

PCS, FEC and PMA Overview

IEEE P802.3db 100 Gb/s, 200 Gb/s, and 400 Gb/s Short Reach Fiber Task Force

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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
- We also propose a motion to adopt the PCS/FEC/PMA for use by this task force

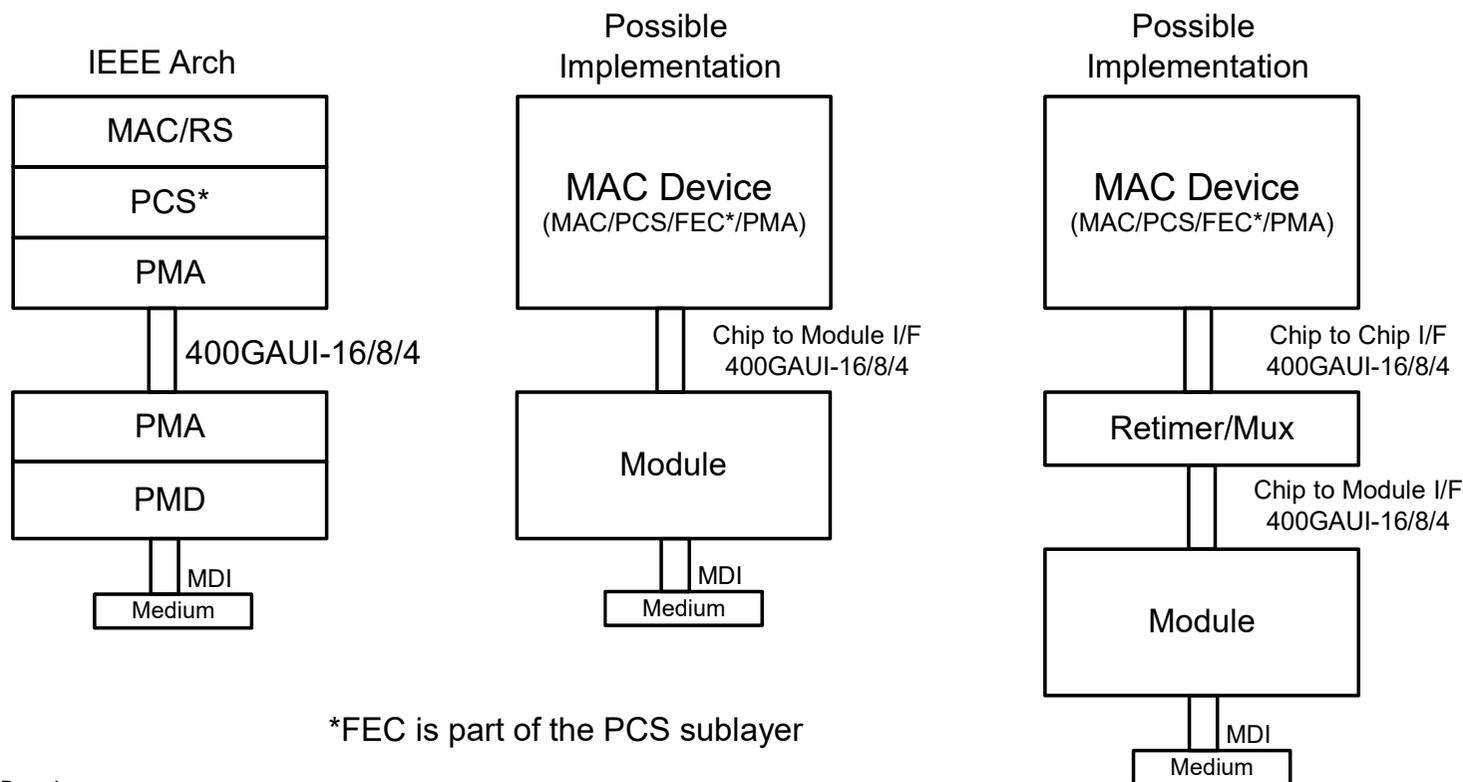
Standards Map/Summary

	Ethernet Speeds	What it is	Of Note to this group
802.3ba	100G/40G	Original 100GbE project, no RS FEC	PCS still used today (CIs 82)
802.3bj	100G	Added in KR4/KP4 RS FEC (CIs 91), backplane and copper cable	RS FEC defined (CIs 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). CIs 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. The 100G backplane and copper cable 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

