Consideration on Symbol Multiplexing for 200G/L

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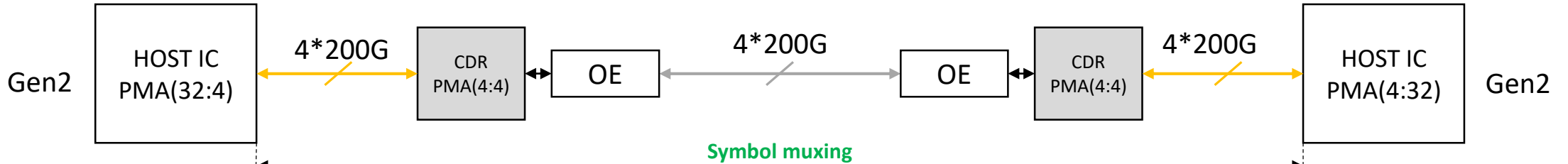Huawei Technologies

Purpose

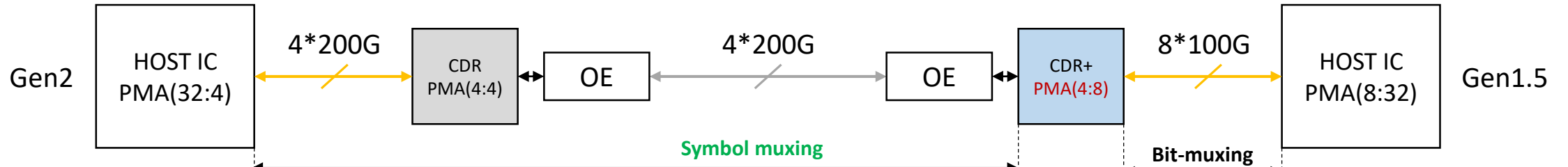- Discuss the symbol muxing for 200G/Lane PMDs.

Background

- 800GBASE-R PCS for 8*100G PHYs has been defined as:
  - 32 PCS lanes with 4 FEC codeword interleaving
- Performance analysis between symbol-muxing and bit-muxing with 32 PCS lanes has been discussed in ran_3df_01a_2211, ran_3df_02a_2211 and he_3df_01_2211, which shows symbol mux outperforms bit mux in 32:4.
- The goal of this presentation is to follow up the symbol mux thoughts for 4*200G/L PHYs (Gen2) and its inteoperability with 100G/L electrical + 200G/L optics PHYs (Gen1.5).
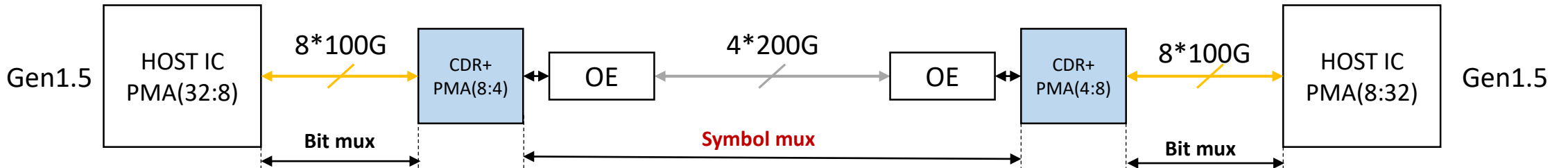
200G/L Scenarios under consideration

Case 1: 200G/L electrical and 200G/L optics with symbol muxing, in which module can be symbol unawareness.
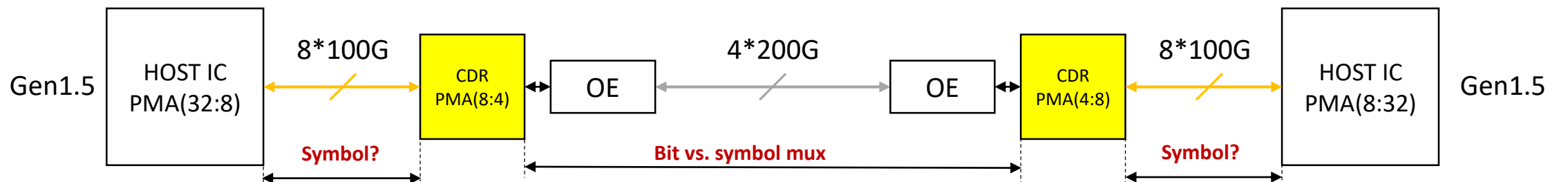
Gen2 | HOST IC PMA(32:4) | 4*200G → | CDR PMA(4:4) | OE | 4*200G | OE | CDR PMA(4:4) | 4*200G ← | HOST IC PMA(4:32) | Gen2

