

Security Level:

Study on Dispersion Penalty for 25G and 50G BiDi Transmission over 40km

Xiang Liu

Futurewei Technologies, USA

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Introduction

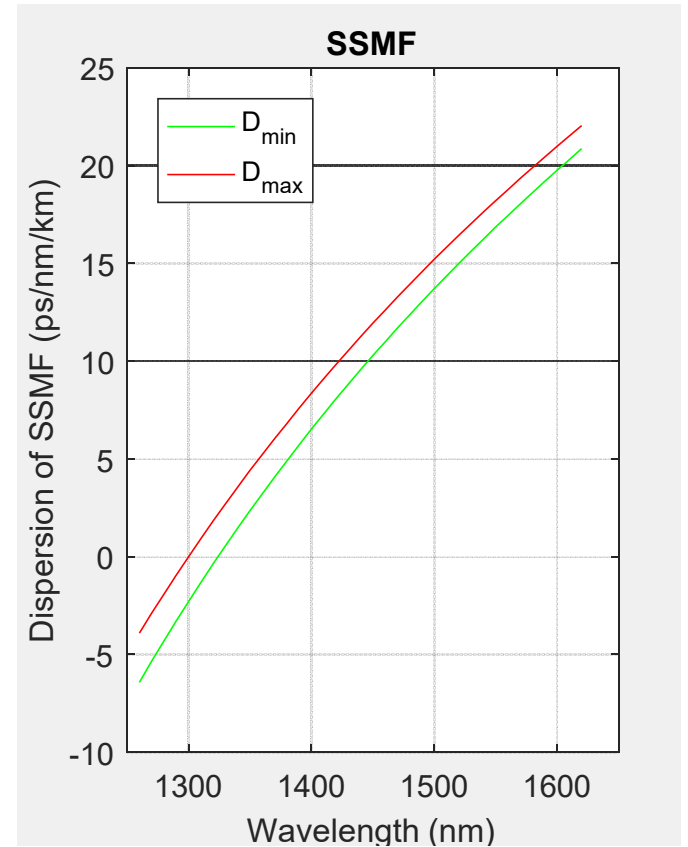
- ❑ Regarding the wavelength plans for BiDi transmission, the recommendations made so far by the Task Force are:
 - All speed/distances upstream (US) channels will use 1260 to 1280 nm.
 - 10G all distances downstream (DS) channels will use 1320 to 1340 nm.
 - 25G all distances downstream (DS) channels will likely use 1300 to 1320 nm, but the dispersion penalty needs to be verified to be sufficiently small.
- ❑ For 50G, PAM4 modulation is preferred, and both the DS and US wavelengths need to be chosen such that the dispersion penalty is sufficiently small.
 - It is preferred that the 50G wavelength plan is the same as that for 25G.
- ❑ So, the current working view of the wavelength plan is:

	10km+7dB	20km+13dB	40km + 23dB
10Gb/s	1330 / 1270 ±10nm	1330 / 1270 ±10nm	1330 / 1270 ±10nm
25Gb/s NRZ	1310 / 1270 ±10nm	1310 / 1270 ±10nm	1310 / 1270 ±10nm
50Gb/s PAM4	? / ?	? / ?	? / ?

- ❑ This presentation considers the effect of dispersion

Worst-case dispersion values for SSMF

	G.652.A&B	G.652.C&D	1300	1324
lambda (nm)	Max Loss (dB/km)	Max Loss (dB/km)	D max (ps/nm.km)	D min (ps/nm.km)
1260		0.478	0.478	-3.9009217
1270		0.466	0.460	-2.8904243
1280		0.453	0.446	-1.9040496
1290		0.439	0.435	-0.9408699
1300		0.427	0.427	0
1310		0.418	0.419	0.91940523
1320		0.414	0.413	1.81815265
1330		0.417	0.407	2.69701303
1340		0.429	0.401	3.55672287
1350		0.451	0.395	4.39798621
1360		0.485	0.389	5.22147623
1370			0.382	6.02783688
1380			0.375	6.81768426
1390			0.368	7.59160813
1400			0.360	8.3501731
1410			0.352	9.09391997
1420	0.457	0.344	9.82336681	8.0627413
1430	0.414	0.336	10.5390101	8.81506313
1440	0.381	0.329	11.2413259	9.55304563
1450	0.354	0.322	11.9307705	10.2771798
1460	0.334	0.315	12.6077818	10.9879368
1470	0.318	0.308	13.2727797	11.6857683
1480	0.307	0.303	13.9261673	12.3711083
1490	0.298	0.297	14.5683317	13.0443729
1500	0.292	0.292	15.1996444	13.7059621
1510	0.287	0.288	15.8204625	14.3562599
1520	0.284	0.284	16.4311288	14.9956352
1530	0.281	0.281	17.031973	15.6244428
1540	0.279	0.278	17.6233119	16.2430234
1550	0.277	0.276	18.2054501	16.8517048
1560	0.276	0.274	18.7786806	17.4508024
1570	0.275	0.273	19.3432853	18.0406193
1580	0.275	0.272	19.8995354	18.6214474
1590	0.276	0.273	20.4476921	19.1935676
1600	0.278	0.275	20.9880066	19.7572503
1610	0.283	0.279	21.520721	20.3127559
1620	0.291	0.285	22.0460684	20.8603352