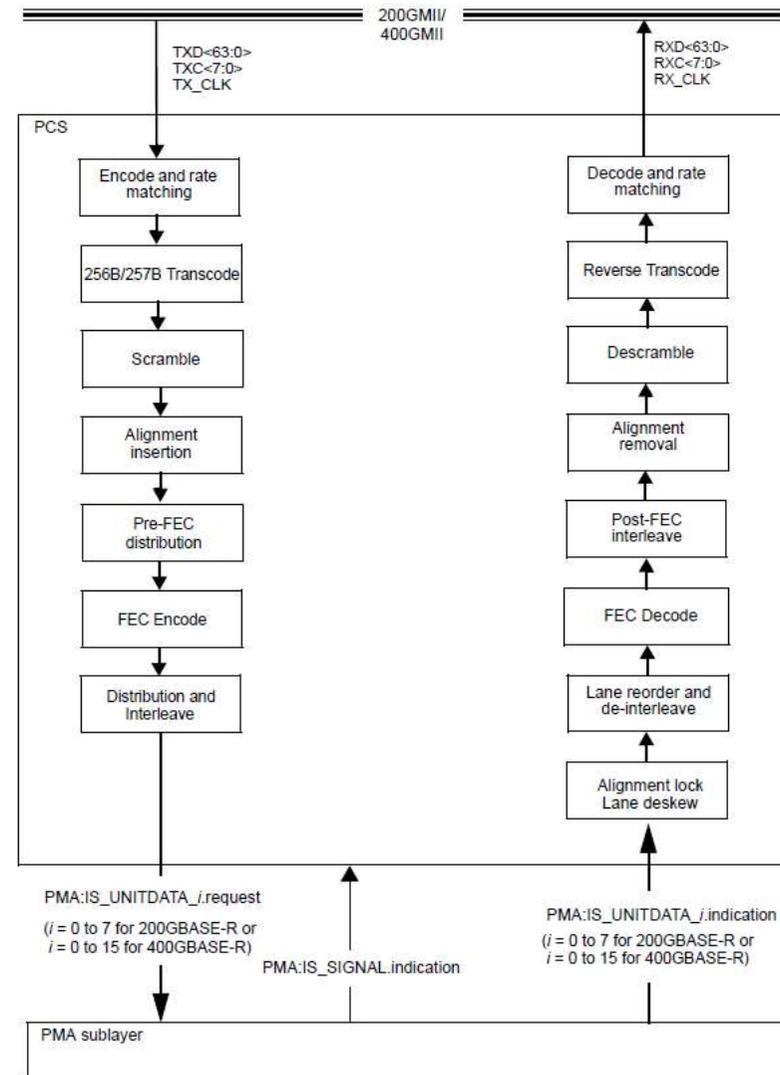
802.3bs Architecture – 200GbE and 400GbE

