PCS, FEC and PMA Overview

100 Gb/s Wavelength Short Reach PHYs Study Group

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Introduction

- This describes the PCS/FEC/PMA architectures that are in use at 100Gb/s per lane today for re-use by this group

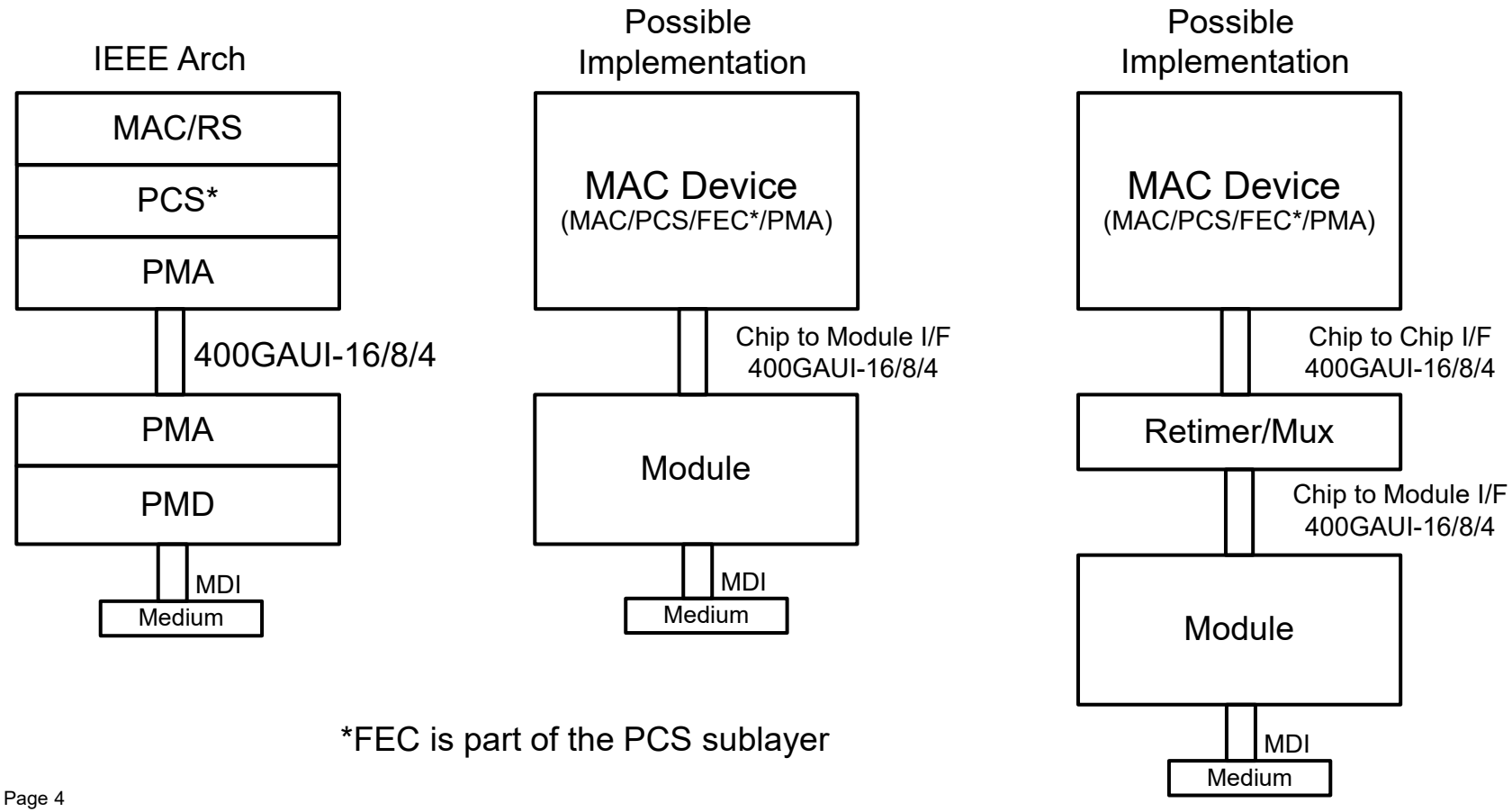
Standards Map/Summary

	Ethernet Speeds	What it is	Of Note to this group
802.3ba	100G/40G	Original 100GbE project, no RS FEC	PCS still used today (Cls 82)
802.3bj	100G	Added in KR4/KP4 RS FEC (Cls 91), backplane and copper cable	RS FEC defined (Cls 91), both RS(528,514) and RS(544,514).
802.3bm	100G	Added in CAUI-4, with or without FEC	RS(528,514) is used over the C2M interface.
802.3bs	400G/200G	Original 400GbE/200GbE project, always with FEC, 50G per lane and one 100G per lane (DR4) technology	RS FEC integrated into the PCS, always on/required, RS(544,514). Cls 119 is the PCS/FEC clause.
