

Technical Feasibility to Support Beyond 10km on 50/200GbE

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Background of Beyond 10km CFI

- In IEEE 802.3 NEA meeting at Huntington Beach, CA, many appear interested in [“Beyond 10km” Optics Strawman \(CFI\) “The Need”](#)
- In this presentation the technical feasibility of 50 & 200GbE for 40 km SMF distances based is investigated using 50Gbps PAM4 technology
- The intent is to support a “Beyond 10km” CFI

SMF Ethernet Standards under Development

Medium	Distance	25 GbE	50 GbE	100 GbE	200 GbE	400 GbE
G.652 SMF	500 m			1x100G	4x50G	4x100G
	2 km		1x50G		4x50G	8x50G
	10 km	1x25G	1x50G		4x50G	8x50G
	40 km	1x25G	?		?	

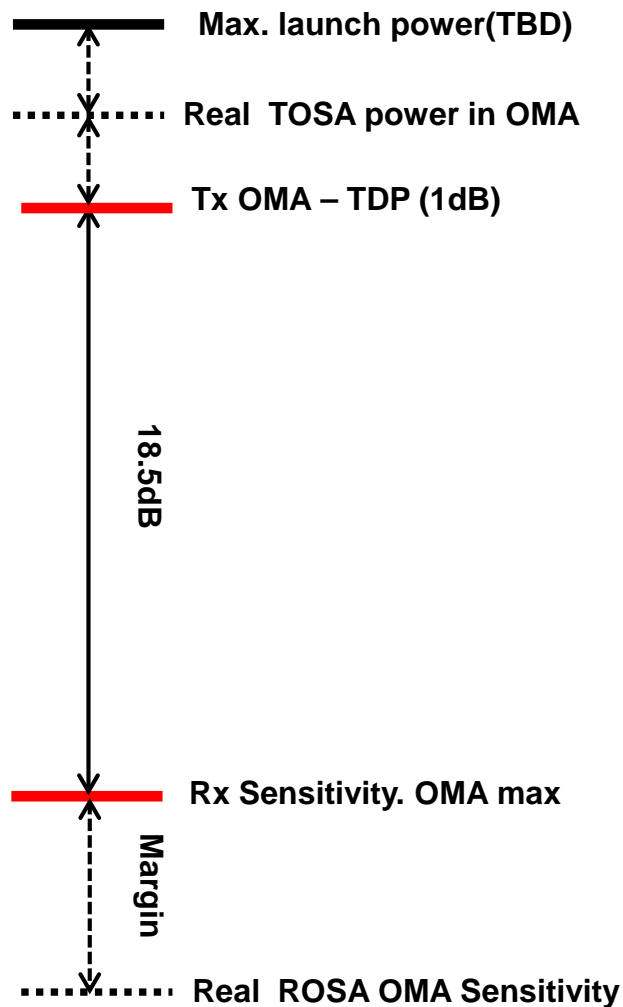
IEEE P802.3bs

IEEE P802.3cc

IEEE P802.cd

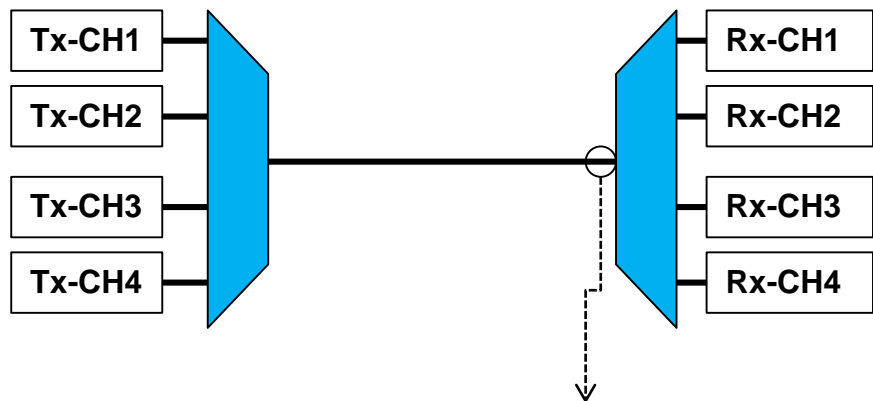
- 50Gbps PAM4 is adopted in 50/200/400GbE-2/10km standards
- Extending this technology beyond 10km optical solution will benefit industry with minimum investment and significant business opportunity