Symbol muxing

Case 2: 200G/L electrical and 200G/L optics to interoperate with 100G/L electrical hosts in bit-muxing

Gen2 | HOST IC PMA(32:4) | 4*200G | CDR PMA(4:4) | OE | 4*200G | OE | CDR+ PMA(4:8) | 8*100G | HOST IC PMA(8:32) | Gen1.5

Symbol muxing   Bit-muxing

Case 3: 200G/L optics with 100G/L electrical with bit mux on electrical and symbol mux on optics

Gen1.5 | HOST IC PMA(32:8) | 8*100G | CDR+ PMA(8:4) | OE | 4*200G | OE | CDR+ PMA(4:8) | 8*100G | HOST IC PMA(8:32) | Gen1.5

Bit mux   Symbol mux   Bit mux

Case 4: what if 200G/L optics with 100G/L electrical can use symbol muxing?

Gen1.5 | HOST IC PMA(32:8) | 8*100G | CDR PMA(8:4) | OE | 4*200G | OE | CDR PMA(4:8) | 8*100G | HOST IC PMA(8:32) | Gen1.5

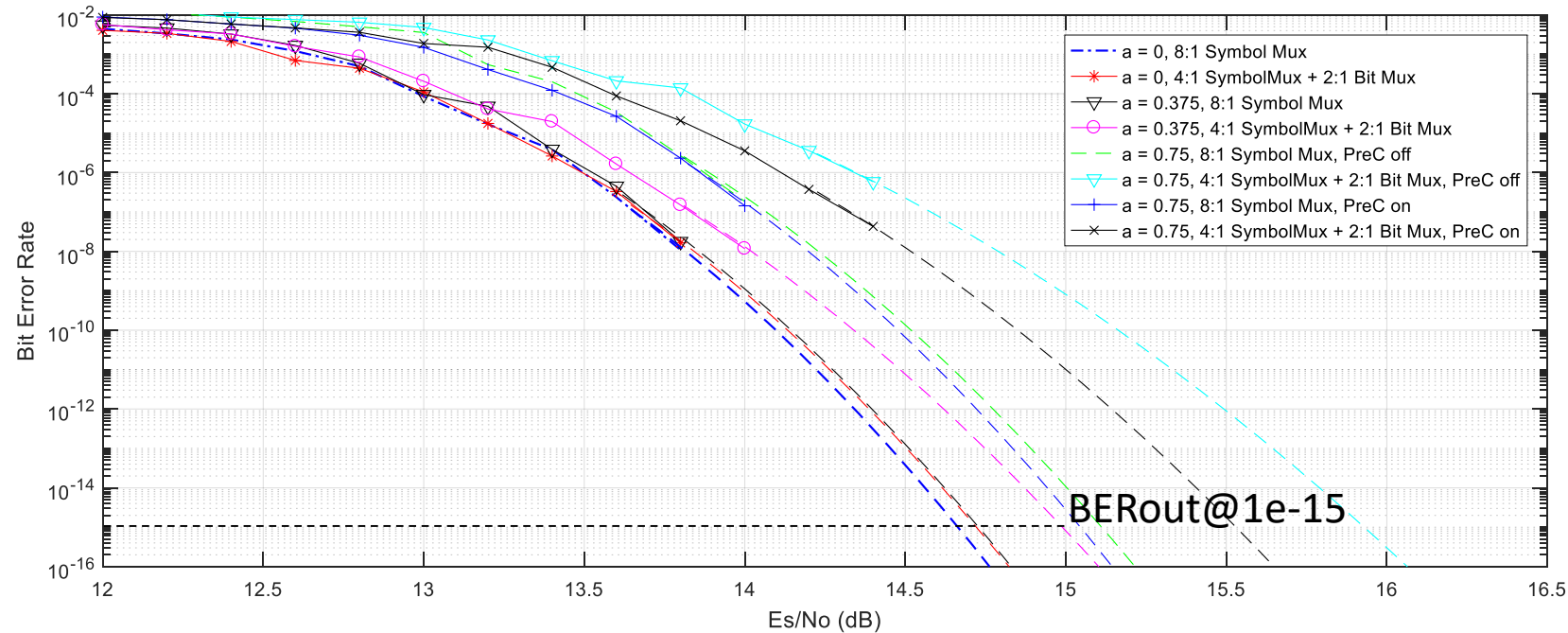Symbol?   Bit vs. symbol mux   Symbol?

