

Error performance objective for 400GbE

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Introduction

The York presentation [anslow 400 01 0913](#) proposed to set a two part error performance objective. One part would cover PHYs that utilise FEC (with an objective equivalent to 1E-15 BER) and the other part for PHYs that do not utilise FEC (with an objective of 1E-13 BER). The proposed objectives were:

For PHYs that utilise FEC, support a frame loss ratio for 64-octet frames of better than or equal to 6.2×10^{-13}

For PHYs that do not utilise FEC, support BER better than or equal to 10^{-13} at the MAC/PLS service interface

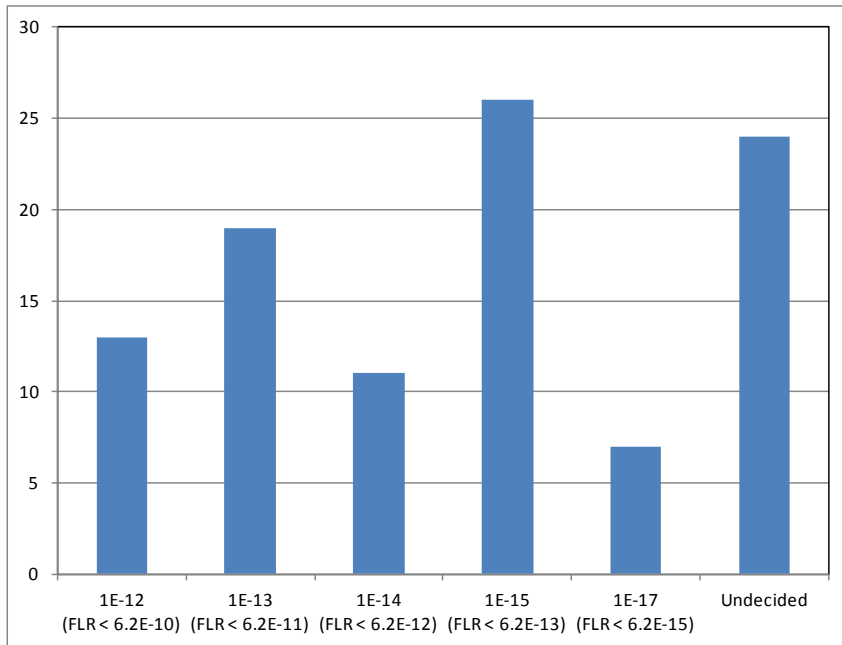
During the discussion of this presentation, views were expressed that the error performance objective should be based on the needs of the applications rather than the capability of the solution.

Subsequent to this presentation, two straw polls of the Study Group related to the error performance objective were taken, the results of which are shown on the next slide.

York straw polls

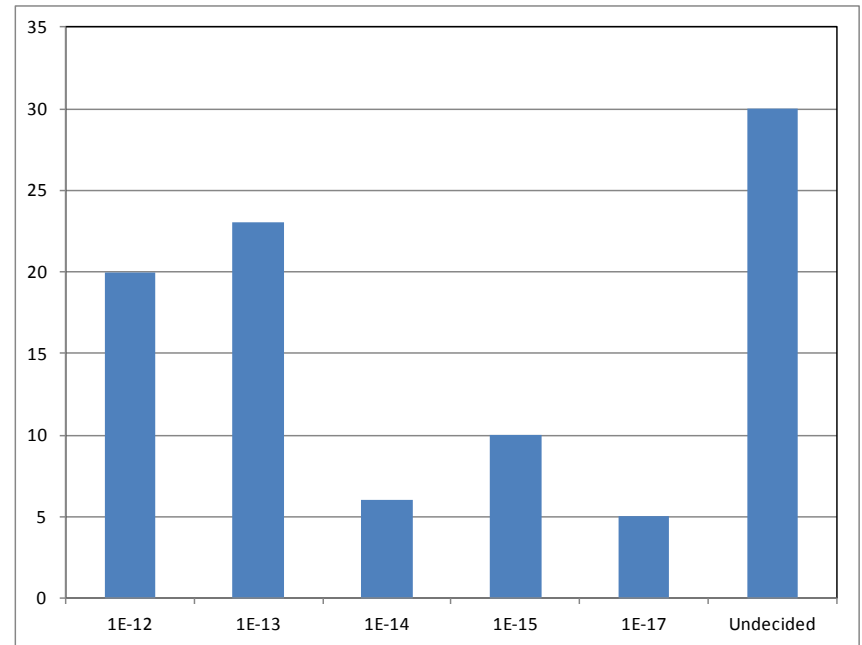
Straw poll #1

I would support an error performance objective (expressed as a FLR) for PHYs that utilize FEC that is equivalent to a BER of: (Chicago rules)



Straw poll #2

I would support an error performance objective for PHYs that do not utilize FEC that is equivalent to a BER of: (Chicago rules)



One performance objective or two?

Generating a proposed set of objectives containing a two part error performance objective (one for PHYs that use FEC and another for PHYs that don't) may attract adverse comment from members of the Working Group on the grounds that the objectives should be driven by needs rather than implementation capability.

Straw poll #1 from the York meeting showed highest support for an objective equivalent to a BER of $1E-15$ for PHYs that utilise FEC with the second highest support being for $1E-13$.

Straw poll #2 from York showed highest support for an objective equivalent to a BER of $1E-13$ for PHYs that do not utilise FEC with the second highest support for $1E-12$ with $1E-15$ coming third.