802.3cd	200G/100G/50G	50G per lane and one 100G per lane (DR) technology	RS(544,514) required for interfaces.
802.3ck	400G/200G/100G	100G per lane electrical interfaces (including C2M)	RS(544,514) required for interfaces. A few PHYs can use an optional interleaved FEC (not applicable to this group).
802.3cu	400G/100G	100G per wavelength PMDs	RS(544,514) required for interfaces.

RS(544,514) used for 50/100G per lane technology
RS(528,514) is used for 25G technology

802.3bs Architecture – 200GbE and 400GbE

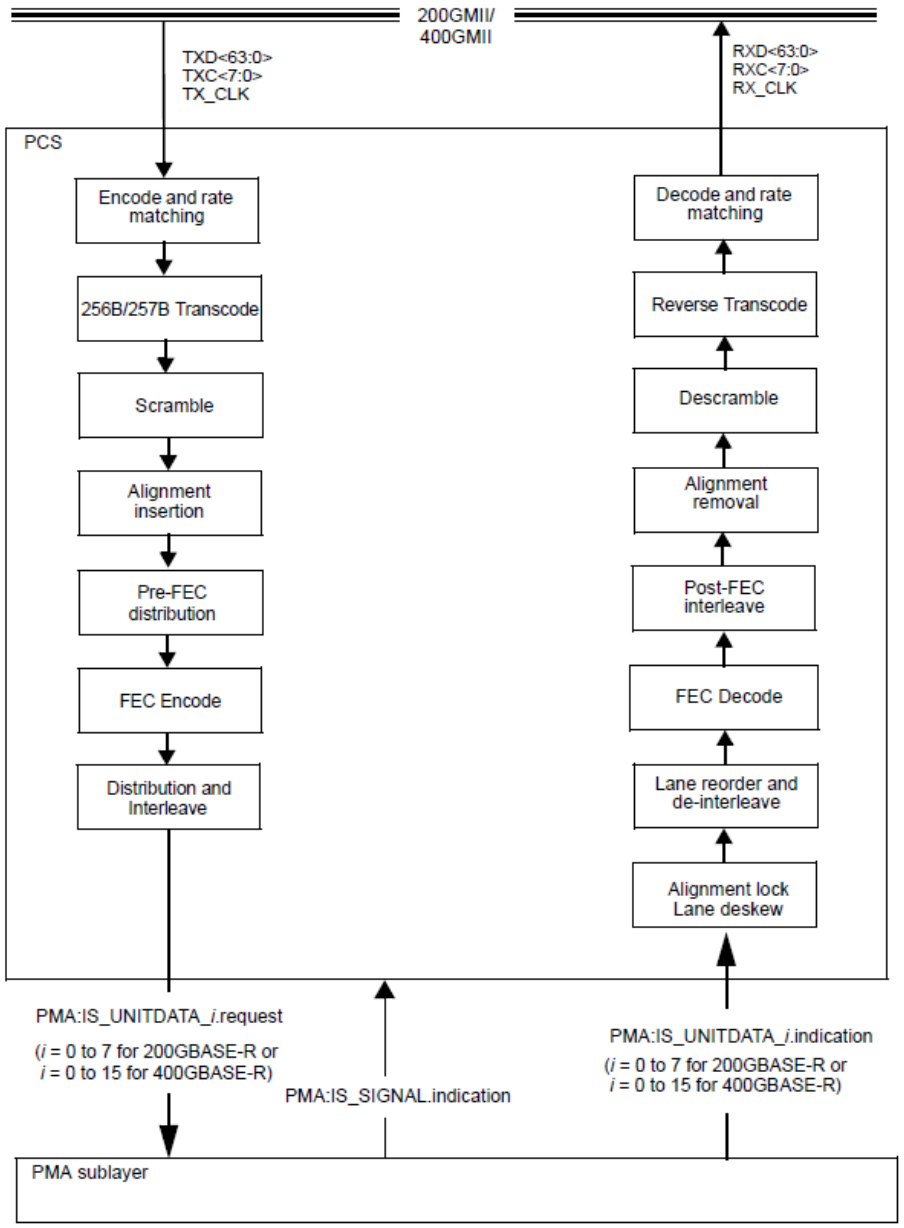
- Adopted architecture and possible implementations are shown below for 400GbE
  - 200GbE is identical except for # lanes and MAC rate
- FEC is part of the PCS sublayer utilizing the RS(544,514) aka “KP4” FEC code.
- An extender sublayer is also defined