- 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



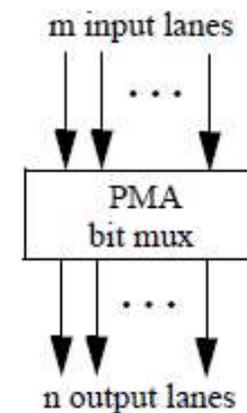
802.3bs PCS

- 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



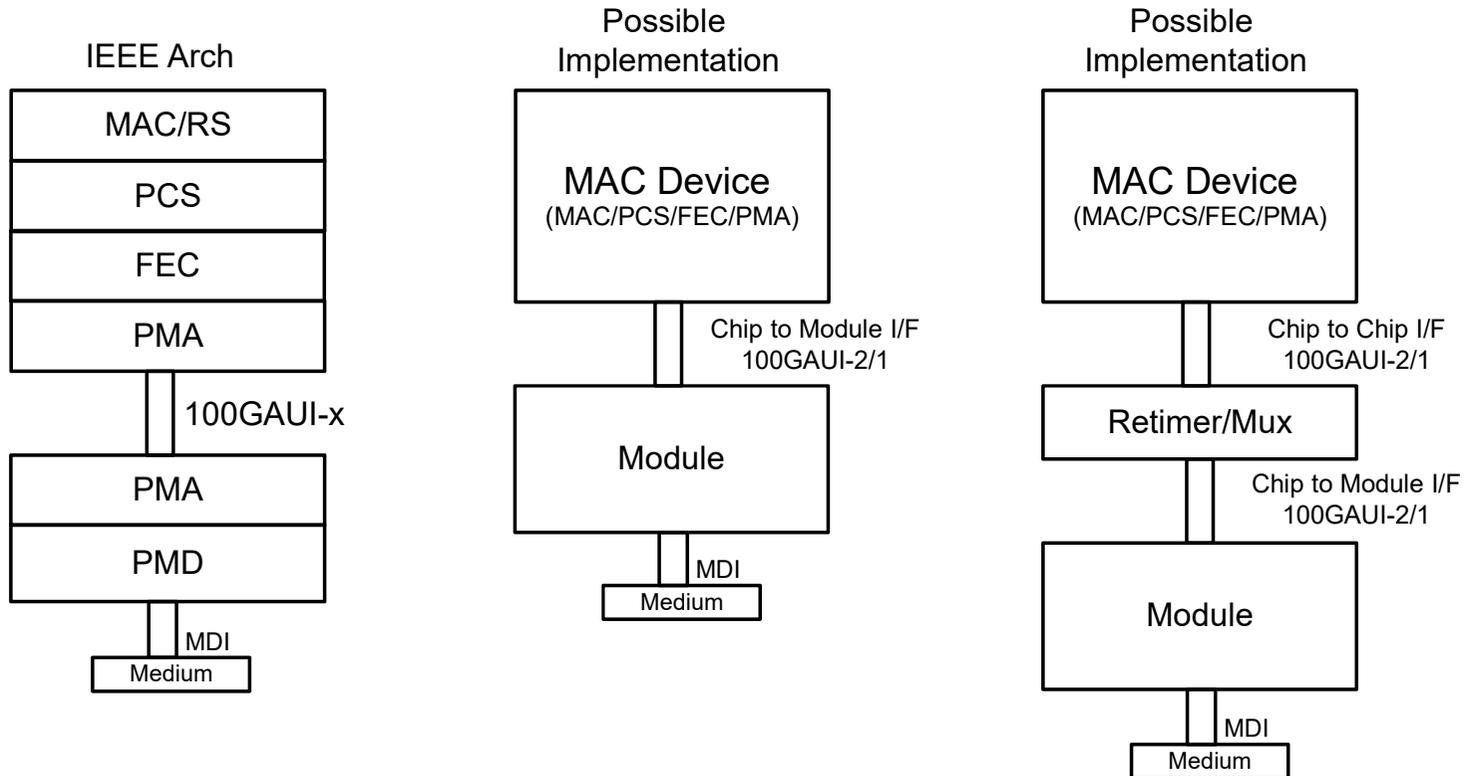
802.3bs PMA

- 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



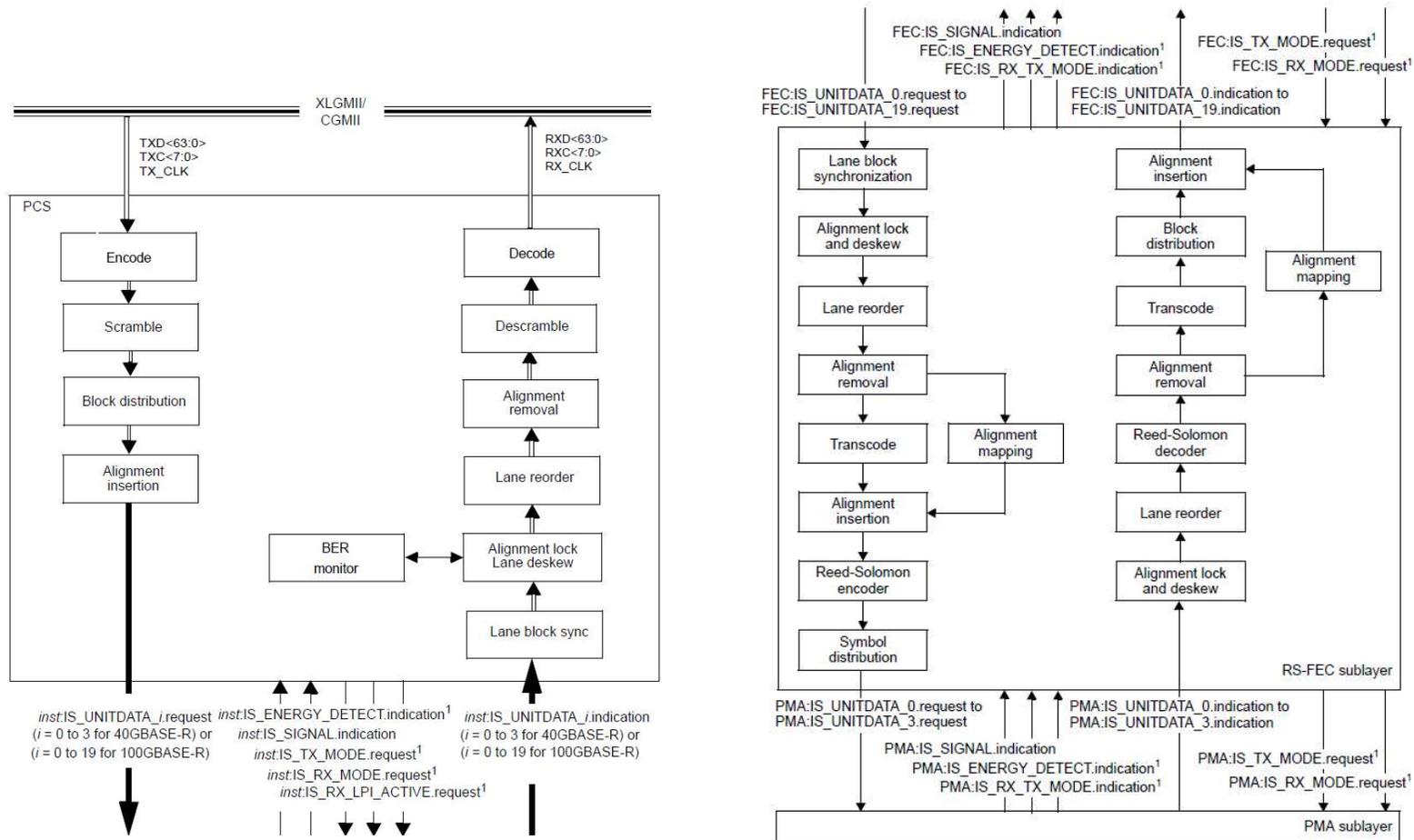
802.3cd Architecture – 100GbE

- 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



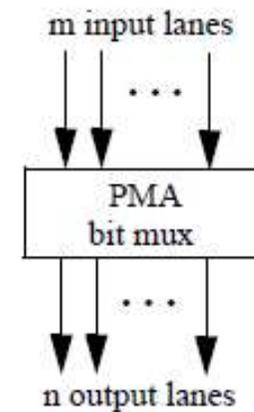
802.3cd PCS/FEC Sublayers

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



802.3cd 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



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 (Clause 161)
 - This interleaved FEC is likely not important to this group since the C2M interface does not support this FEC option at this point
 - If it became important, due to burst error concerns, we could explore supporting it

BER Budgets

