Generic Overview of various FEC Architectures for 200Gb/s per Lane PMD

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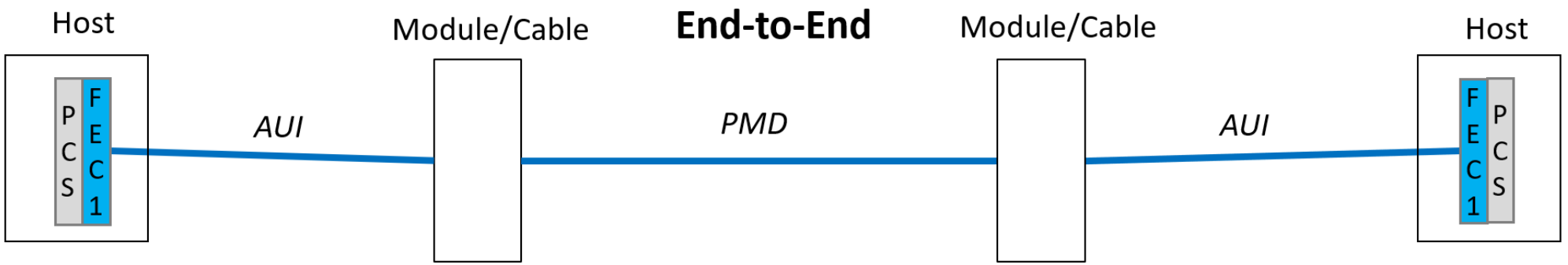
Goal of the presentation

In this presentation, we review the concatenated FEC Architecture that works in conjunction with the standard KP FEC in the host. The proposed FEC Architecture can enable both Concatenated and Segmented FEC schemes using a simple soft decision FEC that sits in the DSP SerDes inside the optical module.

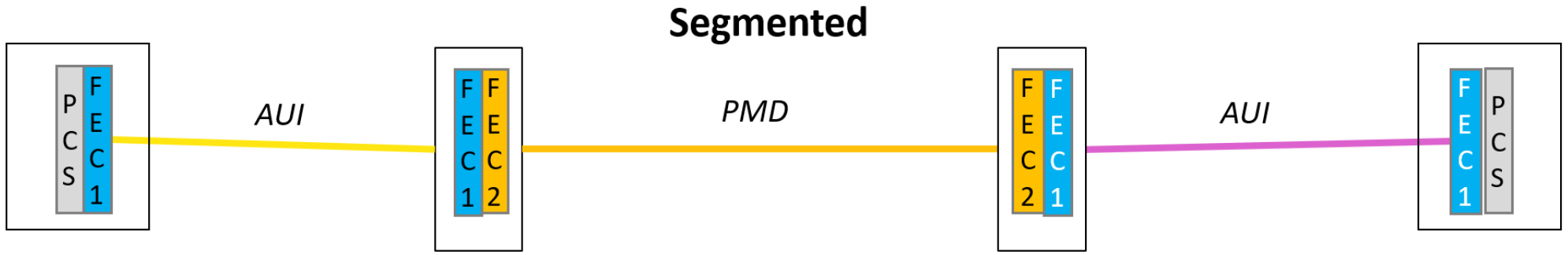
Such a soft decision FEC, when used in concatenated way, can provide overall lower latency, lower power and enough coding gain in terms of error tolerance for both the host and the line sides of the optical module.