*FEC is part of the PCS sublayer

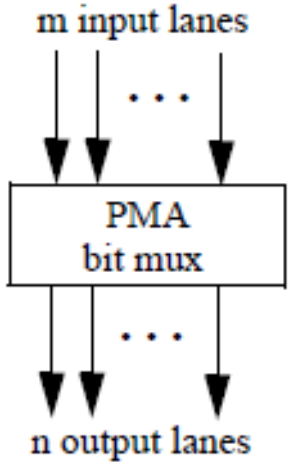
802.3bs PCS

- PCS processing flow is shown in the figure
- The PCS distributes data to 16 PCS lanes for 400GbE and 8 PCS lane for 200GbE
- Pre-FEC distribution plays the data out to two FEC codewords



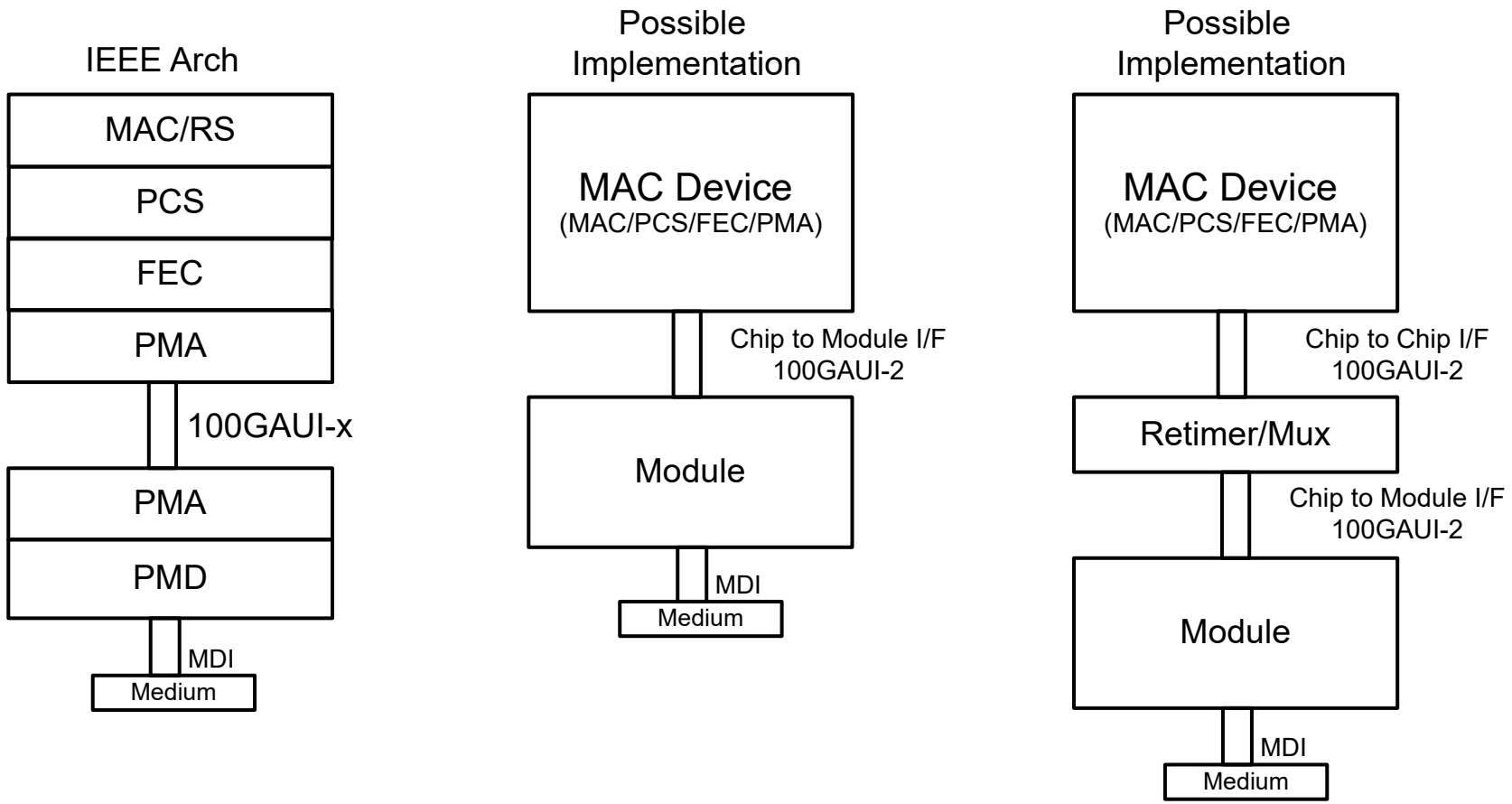
802.3bs PMA

- From a muxing point of view, the PMA is simple, m input lanes are bit muxed to n output lanes
- Bit muxing is blind, lanes can move around, the RX PCS sorts things out
- 4:1 muxing is used for 100G per lane interfaces



