Proposed PMD Progression

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NGMMF Study Group
Next-gen 200 & 400 Gb/s PHYs over Fewer MMF Pairs
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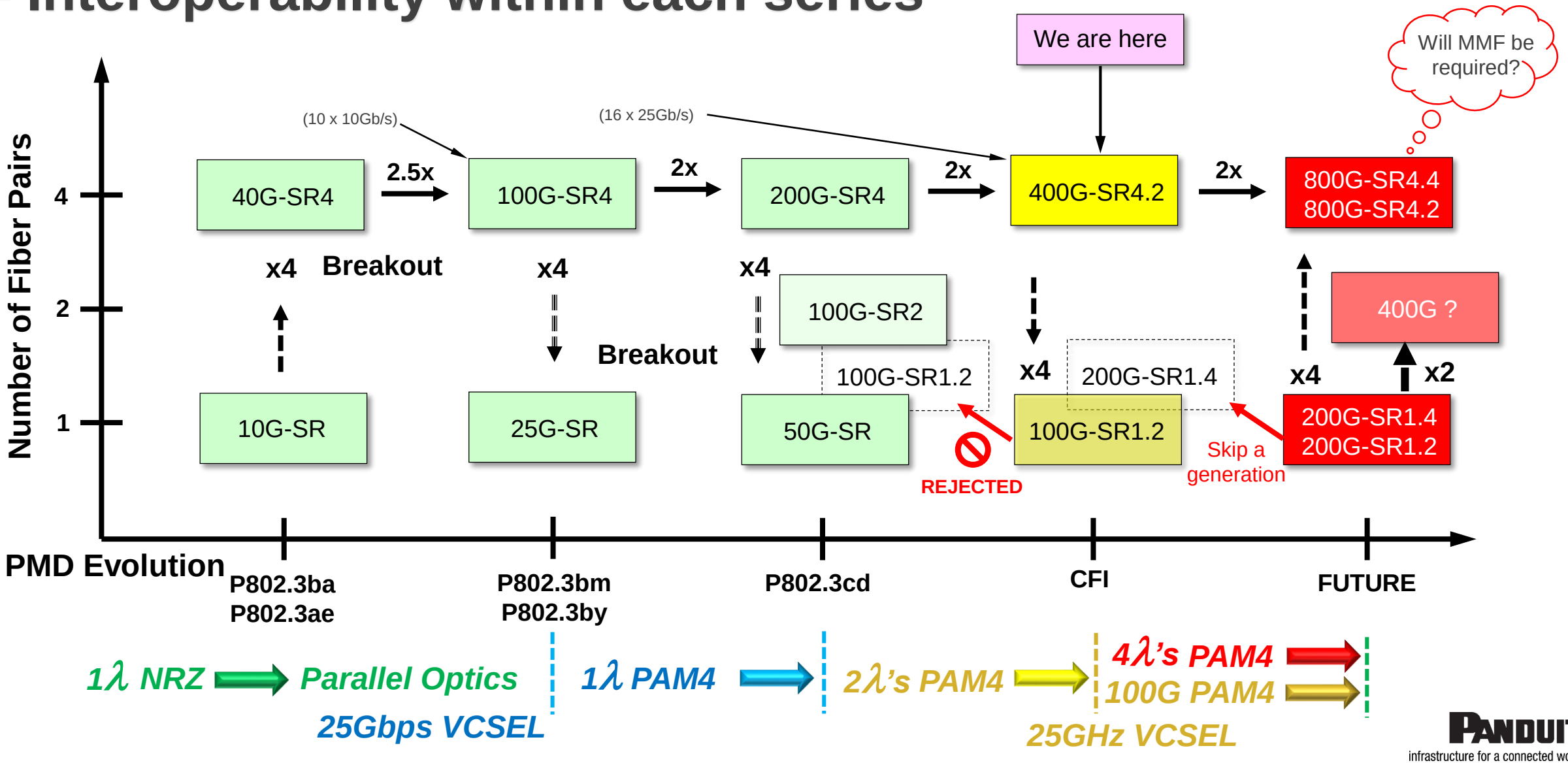
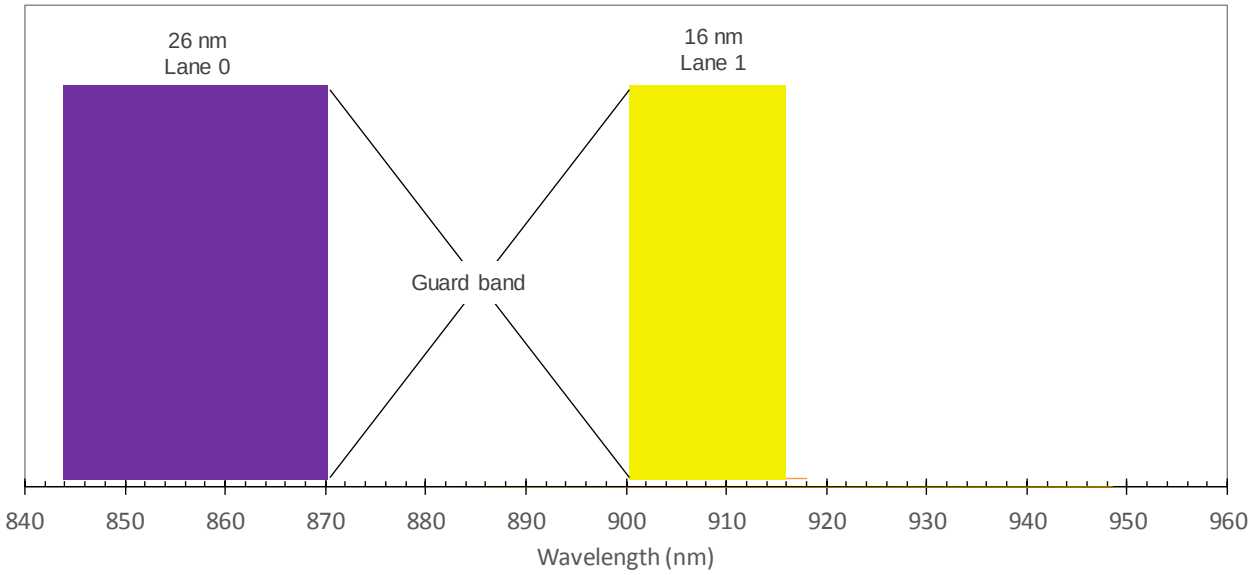
Logical progression of MMF PMDs – Interoperability within each series