Refresh of FEC Architecture already discussed in this forum : End-to-End, Segmented, Concatenated scheme

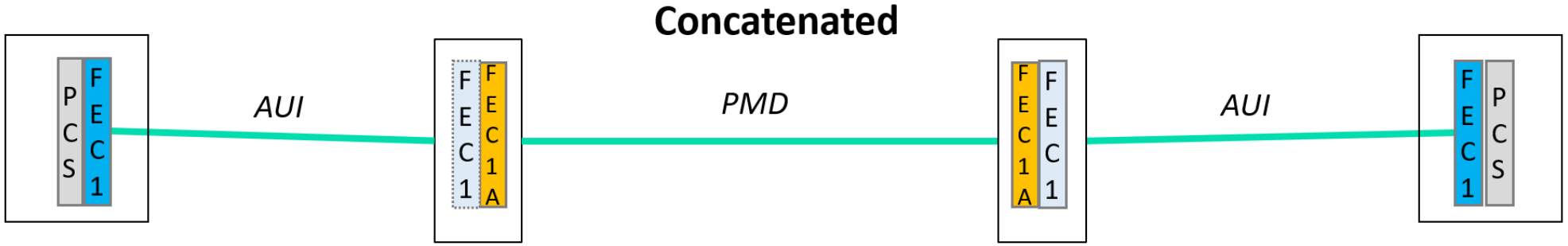
FEC 1: is end-to-end (AUI+PMD+AUI)



FEC 1: AUI only
FEC 2: PMD only

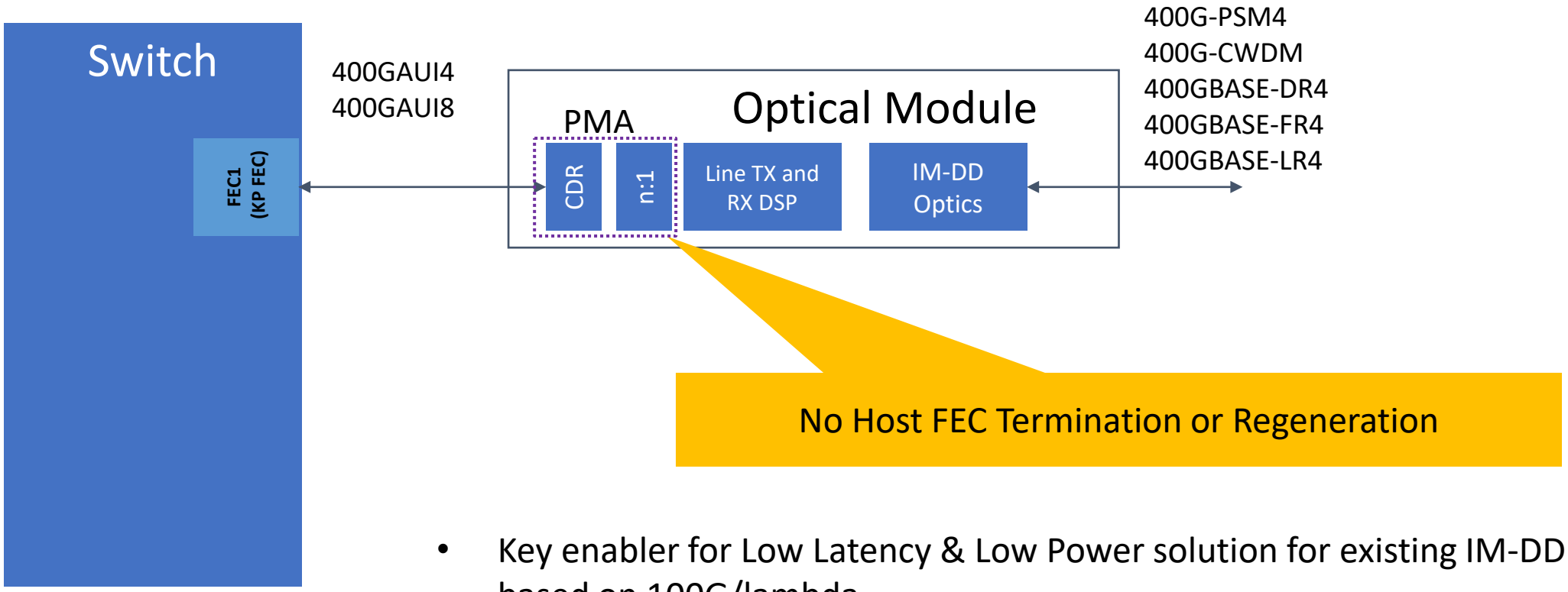


FEC 1 (outer) FEC: (AUI + PMD + AUI**)**
Optional PMD FEC1
FEC 1A (inner) FEC: (PMD only)



What is inside the Data Center Optical modules today?