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Interoperation between 200G/L and 100G/L
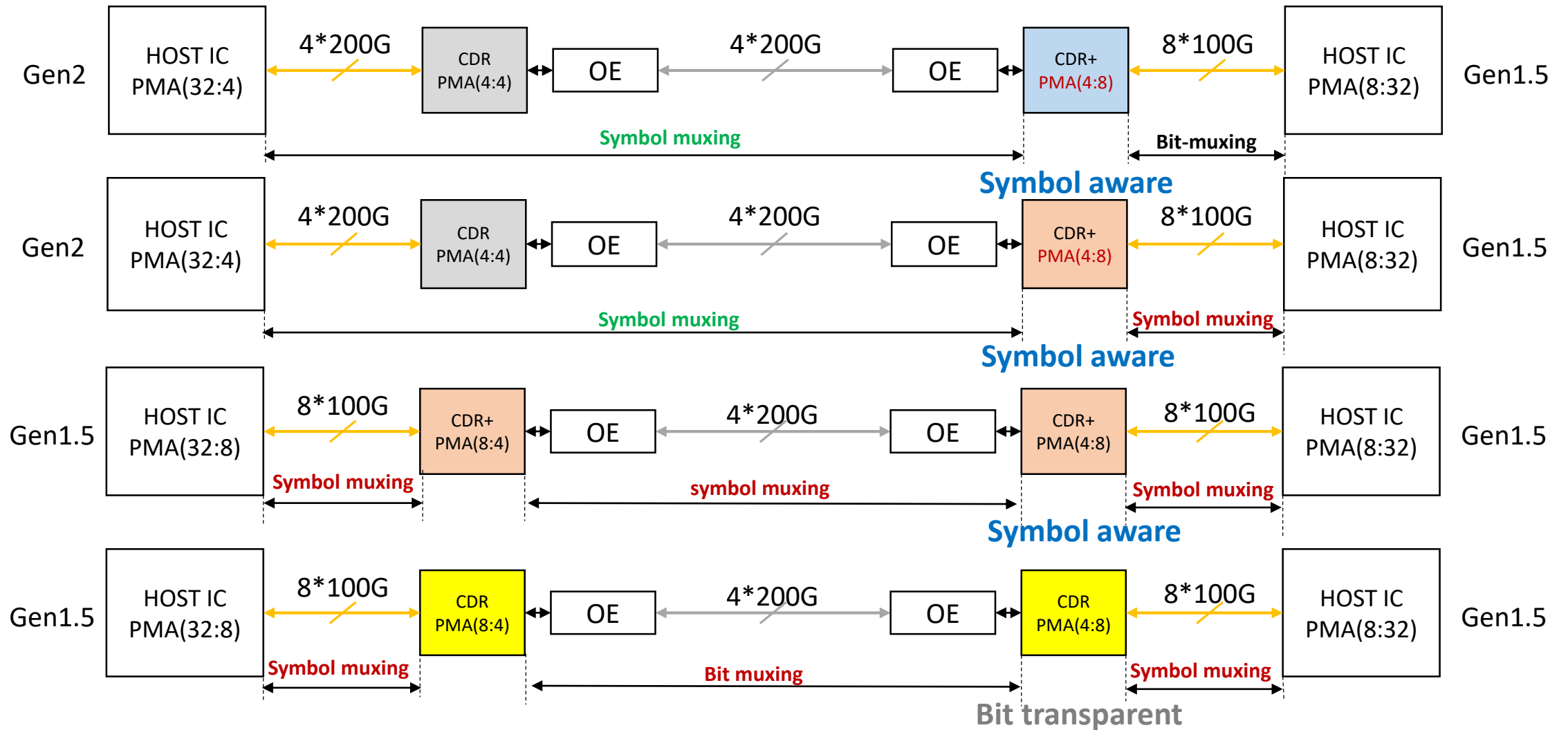
- Interoperation between 100G/L and 200G/L PHYs needs symbol aware CDR/gearbox.
- But for Gen1.5 with 32:8 symbol mux, it can use bit mux when connect to Gen1.5 PHYs with bit transparent CDR/gearbox.

Analysis of 8:1 symbol mux vs. 4:1 symbol + 2:1 bit mux

Scenario	8:1 (32:4) symbol mux	4:1 (32:8) symbol + 2:1 (8:4) bit mux
Uncorrelated errors	14.66(reference), BERin@2.3e-4	14.72(Δ=0.06dB), BERin@2.2e-4
Limited DFE, a = 0.375	14.73(Δ=0.07dB), BERin@2.1e-4	14.99(Δ=0.33dB), BERin@1.4e-4
Limited DFE, a = 0.75	15.11(Δ=0.45dB), BERin@1.2e-4	15.93(Δ=1.23dB), BERin@2.8e-5
Limited DFE, a = 0.75 + precoding	15.05(Δ=0.39dB), BERin@1.3e-4	15.53(Δ=0.87dB), BERin@5.8e-5

8:1 symbol mux has better performance than 4:1 symbol mux + 2:1 bit mux in bursty channels even w/ precoding.