400G SWDM Wavelength Grids – 2λ vs. 4λ

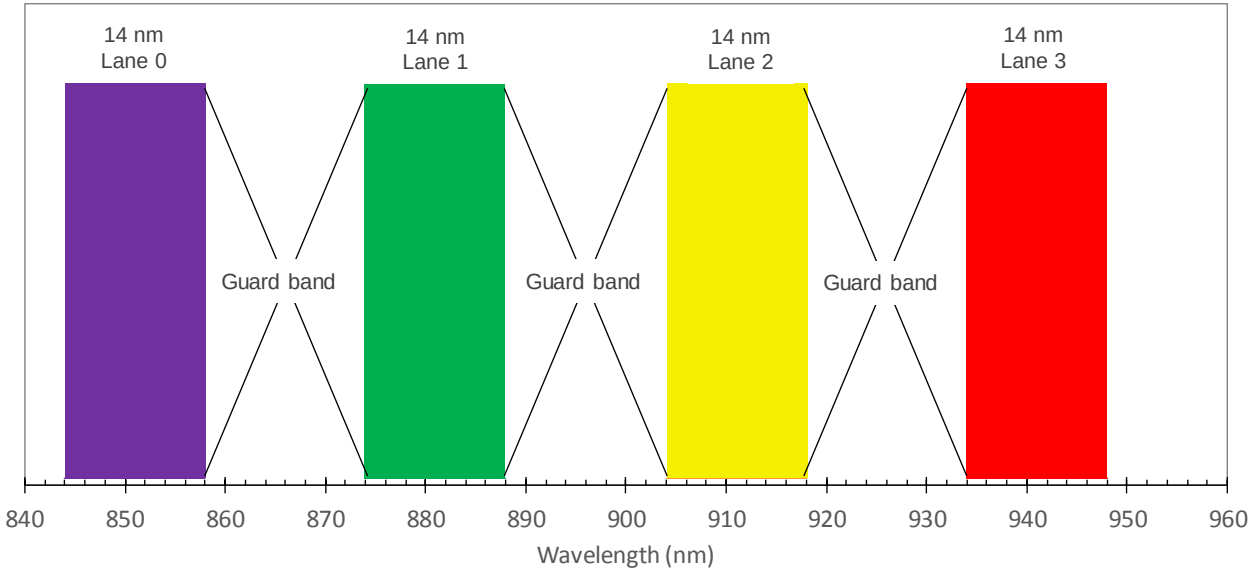
2λ SWDM Proposed in P802.3cd (*ingham_3cd_01a_0916)*

- Larger guard band
- Wider spectral windows
- Lower WDM IL



4λ SWDM

- Tighter specs
- Higher WDM insertion loss
- Increased cross-talk penalty
- Higher power VCSELs required
- Higher power dissipation



ISSUES

No Standards Specified EMB for wavelengths other than 850 nm for OM3 and OM4.