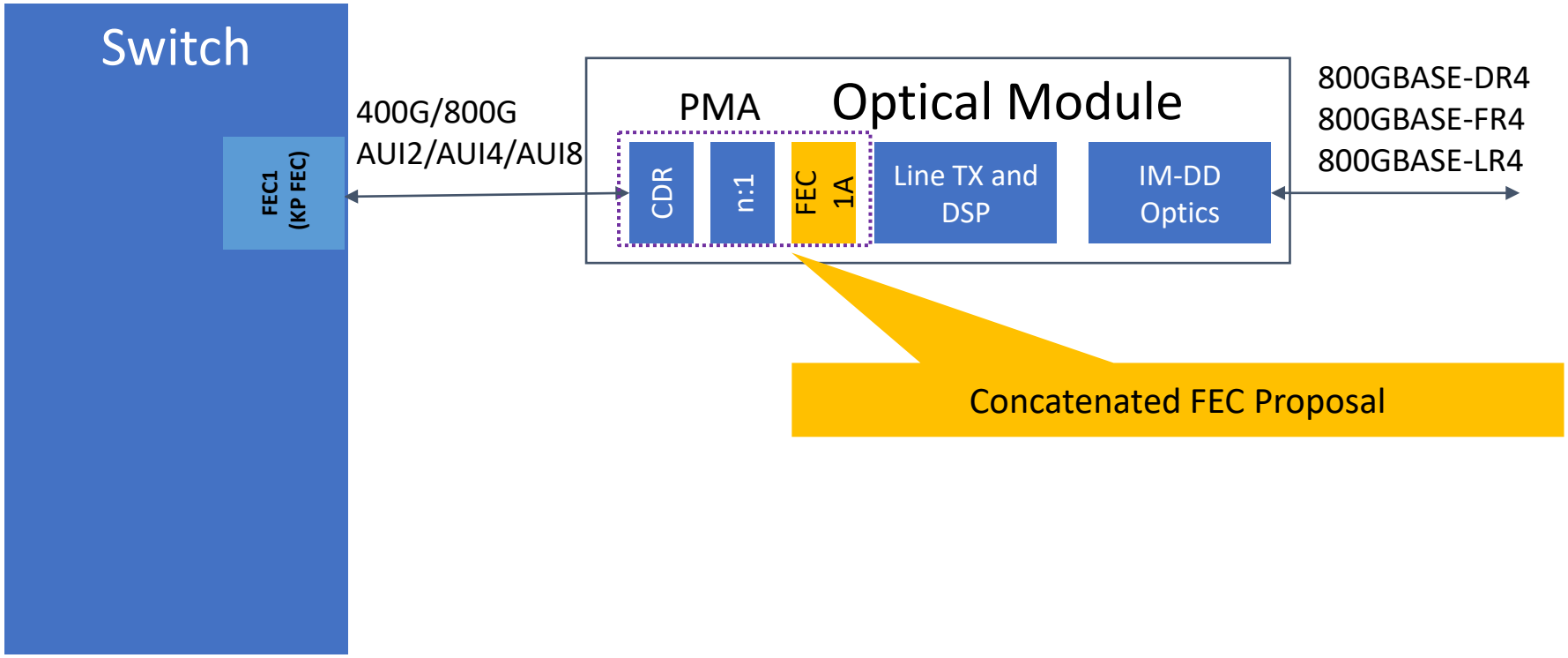
- “Re-timers” and “gearboxes” represent the bulk of DSP deployed inside the IM-DD optics today



- Key enabler for Low Latency & Low Power solution for existing IM-DD optics based on 100G/lambda

