PHY Objectives and Technical Feasibility

Brian Welch (Luxtera)

Hai-Feng Liu (Intel)

Supporters

- David Chen (AOI)
- Rob Stone (Broadcom)
- Mark Kimber (Semtech)
- Phil Sun (Credo)
- Jeff Twombly (Credo)
- Hideki Isono (Fujistu)
- Tomoo Takahara (Fujitsu)
- Ed Ulrichs (Source Photonics)
- Gary Nicholl (Cisco)
- Jeffery Maki (Juniper Networks)
- Matt Brown (MACOM)

Topics

- Proposed PHY objectives
- Recent technical results
- Criteria for Standards Development
  - Proposed draft language

Proposed PHY Objectives

- Define a single-wavelength 100 Gb/s PHY for operation over SMF with lengths up to at least 2 km
- Define a single-wavelength 100 Gb/s PHY for operation over SMF with lengths up to at least 10 km
- Define a four-wavelength 400 Gb/s PHY for operation over SMF with lengths up to at least 2 km
- Define a four-wavelength 400 Gb/s PHY for operation over SMF with lengths up to at least 10 km

Feasibility

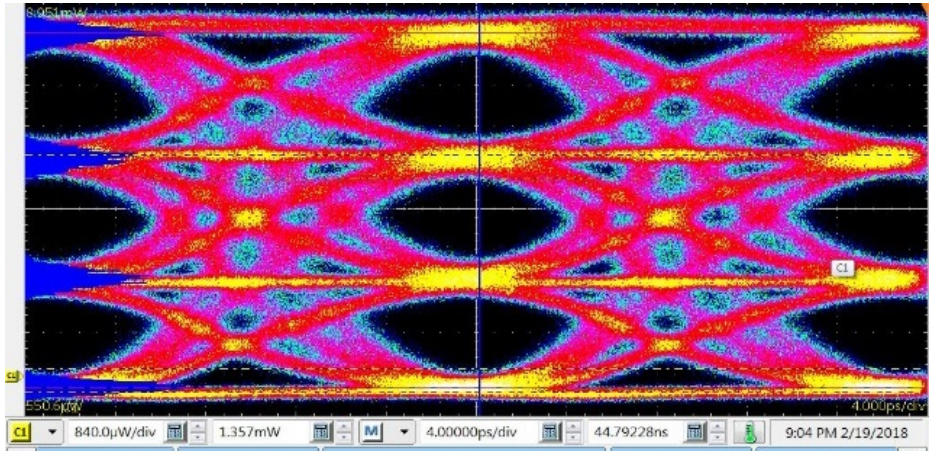
- These objectives are consistent with the scope of the study group and the market justification discussed in the CFI
- The technology to achieve these objectives is maturing quickly after the initiation on the technology development due to the 802.3bs and 802.3cd projects on 400GBASE-DR4 and 100GBASE-DR, respectively.

Technical feasibility - Transmitters

Various transmitters capable of 100 Gb/s PAM4 have been demonstrated or presented

Optical eye

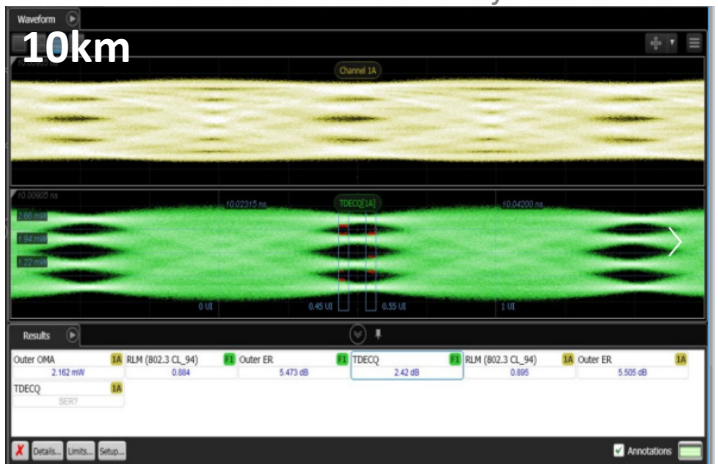
TDECQ = 1.26 dB (2 km @ 5.2 ps/nm)



