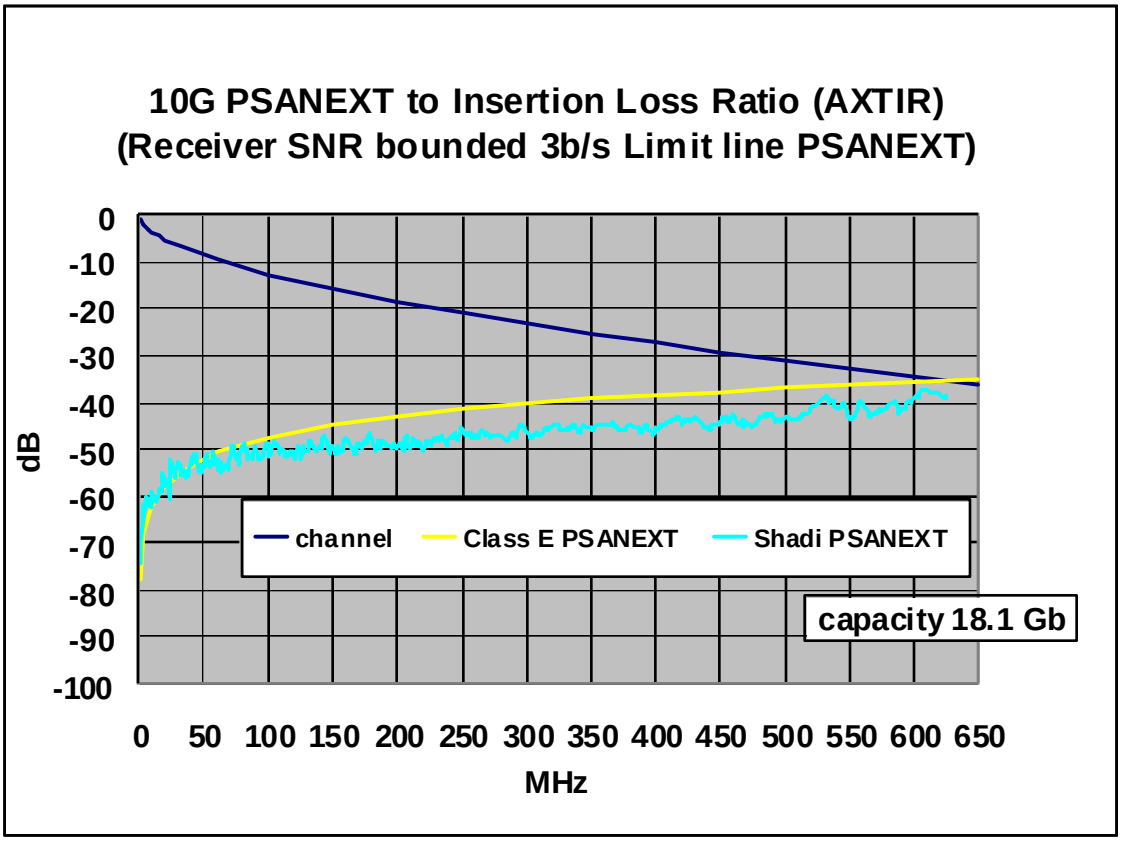

Figure 3. 55m Class E AXTIR with Limit line PSANEXT

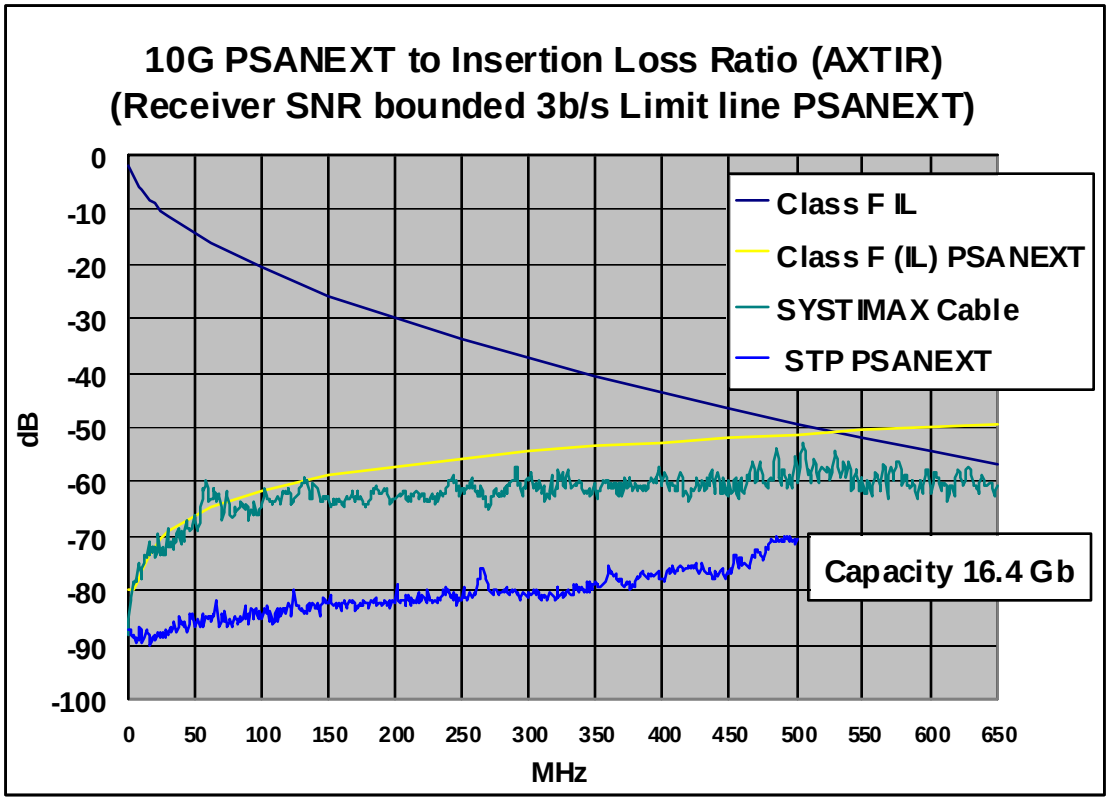

Figure 4. 100m Class F(IL) AXTIR with Limit line PSANEXT