Estimated 40km SMF Link Budget



- Exact number should be investigated at Study Group/Task Force period
- The link parameter should both satisfy the transmission requirement and also economical feasibility

4X50G PAM4 System Performance: BER



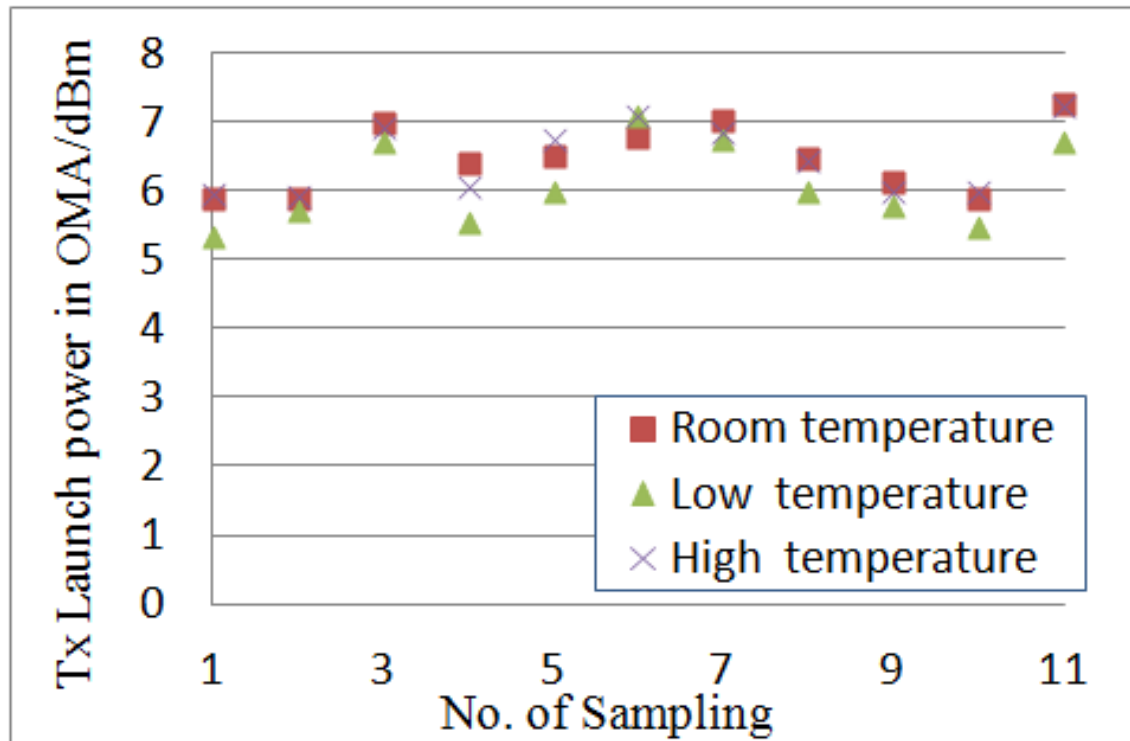
□ Test method

- Online test
- All of optical devices are commercially available
- Tx power (OMA) was adjusted to 5dBm

□ Best/Worst case of BER test result of 11 random samples

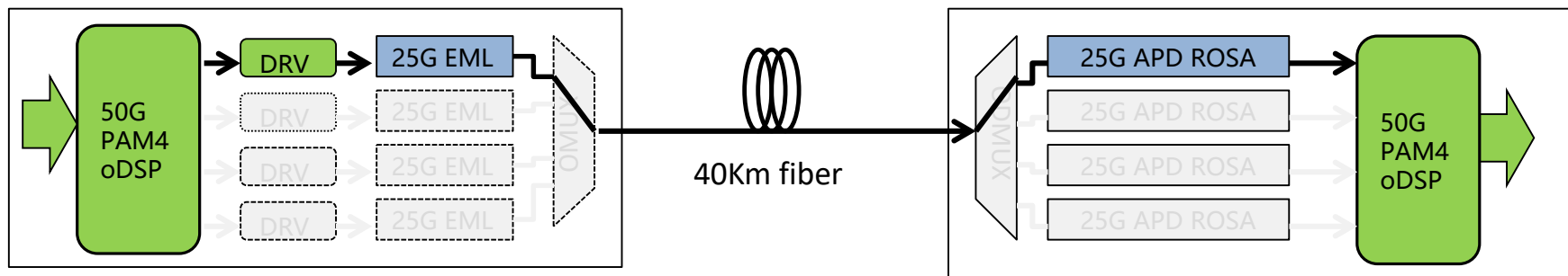
	Tx Power (OMA dBm)	Rx Sensitivity (OMA dBm)	Budget (dB)	Temp (°C)	BER
Sample 1	5	-18.6	23.6	25	2.4E-4
Sample 2	5	-17.9	22.9	25	2.4E-4