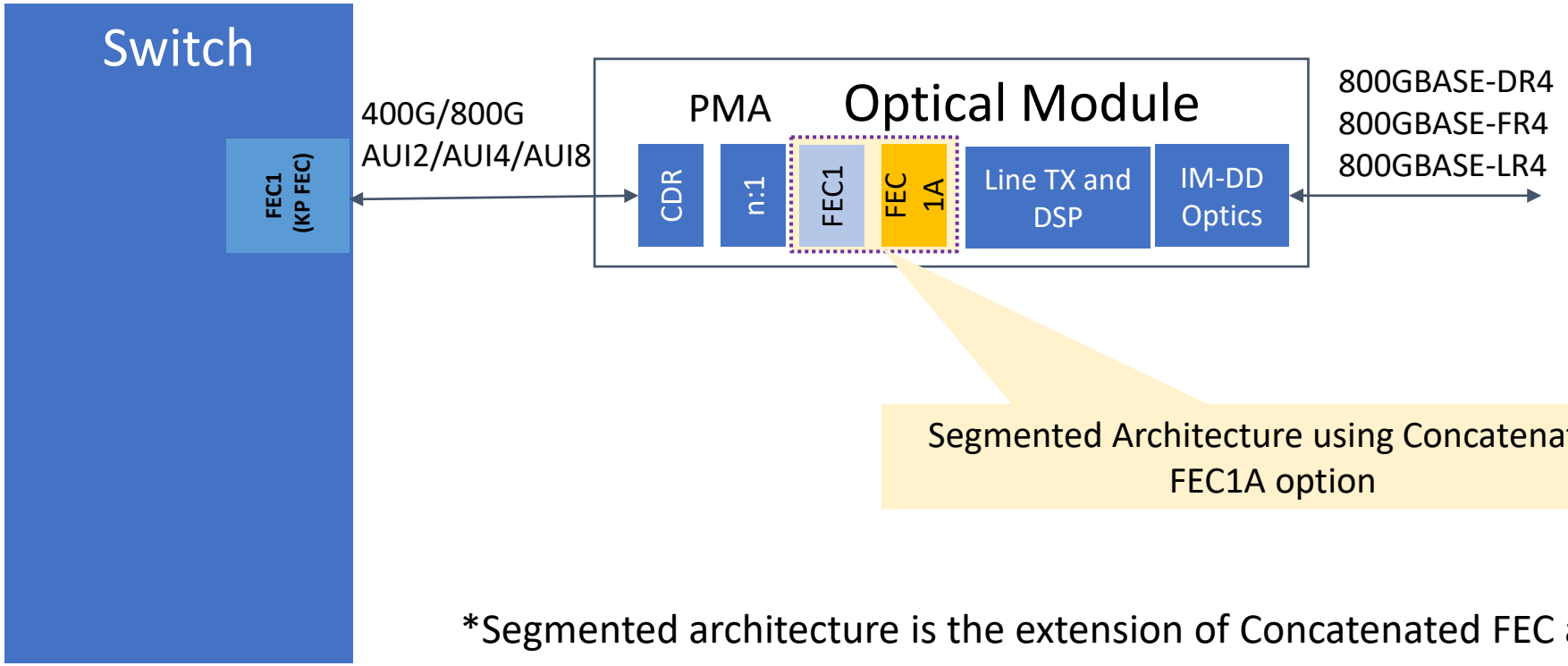
Concatenated FEC extends this concept for NextGen – 200G/lambda

- n:1 “gearbox” generalized to a simple convolutional interleaver
- Inner FEC code (FEC1A) concatenated with the interleaved bit stream



Segmented FEC Architecture – Leveraging Concatenated FEC Option

- In the DSP – FEC1 can be terminated on host side and Segmented FEC (FEC1 +FEC1A) option can be generated on the line side by using the concatenated FEC (FEC1A) scheme



*Segmented architecture is the extension of Concatenated FEC architecture.