Further Consideration including FEC schemes
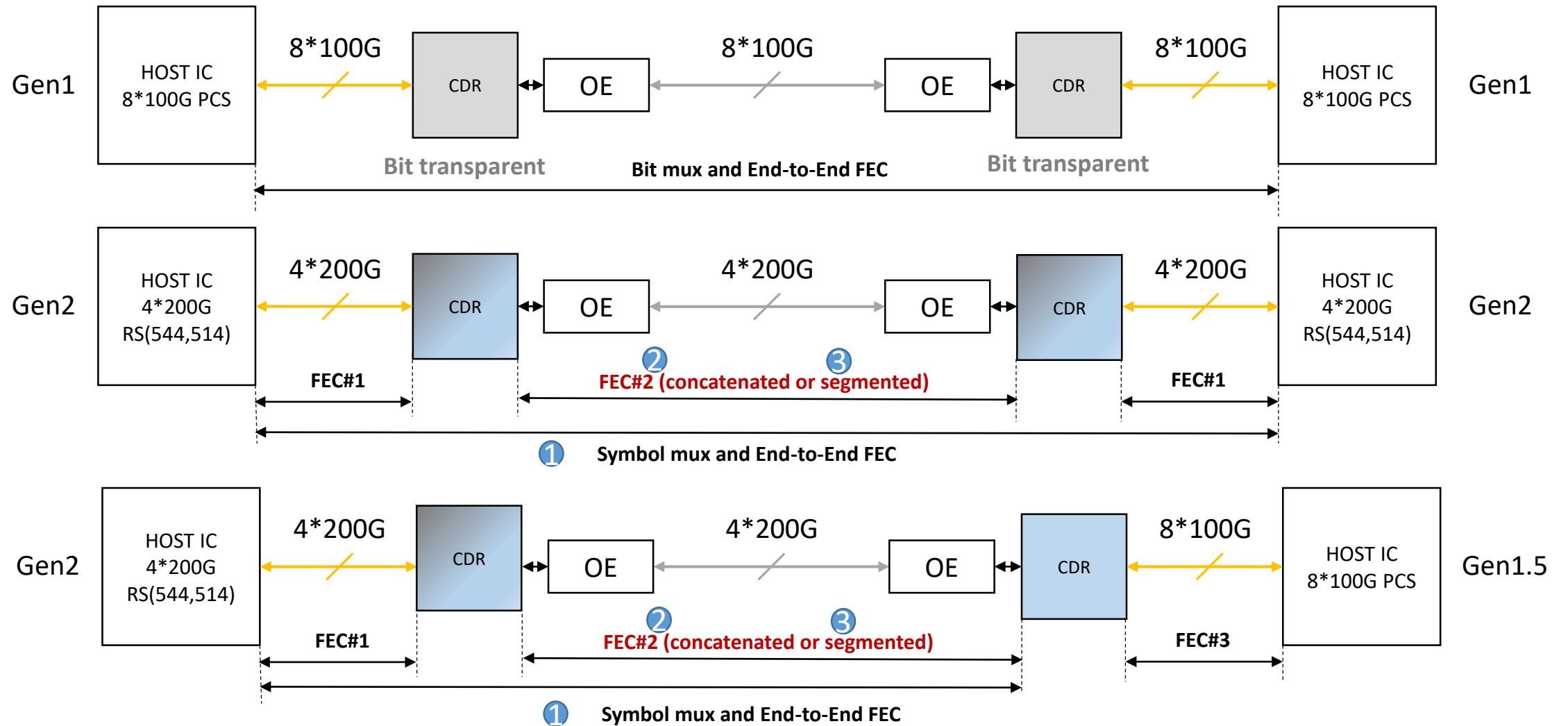
- When considering FEC choices for 200G/L PHYs, the End-to-End FEC can use transparent CDR/Gearbox, but for concatenated/segmented FEC, the CDR/Gearbox can not be bit transparent.

Summary

- Use symbol mux for the 200G/L PHYs.

- The 200G/L PHYs (Gen2) need CDR/Gear box to do muxing conversion to connect to 100G/L electrical + 200G/L optics PHYs (Gen1.5).

- For Gen 1.5 (100G/L electrical + 200G/L optics), if considering using 32:8 symbol mux, 2:1 symbol mux performance is better than 2:1 bit mux in bursty channel.

- When considering FEC for 200G/L PHYs, only end-to-end FEC uses transparent CDR/Gearbox. For segmented and concatenated FEC architecture, the CDR can not be bit-transparent, it needs FEC processing inside the CDR anyway. (as we discussed in lu_3df_logic_220425).

Thanks!