Clause 175 1.6TBASE-R hi_ser Timing and Codeword Count

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Overview

A comment regarding timing was submitted in 802.3dj d2.3

- The comment was deemed out of scope, based on the lack of previous comments on this clause
- There was a request to resubmit in SA ballot if this was still a desired change

Response was that this required more discussion

Initial response from editorial team was that the proposed change wasn't useful:
https://www.ieee802.org/3/dj/public/26_01/opsasnick_3dj_01b_2601.pdf

The intent of this contribution is to provide details of the request and justification

What time is appropriate?

The editorial response was that moving to a faster time is desirable as rates increase to reduce probability of false packet acceptance

Alternatively, a faster time provides a higher probability of an erroneous hi_ser

Prior to FEC, hi_ber was based on counts of invalid sync-headers in a defined time-window

Evolution of hi_ber time windows contradicts the idea that the intent is to reduce time as rates increase

- Increase in time for 40-100GbE was to avoid raising hi_ber from short bursts

Ethernet Speed	Clause	hi_ber Threshold (SH errors)	Time Window
10GBASE-R	49	16	125 µs
40GBASE-R	82	97	1.25 ms
100GBASE-R	82	97	500 µs

https://www.ieee802.org/3/ba/public/nov08/gustlin_03_1108.pdf#page=15

Hi_SER timing

Historically hi_ser used 8192 codewords as the interval to raise hi_ser

- The Aligment Marker period of the RS FEC (clause 91) is 4k codewords
- The hi_ser interval (clause 91) is 2 AM periods

Subsequent clauses using RS FEC always tied the hi_ser interval to an integer multiple of the AM interval

800GBASE-R (clause 172) used two parallel 400GbE instances

- Each of these was calculated independently and the results were OR’d
- 8192 codewords per FEC flow was implemented

Details on various rates

Ethernet Speed	802.3 Clause	Measurement Window (FEC Codewords)	Error Threshold (Symbol errors Symbols)	**Measurement Time (µs)**	AM Interval (CW)	AM Interval (µs)	**hi_ser Window (AM Interval)**
50GbE (1x50G)	Cl. 91/136	8,192	6,380	**838.9 µs**	1k	104.9 µs	**8 AM periods**
100GbE (4x25G)	Cl. 91	8,192	417	**419.4 µs**	4k	209.7 µs	**2 AM periods**
100GbE (2x50G)	Cl. 136	8,192	6,380	**419.4 µs**	4k	209.7 µs	**2 AM periods**
100GbE	Cl. 161	8,192	5,560	**419.4 µs**	4k	209.7 µs	**2 AM periods**
200GbE	Cl. 119	8,192	5,560	**209.7 µs**	4k	104.9 µs	**2 AM periods**
400GbE	Cl. 119	8,192	5,560	**104.9 µs**	8k	104.9 µs	**1 AM period**
800GbE (* per flow)	Cl. 172	8,192*	5,560	**104.9 µs**	8k	104.9 µs	**1 AM period**
1.6TbE (16x100G)	Cl. 175	8,192	5,560	**26.2 µs**	32k	104.9 µs	**0.25 AM periods**

This table shows details of the key parameters

Currently 1600BASE-R uses 8192 codewords, with symbol errors accumulated over all FEC instances:

Result: 1/4 of an AM period for hi_ser

Concerns with the Clause 175 implementation

No previous Ethernet rate using RS528 or RS544 FEC required a codeword counter for hi_ser

- The measurement window was always a multiple of the AM period

A counter is required for framing, however this may not be available throughout the data path.

A simplification would be to allow each FEC instance to calulate hi_ser independently

- This is consistent with 800GBASE-R
- A logical OR of each FEC flow would report hi_ser
- No logic to add symbol errors from different flows or counter is required
- More robust to short error bursts

Alternatively we could increase the CW and Symbol error counts 4x

- Threshold is unchanged, but this is less of a simplification

Modifications to improve hi_ser implementation will not change the threshold, they'll only simplify implementations

Summary

The 1600BASE-R implementation of hi_ser in clause 175 is the first time 802.3 has used a window that is not a multiple of the AM period

A logical simplification can be implemented by changing the interval to 8192 FEC codewords per FEC Flow

OR-ing signals from each flow simplifies the logic and is consistent with 800GBASE-R

Alternatively alternate implementations could be allowed, allowing both an 8192 codeword implementation along with per flow by specifying hi_ser based on 8192 - 32768 codewords

This discussion is important: How do we want to implement hi_ser moving forward?

- For implementations with multiple FEC flows, implementing hi_ser per flow simplifies logical implementation

Thanks!