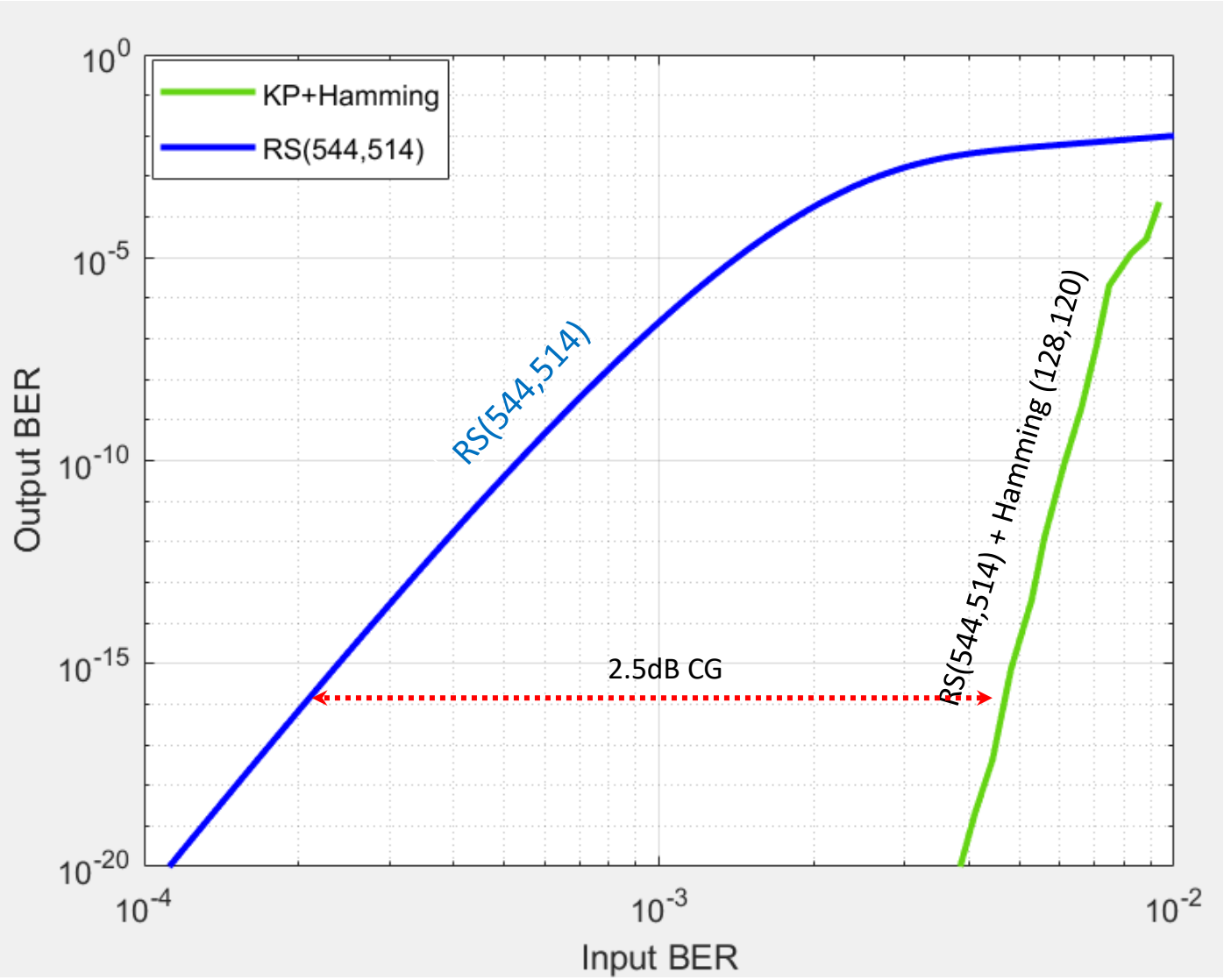
Overview of various Concatenated SFEC Proposal presented in this forum