If the Study Group concludes that proposing a two part error performance objective would be too controversial, then since an objective equivalent to a BER of $1E-13$ gained most support in Straw poll #2 and second most support in Straw poll #1, this seems like the best choice for a single error performance objective.

BER verification

PMDs with FEC

For routine measurement of modules that don't contain the FEC decoder, obtaining the pre-FEC BER should be ok. However this would have to be backed up with at least occasional verification that the error statistics are such that the post FEC BER is met. The easiest way to do this is apply the FEC decoder and count errors or lost frames.

PMDs without FEC

Here extrapolation from measurements at $1E-12$ and above could be used to indicate the expected performance to lower BER, but this would also have to be backed up with at least occasional measurement down to the BER target.

Some customers may insist on measurement down to the BER target to ensure that there isn't a hidden error floor.

BER measurement times

To obtain a reasonable estimate of the BER when the PHY is making some errors it is necessary to measure at least 10 errors. The time taken to do this at 400 Gb/s is:

BER	Time
1E-12	25 seconds
1E-13	4 minutes
1E-15	7 hours

If the PHY does not make any errors then using Equation 9-11 from ITU-T [G.Sup39](#):

$$n = \frac{\log(1 - C)}{\log(1 - P_E)}$$

Where:

- n is the required number of error free bits
- C is the confidence level (e.g., 0.95 for 95% confidence)
- P_E is the BER requirement (e.g., 10^{-12})

Then the time taken for 95% confidence that the BER is below the requirement is:

BER	Time
1E-12	7.5 seconds
1E-13	1.25 minutes
1E-15	2 hours

FLR from BER

The BERs discussed previously can be translated using the analysis given in [anslow_01_0613_logic](#) to the equivalent Frame Loss Ratios for 64-octet frames with minimum interpacket gap - according to the definition being introduced by P802.3bj and being used by P802.3bm:

1.4.210a frame loss ratio: The number of transmitted frames not received as valid by the MAC divided by the total number of transmitted frames.

This gives:

BER	FLR
10^{-12}	6.2×10^{-10}
10^{-13}	6.2×10^{-11}
10^{-15}	6.2×10^{-13}

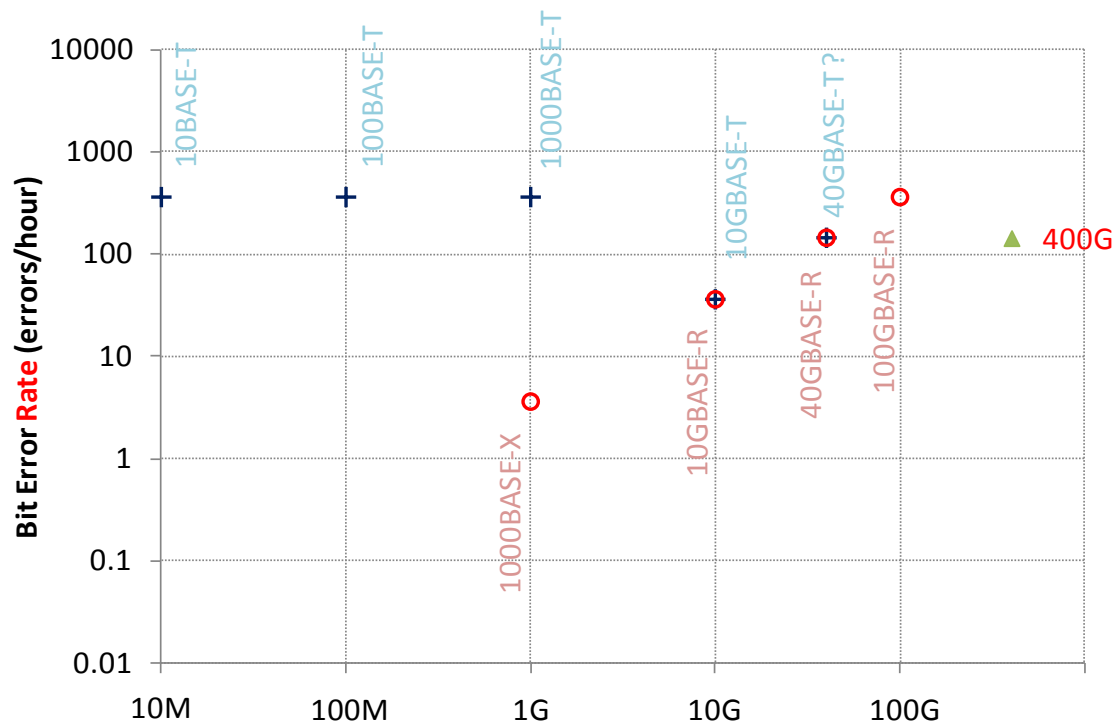
However, most people are much more familiar with BER values than they are with FLR so it has been proposed that a single error performance objective could be phrased as:

Support a BER of better than or equal to 10^{-x} at the MAC/PLS service interface (or the frame loss ratio equivalent of better than 6.2×10^{-y} for 64-octet frames)

Conclusion

Since we cannot decide that all PHYs will use FEC in the Study Group phase the error performance objective should be set so as to not burden any non-FEC PHYs with costly measurements:

Support a BER of better than or equal to 10^{-13} at the MAC/PLS service interface (or the frame loss ratio equivalent of better than 6.2×10^{-11} for 64-octet frames)



Thanks!