Tested Result of Transmitter Output Power



- 11 samples were tested in whole temperature range
- All of TX output power are higher than 5dBm, even under worst case.

1X50G PAM4 System Performance: Dispersion Penalty



Suggested wavelength assignments:
Same wavelength as 50GBASE-LR

Lane	Center Wavelength	Wavelength Range
CH	1311nm	1304.5 to 1317.5 nm

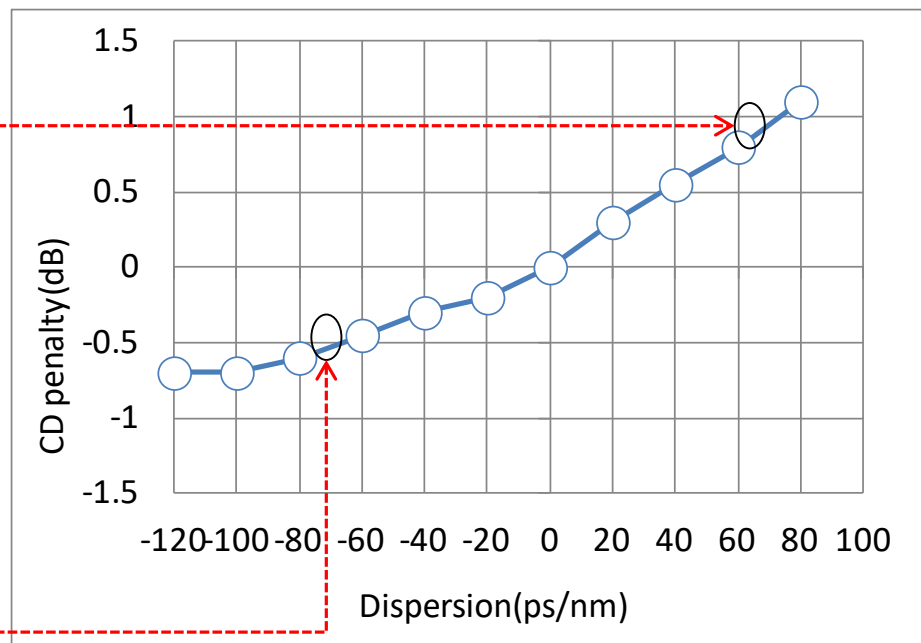
Worst case dispersion analysis:

$$\text{Dispersion min.: } 0.2325 * \lambda * \left[1 - \left(\frac{1324}{\lambda} \right)^4 \right]$$

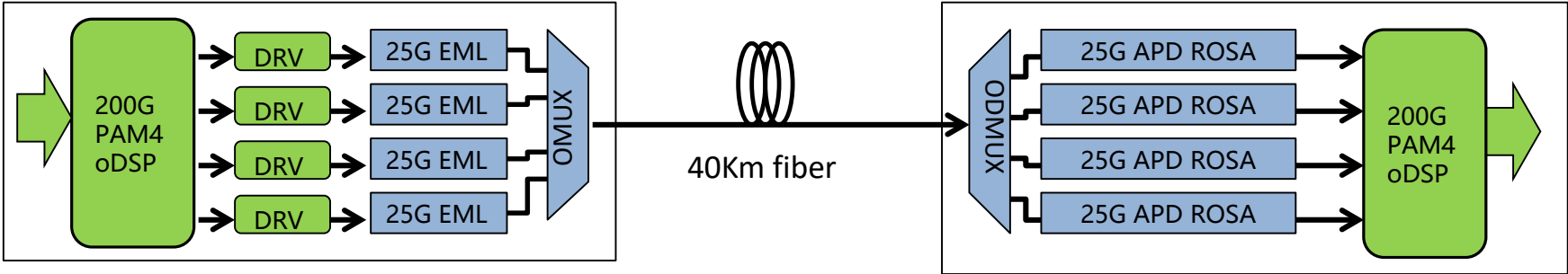
$$\text{Dispersion max.: } 0.2325 * \lambda * \left[1 - \left(\frac{1300}{\lambda} \right)^4 \right]$$