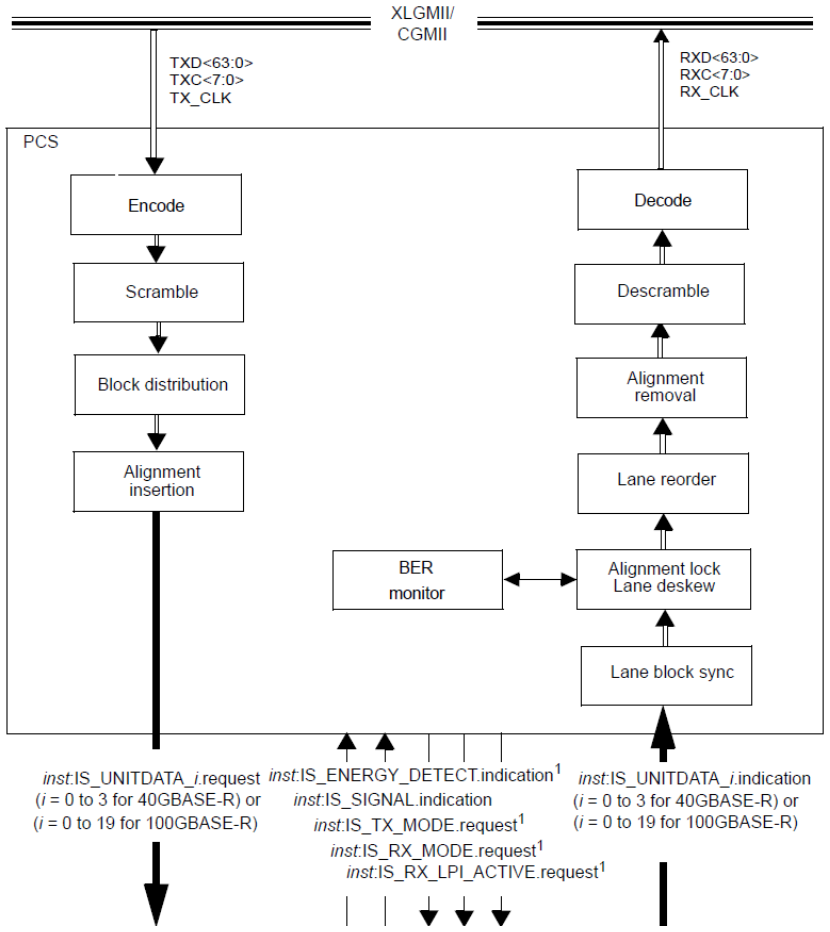
802.3cd Architecture – 100GbE

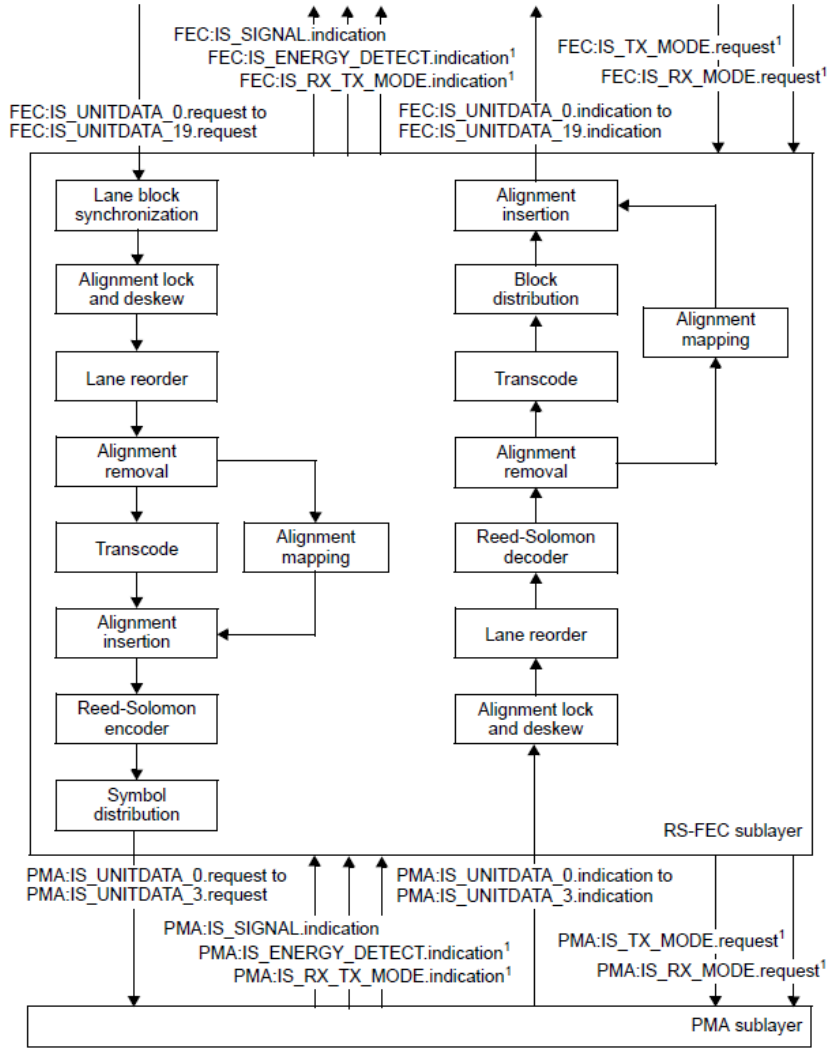
- Adopted architecture and possible implementations are shown below for 100GbE
- FEC is in the FEC sublayer, RS(544,514) aka “KP4” FEC
  - An AUI may exist between the FEC and PCS sublayers



802.3cd PCS/FEC Sublayers

- PCS processing flow is shown in the figure to the left, FEC to the right





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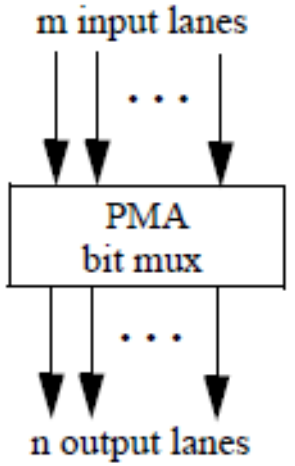


