Technical feasibility of a 400 Gb/s optical PMD supporting four MMF pairs

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Motivation for a four-pair PMD using WDM

- Expect broad market potential for a four-fiber-pair MMF PMD at 400 Gb/s. For example, this would provide an attractive upgrade path for users of the successful 100GBASE-SR4 PMD
- Current MMF infrastructure is mainly single-fiber-pair or four-fiber-pair. Hence, standardization of a four-fiber-pair MMF PMD at 400 Gb/s would help to maintain the relevance of this infrastructure, significantly more so than 400GBASE-SR16
- Large industry investment in multimode WDM in recent years, evidenced by: (i) proven and widely-adopted (volume in millions) two-wavelength transceivers such as 40G Bi-Di and 100G Bi-Di; (ii) SWDM MSA four-wavelength specifications; (iii) completion of TIA-492AAAE (leading to OM5 MMF standardization)

Technical feasibility (1)

- Technical feasibility already demonstrated for RS(544, 514) FEC-supported 26.5625 GBd PAM-4 modulation using uncooled 850 nm VCSELs. This is under standardization as 50GBASE-SR, 100GBASE-SR2 and 200GBASE-SR4 in P802.3cd

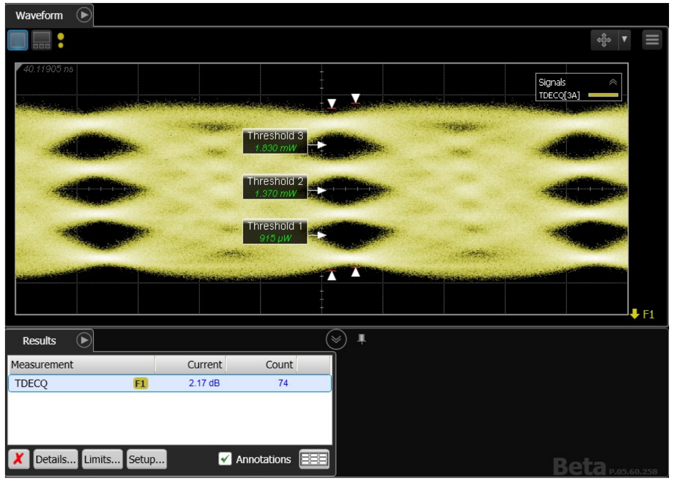
- Existing two-wavelength WDM products, such as 40G Bi-Di and 100G Bi-Di, support MMF with transmission at 855 nm and 908 nm. In particular, 100G Bi-Di uses RS(544, 514) FEC and 26.5625 GBd PAM-4 modulation to achieve 70 m, 100 m and 150 m reach over OM3, OM4 and OM5 MMF, respectively

Technical feasibility (2)

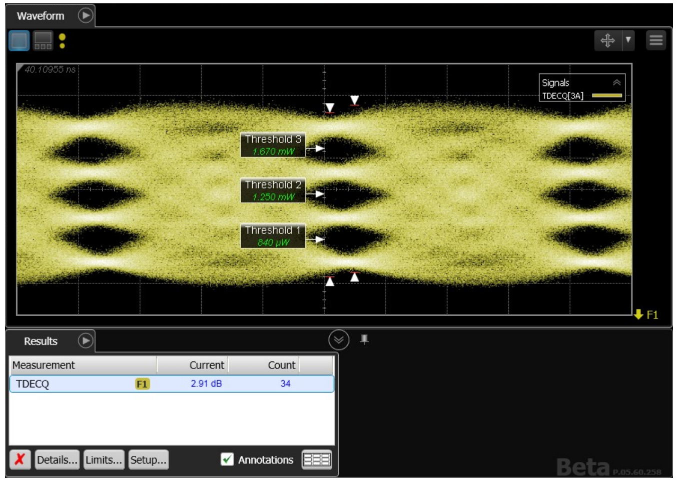
- Extensive literature to support technical feasibility – see Earl Parsons' detailed contribution to this meeting

- Guidance from fiber manufacturers and cabling suppliers has been received regarding performance of OM3 and OM4 MMF beyond 850 nm. Further refinement of this guidance during the Study Group is expected and welcomed

Technical feasibility (3)



855 nm Tx
TDECQ: 2.2 dB



908 nm Tx
TDECQ: 2.9 dB

- Measured after 70 m worst-case OM3 MMF (estimated EMB of ≈2000 MHz km at 850 nm and ≈1400 MHz km at 916 nm)
- TDECQ within the 4.9 dB limit from Clause 138
- 100 m OM4 MMF is approximately equivalent to 70 m OM3 MMF in terms of EMB at 916 nm and has been verified, for both channels, to also result in TDECQ within the 4.9 dB limit from Clause 138

Suggested wavelength ranges

Wavelength designation	Center of wavelength range	Wavelength range
L_0	855 nm	847 nm to 863 nm
L_1	908 nm	900 nm to 916 nm

- These wavelengths are suggested on the basis of being close to optimal for two-wavelength transceivers
- Interoperation with four-wavelength transceivers is not expected to be required and therefore not a criterion here
- The same two wavelengths could be used for a "200GBASE-SR2.2" PMD, thus avoiding the need for more VCSEL wavelengths to support both a four-wavelength 200 Gb/s PMD ("200GBASE-SR1.4") and a two-wavelength 400 Gb/s PMD. This would enable lower-cost transceivers

Bi-directional or co-directional?

- Both schemes are technically feasible
- A bi-directional approach would have the significant advantage of allowing breakout from a “400GBASE-SR4.2” transceiver to four 100G Bi-Di transceivers
- This decision should be made in the Task Force

Recommended path forward

- It is recommended that the Study Group decide on an objective to define “a 400 Gb/s PHY over four pairs of MMF with lengths up to at least 100 m”
- Such an objective would be expected to be met by a two-wavelength PMD, using the RS(544, 514) FEC provided by the 400GBASE-R PCS, enabling a “PMD-only” specification
- The Clause 138 specifications, including the TDECQ and SECQ methodology, with simple extension to a second wavelength, would provide an excellent technical basis