- KP4 + Extended Hamming (128,120) – Concatenated FEC candidate – works in conjunction with Host KP4 FEC
  - patra_3df_01_ 2207, bliss_3df_01c_220517
  - A perfect multiple of 10b RS symbols → works very well with proposed convolutional interleaver

- KP4 + Extended Hamming (144,136) – another suitable Concatenated FEC candidate
  - he_3df_01a_220308
  - Not a multiple of 10b RS symbols → Needing gearbox kind of extra logic to work with Convolutional interleaver

- KP4 + Shortened Hamming (76,68) – another suitable Concatenated FEC candidate
  - bliss_3df_01_220929.pdf
  - Not a multiple of 10b RS symbols → Needing gearbox kind of logic to work with Convolutional interleaver

Performance of RS (544,514) Vs RS (544,514) + Hamming (128,120) in Concatenated mode

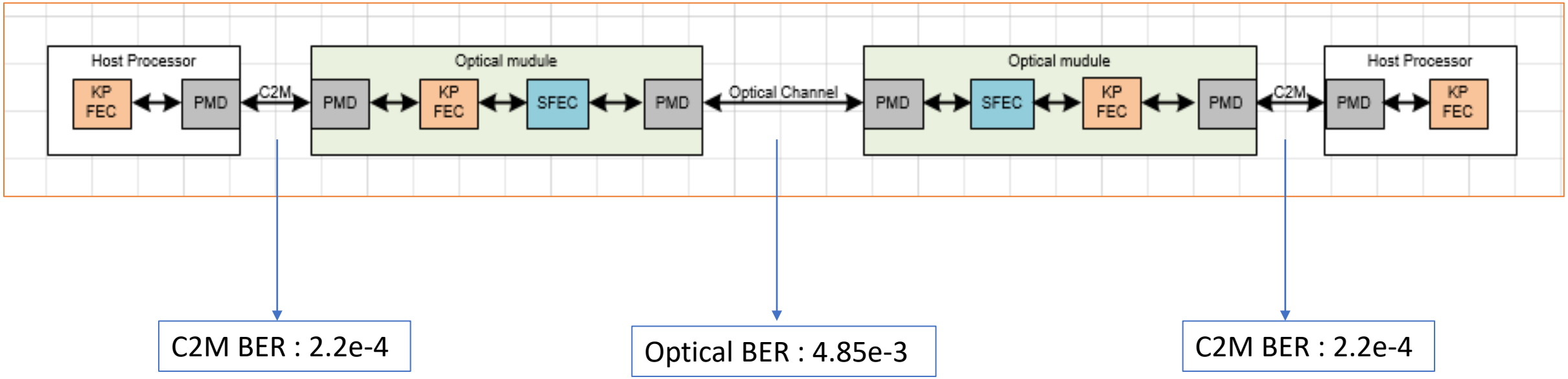


KP4 Vs KP4 + Hamming (128,120) performance:

Coding gain delta : ~2.5dB with ~6.6% overhead increase

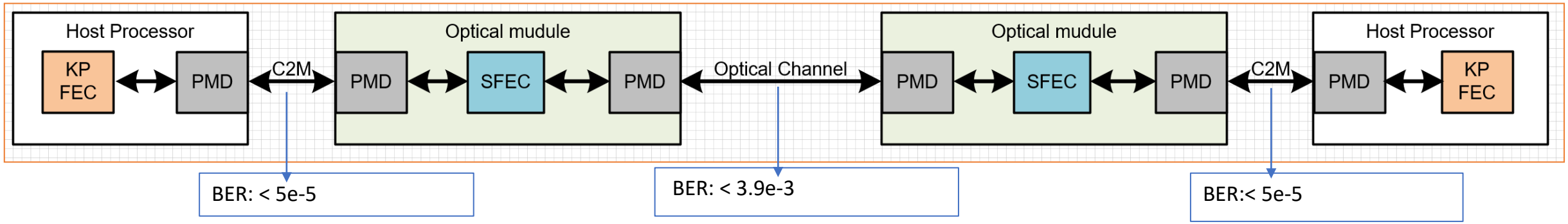
* This is an AWGN simulation

Segmented implementation of the Concatenated FEC scheme



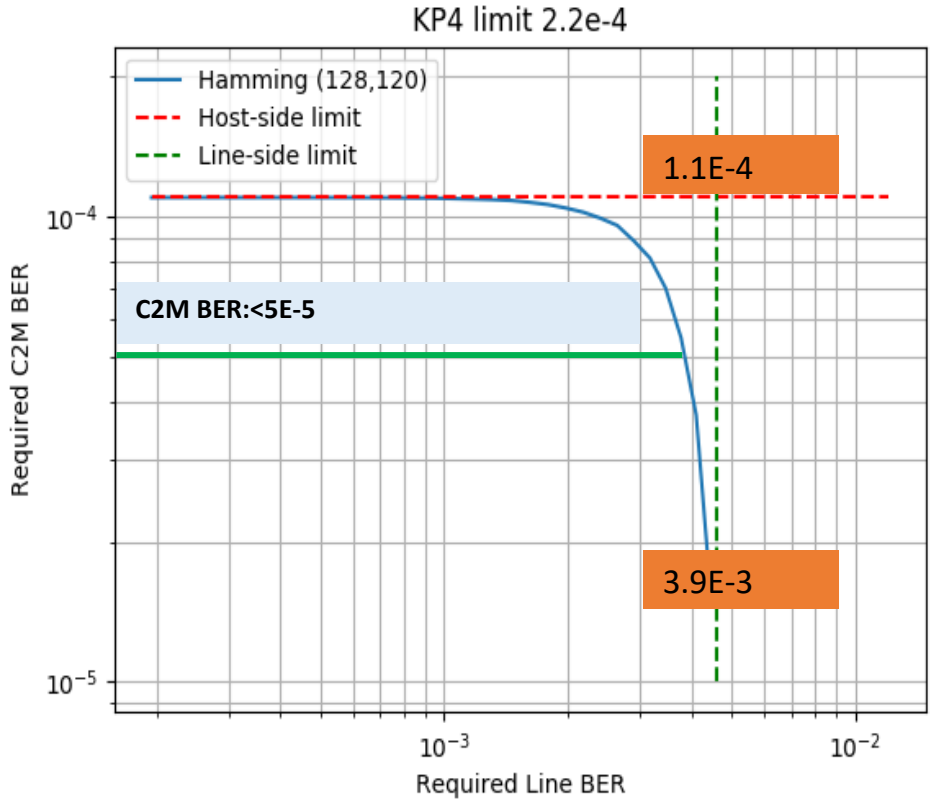
For some of the stringent high loss AUI Channels on the host, we may need to turn on the segmentation FEC proposal to close the link budget.

Non-Segmented implementation of the Concatenated FEC scheme



C2M Host BER	Line side BER	Host SNR	Line SNR	Line side SNR to ideal 4.8e-3	Host side penalty to ideal Segmented implementation of 2.2e-4
1e-5	4.8e-3	19.5db	14.9db	~0.0dB	1.74dB
5e-5	3.9e-3	18.6db	15.2db	0.3dB	0.92dB
8e-5	3.3e-3	18.4db	15.4db	0.5dB	0.64dB
1e-4	2.4e-3	18.2db	15.7db	0.8dB	0.49dB

For medium and low loss AUIs, there is no need to rely on segmented FEC proposal. For example, a 5e-5 to 8e-5 C2M BER threshold will result in a good compromise between host and line error tolerance.



Summary

- Simple concatenated soft FEC schemes like extended Hamming (128,120) can provide enough coding boost to enable 200G PMD over Optical medium.

- Concatenated FEC architecture can enable the Segmented FEC Option as well for stringent C2M channels.

- Leveraging the existing KP4 FEC for 200G AUI will benefit the industry and will ease the backward compatibility issues.

Thanks !