53 GBaud PAM4 (106 Gb/s)

IEEE Pattern PRBS13Q See – mazzini_3cd_01a_0518

Courtesy Broadcom

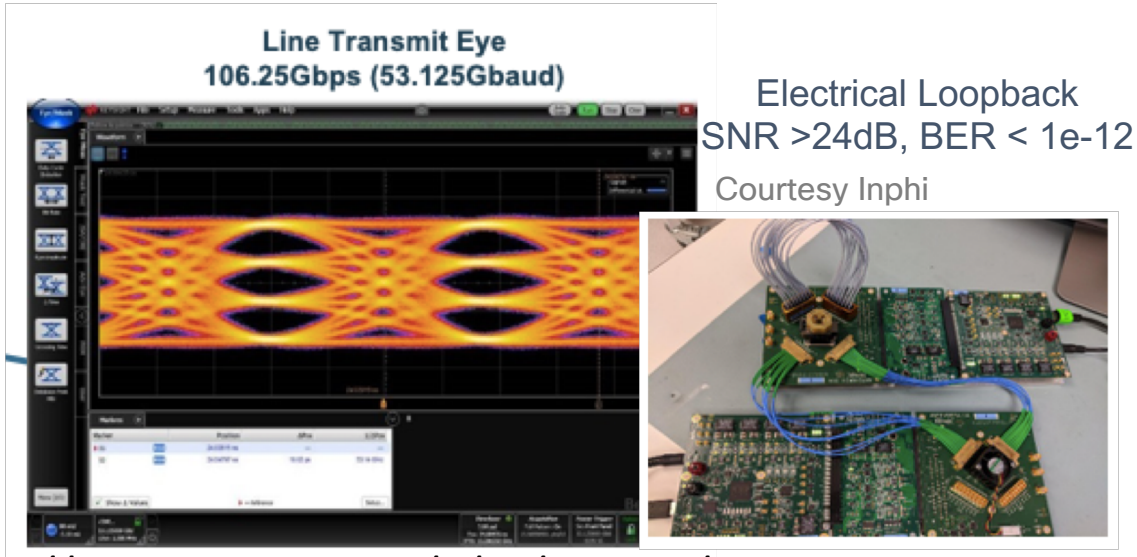


ER=6.9dB, TDECQ= 2.78dB

10 km Penalty
= 0.21dB

19 ps/nm

Electrical eye



Electrical Loopback
SNR >24dB, BER < 1e-12

Courtesy Inphi

ER=7.4dB, TDECQ= 4.24dB

21 km Penalty
= 1.54 dB

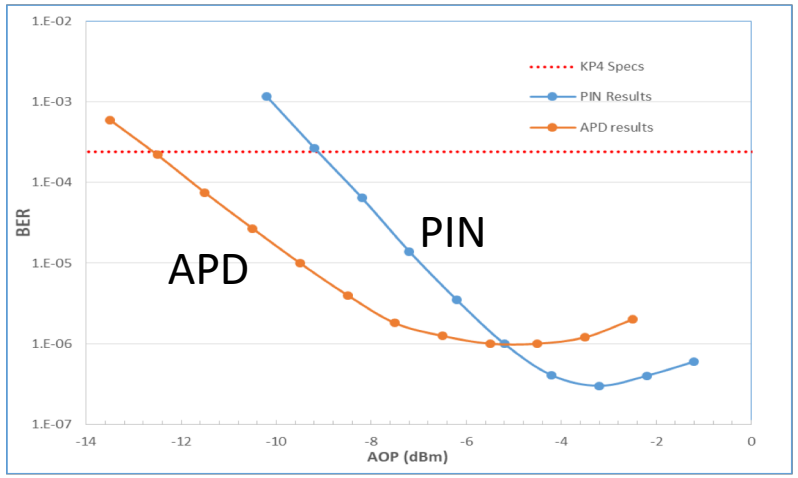
31 ps/nm

Transmitter:
AWG + linear amplifier, Vpp = 1.2V
No emphasis applied at the AWG
SSPRQ pattern at 53 GBd
56GBd EML CoC, λ = **1330nm**