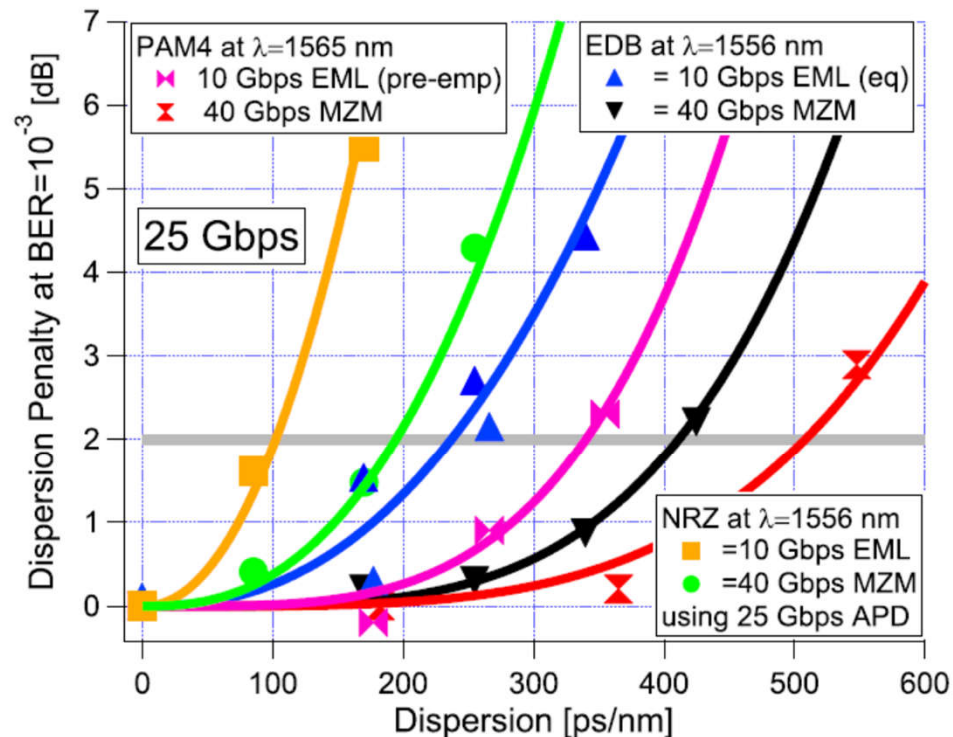


Previous reported dispersion tolerance at 25Gb/s

V. Houtsma and D. van Veen,

"A Study of Options for High-Speed TDM-PON Beyond 10G,"

in *Journal of Lightwave Technology*, vol. 35, no. 4, pp. 1059-1066, 15 Feb.15, 2017.



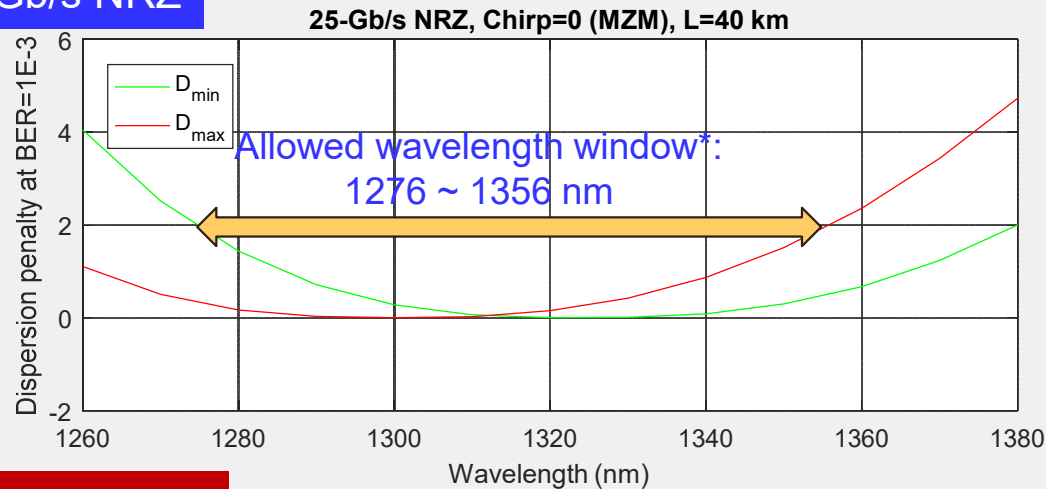
Dispersion tolerance
(for 2-dB penalty at BER=1E-3)