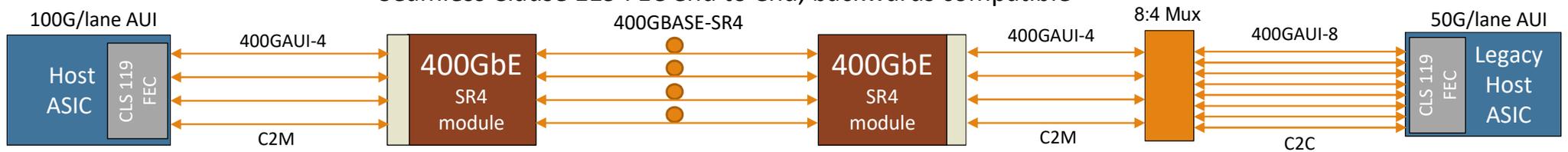
- The existing 100G per lane BER budget is split out across AUI interfaces and the PMD budget
 - 1×10^{-5} for the AUI interfaces
 - 2.4×10^{-4} for the PMD interface
 - (for 200/400GbE): Provided that the error statistics are sufficiently random that this results in a frame loss ratio (see 1.4.223) 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

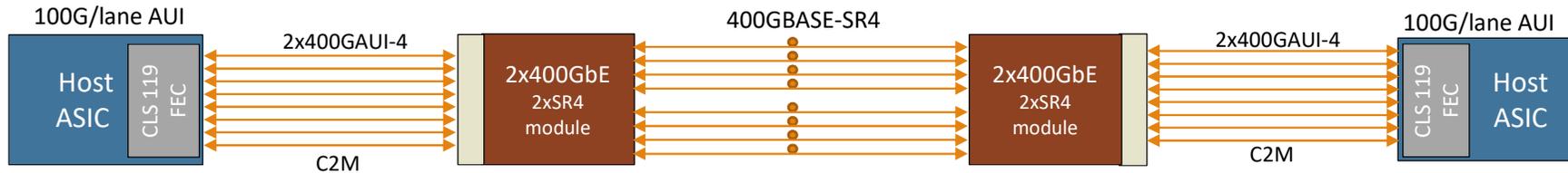
Seamless Clause 91 FEC (RS544) end to end, backwards compatible



Seamless Clause 119 FEC end to end, backwards compatible



Clause 119 FEC



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

Proposed Motions

- **Adopt Clause 119 as the PCS/FEC and Clause 120 as the PMA for all 200 Gb/s and 400Gb/s PHYs for this project**
- **Adopt Clause 82 as the PCS, Clause 91 as the FEC (RS544), and Clause 135 as the PMA for all 100 Gb/s PHYs for this project**

Thanks!