http://www.ieee802.org/3/cfi/1118_1/CFI_01_1118.pdf

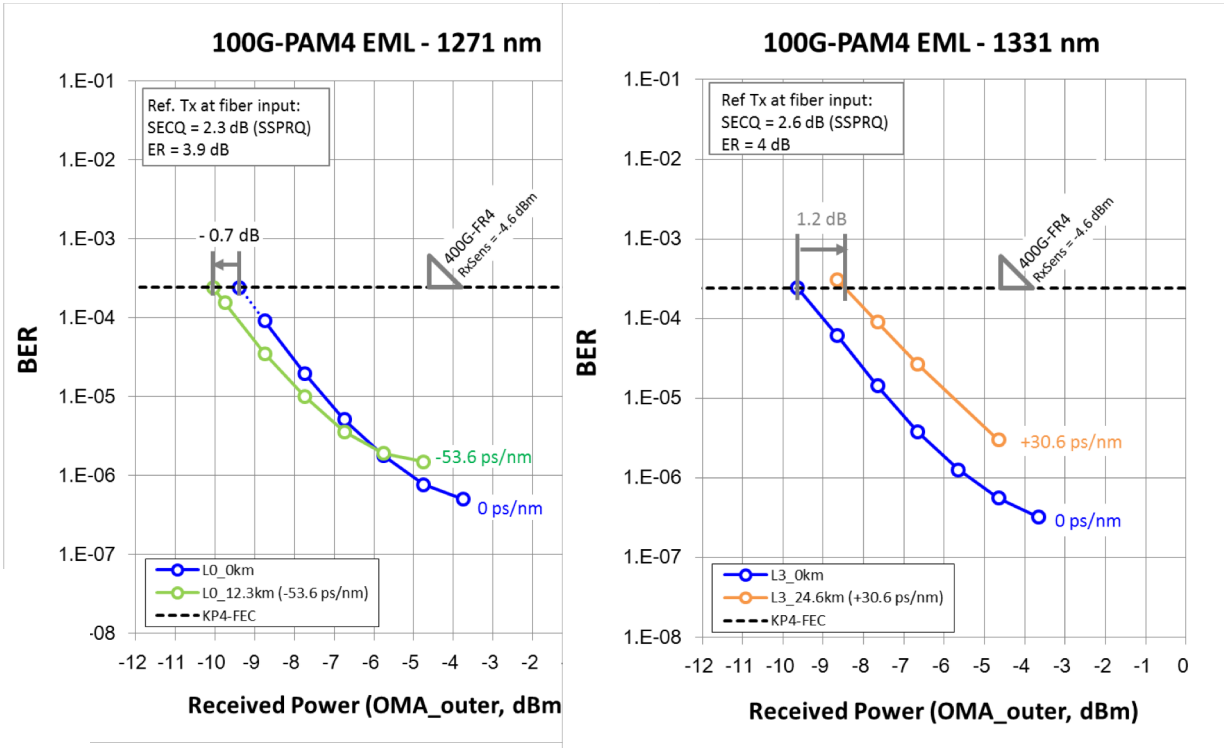
Technical feasibility – Receivers

http://www.ieee802.org/3/cfi/1118_1/CFI_01_1118.pdf



- 53.125GBaud, PAM4 PRBS31Q EML CoC (1304nm), ER ~ 5.1dB, SECQ ~ 1.8dB
- Same TIA, Same DSP

Source: IEEE OI'2018, Santa Fe, 4-6 June 2018 (Inphi/Source)
https://ieee-oi.org/program/

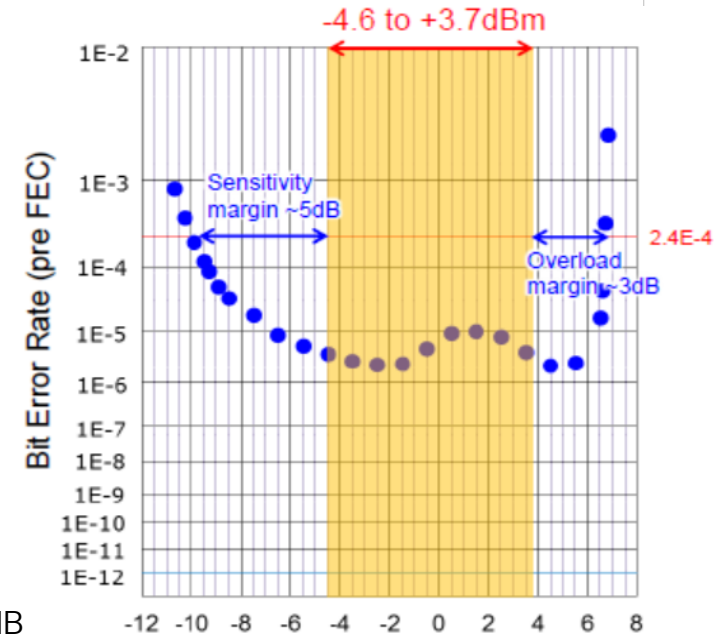


	CD (ps/nm)
IEEE MIN Spec for L0, 10km	-59.4
Measured (1271 nm, 12.3 km)	-53.6

	CD (ps/nm)
IEEE MAX Spec for L3, 10km	33.4
Measured (1331 nm, 24.6 km)	30.6

Courtesy: Oclaro

400G - 2km CWDM



53.125Gbd
PRBS15Q
ER=5.5dB
TDECQ1.6dB

Courtesy: Sumitomo Electric

Experimental Configuration:
PRBS15 53.125 Gbaud PAM4
CWDM EML CWDM PIN-PD
DSP (FFE>5 taps)
SM fiber: L0 (12.3 km) & L3 (24.6 km)

Technical Feasibility - Reliability

- Material, components and subsystems needed to build products based on these objectives are consistent with known technologies currently being developed and deployed for Ethernet based solutions
- From a reliability perspective, proposed objectives would result in products consistent with known practices for the common deployments:
  - Lasers, modulators, photodetectors, analog & digital electronics, transceiver integration & system design

Summary

- Draft PHY objectives proposed
- Existing 100 Gb/s per wavelength technology for 500m reaches has been demonstrated publicly and Technical Feasibility for longer reaches has shown through multiple examples from multiple companies of technology options to meet the objectives