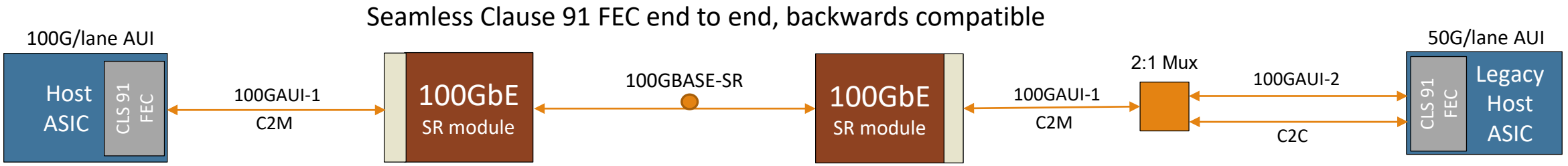
Direction in 802.3ck (in draft 1.0)

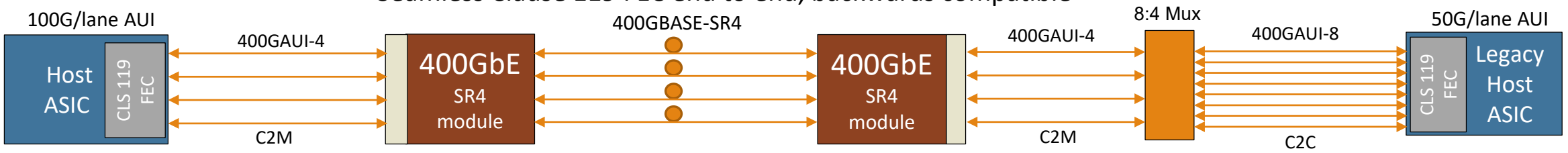
- Adopted 802.3bs PCS/FEC/PMA structure for all interfaces for 400G/200G PHYs
- Adopted 802.3cd PCS/FEC/PMA structures for all interfaces, with the exception:
  - 100GBASE-KR1/CR1, which also have an interleaved option for the FEC in addition to the above
  - This interleaved FEC is not important to this group since the C2M interface does not support this FEC option

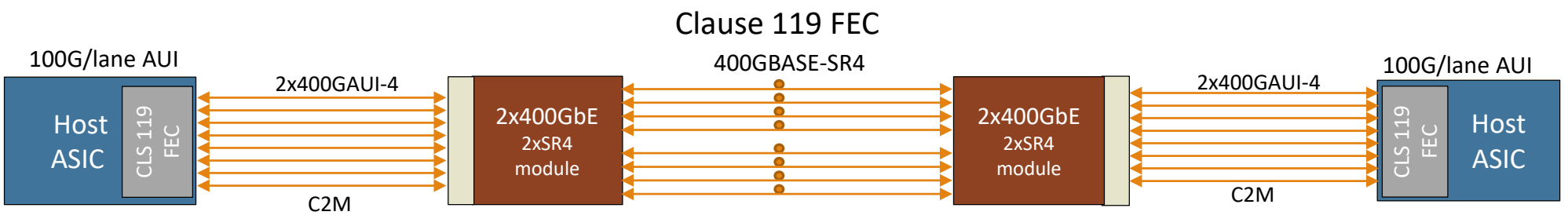
BER Budgets

- The existing 100G per lane BER budget is split out across AUI interfaces and the PMD budget
  - $1x10^{-5}$ for the AUI interfaces
  - $2.4x10^{-4}$ for the PMD interface
    - (for 200/400GbE): Provided that the error statistics are sufficiently random that this results in a frame loss ratio (see 1.4.223) of less than 1.7×10^{-12} for 64-octet frames with minimum interpacket gap when processed according to Clause 120 and then Clause 119.
    - (for 100GbE): Provided that the error statistics are sufficiently random that this results in a frame loss ratio (see 1.4.275) of less than 9.2×10^{-13} for 64-octet frames with minimum interpacket gap when additionally processed by the FEC (Clause 91) and PCS (Clause 82).
  - Any new PMD would need to match these requirements, if they do, then the current 802.3 architecture and PCS/FEC is directly applicable to this project

Example Configurations







Thoughts on the Re-Use

- There has been a big investment in the 802.3bs/cd architectures in the industry
  - They are already used for 100G per lane optical interfaces for 100GBASE-DR and 400GBASE-DR4 interfaces
  - 802.3cu is re-using these architectures
- **This group should re-use these industry investments as is**
  - RS(544,514) FEC with 4:1 bit muxing

Thanks!