Item	Wavelength (nm)	Dispersion ($\lambda_0=1300$) ps/nm	Dispersion ($\lambda_0=1324$) ps/nm
1	1317.5	+63.81	--
2	1304.5	--	-74.18

Dispersion Penalty @2.4E-4



4X50G PAM4 System Performance: Dispersion Penalty



Suggested WDM assignments:
Same wavelength as 200GBASE-LR4

Lane	Center Frequency	Center Wavelength	Wavelength Range
L0	231.4THz	1295.56nm	1294.53~1296.59 nm
L1	230.6THz	1300.05nm	1299.02~1301.09nm
L2	229.8THz	1304.58nm	1303.54~1305.63nm
L3	229THz	1309.14nm	1308.09~1310.19nm

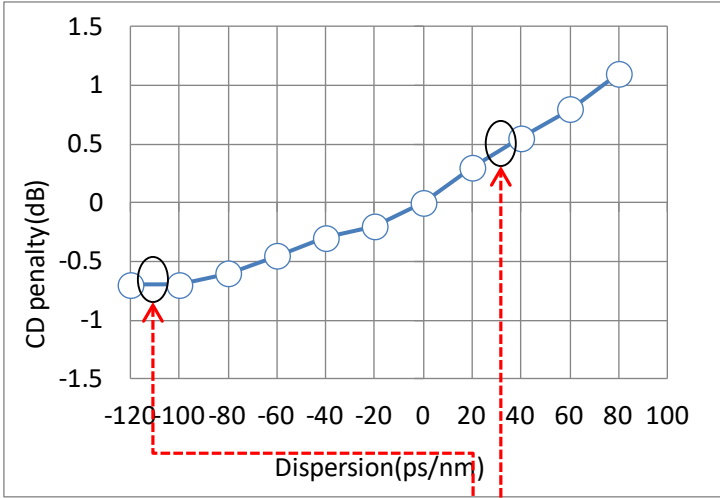
Worst case dispersion analysis:

$$Dispersion\ min.: 0.2325 * \lambda * \left[1 - \left(\frac{1324}{\lambda} \right)^4 \right]$$

$$Dispersion\ max.: 0.2325 * \lambda * \left[1 - \left(\frac{1300}{\lambda} \right)^4 \right]$$

Lane	Wavelength (nm)	Dispersion ($\lambda_0=1300$) ps/nm	Dispersion ($\lambda_0=1324$) ps/nm
L0	1294.53	--	-113.43
L3	1310.19	+37.47	--

Dispersion Penalty @2.4E-4



1/4X 50G PAM4 System Performance: Transmitter & Receiver

Transmitter characteristics

Description	50GE	200GE
Signaling Rate (GBaud/Lane)	26.5625	26.5625
Modulation format	PAM4	PAM4
Lane wavelength (nm)	1304.5~1317.5	1294.53~1296.59 1299.02~1301.09 1303.54~1305.63 1308.09~1310.19
Launch power OMAouter(dBm)	TBD	TBD
TDECQ(Db)	TBD	TBD
Extinction Ratio/dB	6	6
Transmitter reflectance (dB)	-26	-26

Receiver characteristics

Description	50GE	200GE
Signaling Rate (GBaud/Lane)	26.5625	26.5625
Modulation format	PAM4	PAM4
Damage Threshold, (dBm/Lane)	TBD	TBD
Over load power (dBm/Lane)	TBD	TBD
Receive power (OMAouter) (dBm/Lane)	TBD	TBD
Receiver sensitivity (OMAouter) (dBm/Lane)	-16.0	-14.5
Receiver reflectance (dB)	-26	-26

Summary

- Test data supporting 50/200 GbE for 40 km based on 50 Gb/s PAM4 technology is presented
- Experimental data show feasibility of 50/200 GbE operation beyond 10 km reach
- A Study Group in 802.3 will need to further study suitable PMDs in support of 50/200 GbE with reach > 10 km.

Thank You