	25Gb/s (measured)	50Gb/s (expected)
Chirp-free NRZ (via MZM)	200 ps/nm	50 ps/nm
Chirped NRZ (via EML/DML)	100 ps/nm	25 ps/nm
Chirp-free PAM4	510 ps/nm	127.5 ps/nm
Chirped PAM4	340 ps/nm	85 ps/nm

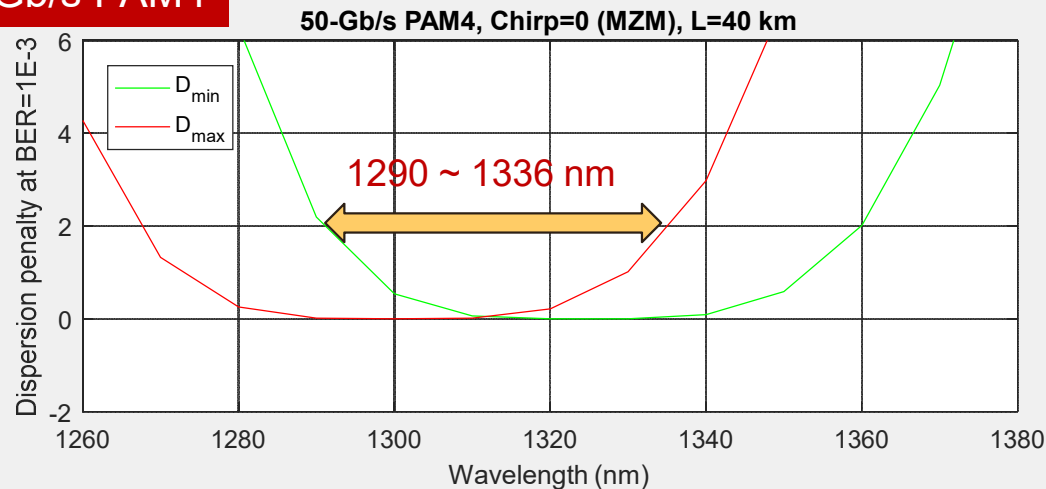
Fig. 2. Measured dispersion tolerance at 25 Gbps using a 10 Gbps APD for EDB and PAM-4 using 10 Gbps EML and 40 Gbps MZM as the transmitter. 25 Gbps NRZ using a 25 Gbps APD receiver shown as well.

Modeling results (1): The chirp-free case

25Gb/s NRZ



50Gb/s PAM4



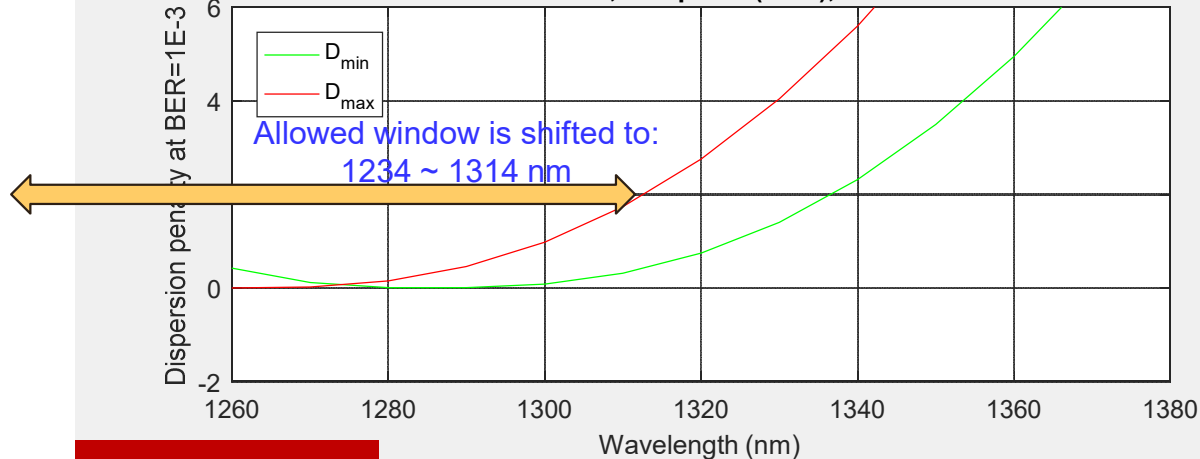
Observations:

- 1) Here, we assume an allowed dispersion penalty of 2dB.
- 2) Note that with receiver-side equalization, the penalty may be reduced.
- 3) For the chirp-free case, US wavelength centered at 1270nm can not be used.
- 4) Since chirp-free modulation is also expensive to obtain, it is thus recommended that we focus on the chirped case based on low-cost EML or DML.

Modeling results (2): The chirped case

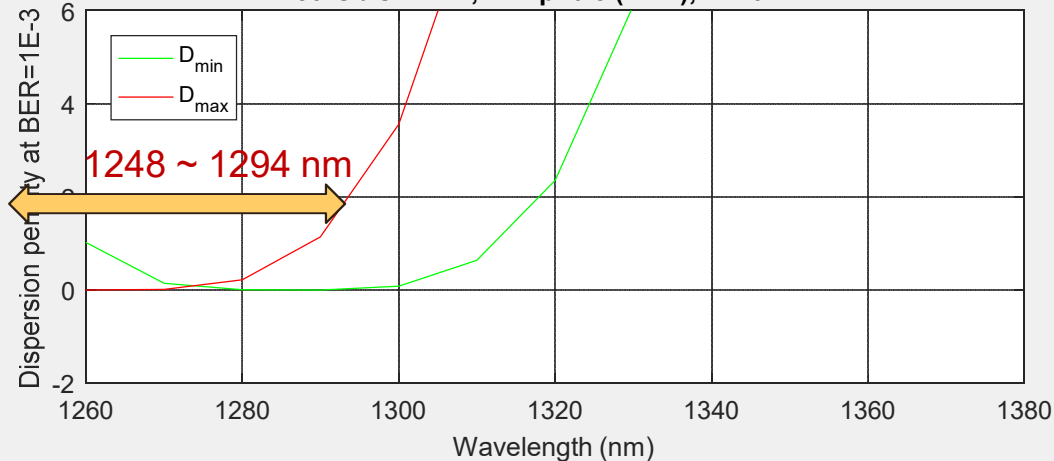
25Gb/s NRZ

25-Gb/s NRZ, Chirp=0.5 (EML), L=40 km



50Gb/s PAM4

50-Gb/s PAM4, Chirp=0.5 (EML), L=40 km



Observations:

- 1) Here, we assume a moderate chirp parameter of 0.5.
- 2) Note that with receiver-side equalization, the penalty may be reduced.
- 3) For the moderately chirped case, the allowed wavelength window is shifted by about -42 nm.
- 4) It is good that the US wavelength can be centered at 1270nm.
- 5) However, the DS wavelength needs to be <1310 nm (preferably <1294 nm) for 50Gb/s PAM4 over 40 km.

Recommendation

- ❑ Based on the dispersion penalty study, we would recommend the following wavelength plan for BiDi transmission:

	10km+7dB	20km+13dB	40km + 23dB
10Gb/s	1330 / 1270 ±10nm	1330 / 1270 ±10nm	1330 / 1270 ±10nm
25Gb/s NRZ	1330 / 1270 ±10nm	1300 / 1270 ±10nm	1300 / 1270 ±10nm
50Gb/s PAM4	1330 / 1270 ±10nm	1300 / 1270 ±10nm	1300 / 1270 ±10nm

- ❑ The above wavelength plan offers the following key benefits:
 - ✓ All DS and US wavelengths (except 10G big budget) have a default window of ±10nm, allowing the use of low-cost uncooled lasers.
 - ✓ All US wavelengths (except 10G big budget) are at 1270 ±10nm, allowing the same laser to be used.
 - ✓ The 50G wavelength plan is the same as that for 25G.
 - For 50Gb/s PAM4 over 40km, the DS wavelength window can be narrowed to 1292 ± 2nm, e.g., via a cooled laser, to (i) reduce dispersion penalty and (ii) increase laser output power, thereby increasing the link budget.
- ❑ More verifications are encouraged.

Thank you

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