Clause 175 1.6TBASE-R hi_ser Timing and Codeword Count

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Overview

A comment regarding hi_ser 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 for raising hi_ser?

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

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

Prior to RS-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

Implementation of hi_ser

Historically hi_ser used 8192 codewords as the interval to raise hi_ser

    The Aligment Marker period of the RS FEC (100GbE, clause 91) is 4k codewords

    The hi_ser interval (clause 91) is 2 AM periods

Subsequent clauses using RS FEC always used a hi_ser interval that is 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	16,384 (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 1.6TBASE-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 Codeword 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

Illustration of the proposed change

1.6TbE PCS/FEC Architecture Evolution : Rx Flow
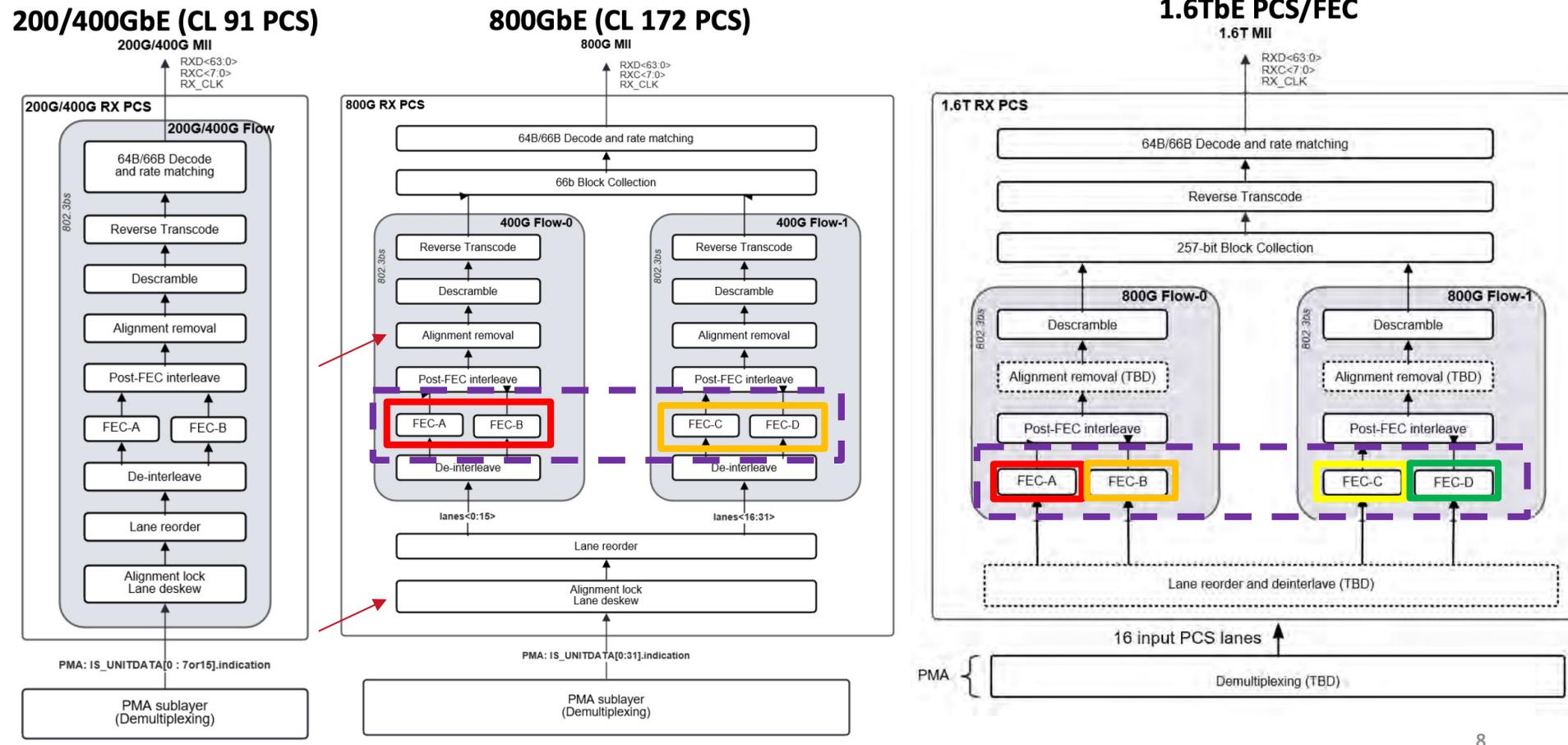
In 802.3dj hi_ser accumulated across 25% of an AM interval summed across FEC-A,B,C,D

Recommendation is to calculate hi_ser across 8192 FEC codewords per FEC instance mapped into one hi_ser report

Figure from
https://www.ieee802.org/3/dj/public/23_01/23_0206/gustlin_3dj_01b_230206.pdf

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Summary

The 1.6TBASE-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 instance

OR-ing signals from each FEC instance 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!