MinEMBc at 910 nm will be higher than at 953 nm, providing greater reach over OM3 and OM4

Request TIA to begin development on an amendment to OM3/OM4 Standards for EMB at the 2nd wavelength.

Modular Transceivers and Form Factor Proposed Evolution

- Two MMF Transceiver Form Factors – Duplex and Quad fiber pairs:

Per lane rate Gb/s	Single lane rate Form factor	IEEE Standard	Quad lane rate Gb/s	Quad lane rate Form Factor	IEEE Standard
1	SFP	1000BASE-SR	N/A	N/A	N/A
10	SFP+	10GBASE-SR	40	QSFP+	40GBASE-SR4
25	SFP28	25GBASE-SR	100	QSFP28	100GBASE-SR4
50	SFP56	50GBASE-SR	200	QSFP56	200GBASE-SR4
100*	TBD	Non-standard BiDi/SWDM2	400	QSFPDD	400GBASE-SR4.2
200	TBD	200GBASE-SR1.4	800	TBD	800GBASE-SR4.4

* Out of scope, however, specified by default in 400G, i.e., 1 of 4 lanes of 400GBASE-SR4.2 (create MSA)

400GBASE-SR4.2 (2 λs over 4 fiber pairs)

ADVANTAGES	DISADVANTAGES
Facilitates adoption in both green field an brown field installations. 4-fiber pair structured cabling is used for 10/40G, 25/100G, and 50/200G Ethernet applications.	Delays the specification of 800Gb/s if determined to be needed, new CFI required.
Works better with legacy fiber since the longest wavelength is not utilized.	
Less complex transceiver: fewer components, cheaper optical filters, less crosstalk, less need for equalization.	
Leverages previous work using 2 wavelengths: e.g., 40Gb/s BiDi.	
Enables breakout (400G to 100G) thereby satisfying potential need for high density ToR to 100Gbps servers.	
Leverages well established ecosystem for optical taps, adapters, connectors, and cabling.	

200GBASE-SR1.4 (4 λs over 1 fiber pair)

ADVANTAGES	DISADVANTAGES
Sets higher expectations and longer life for MMF in the data center. The "difficult" work for implementing 4 wavelength transceivers with multi-level modulation (PAM4), will be solved first. The transition to 800Gb/s will be straight forward (just add 3 fiber pairs), compared to increasing the number of wavelengths for 400GBASE-SR4.2.	Legacy issues. Does not support current reaches in currently deployed structured cabling. Limited adoption in brown filed installations.
	More complex transceivers required to make them work with legacy fibers. Difficult to support comparable reaches at the longest wavelength.
	Non optimized use of well established ecosystem for legacy optical adapters, connectors, and structured cabling. Not compatible with Taps.
Some leverage on work already developed for SWDM4, although the development would need to focus on PAM4 (as opposed to NRZ), which can be challenging at the longest wavelength.	To optimize its use, it would require customers to replace installed OM3 and OM4 with more expensive OM5. Investment and payback could be risky due to reductions in cost of SMF solutions. Impacts broad market potential.
	Two different PMDs to be specified in Task Force, which is more challenging for PAM4 modulation.

Conclusions

- **400GBASE SR4.2 is the appropriate choice for next-gen PHY over fewer MMF pairs**
  - Preserves current Ethernet cabling use cases
  - Enables a simple upgrade path to higher speed Ethernet
  - 4 fiber pair PMDs are universally accepted in industry
- **A 4 wavelength solution will be more challenging to develop than 2 wavelengths**
  - Tighter wavelength grid: higher control of 4 VCSEL EPI growths, tighter filter control, smaller guard bands
- **No Standards specifying EMB at wavelengths other than 850 nm for OM3 and OM4**
  - Channel reach over OM3 & OM4 will be shorter for 4 wavelengths compared to 2
  - The DMD weighing functions for the 953 nm VCSELs were assumed to be the same as 850 nm (should verify)
- **The objective of this new Standard should only be the development of 400GBASE-SR4.2**
  - 400G over fewer MMF pairs is needed, a 2 wavelength progression is the next logical step
  - 100G for breakout is specified by default, transceiver can be defined in an MSA
  - Next gen 200G should be deferred to the next CFI to consider 100Gb/s PAM4 vs SWDM4