Baseline Proposal for 8 x 50G NRZ for 400GbE 2km and 10km PMD

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Introduction

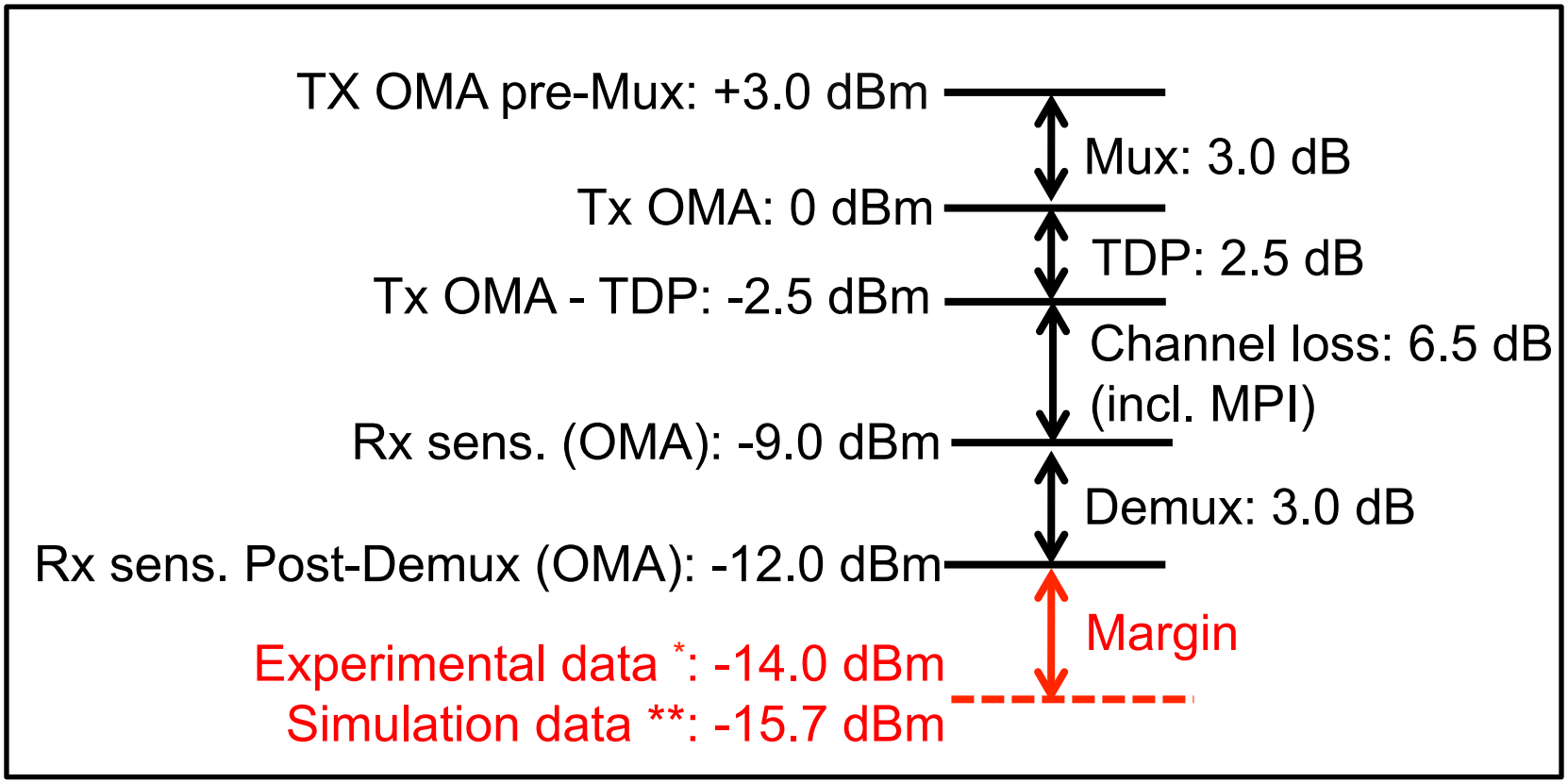
- This contribution is a baseline proposal for 8 x 50 Gb/s NRZ for 2 km and 10 km SMF.
  - The specifications are almost identical to cole_3bs_01_0115.

- 50 Gb/s NRZ is the most robust modulation formats being considered.
  - It does not show any error-floor behavior, using 40nm SerDes and commercially available 40G components (wen_3bs_01_1114)
  - It is least susceptible to multi path interference (MPI).
  - KP4 FEC (BER threshold = 2e-4) can be used.

- Chromatic dispersion is not a major issue.
- Updated power consumption data shows it is nearly comparable to other formats.

Loss budget consideration (10km)

- 8 x 50Gb/s NRZ can accommodate KP4 FEC for 400GbE 10km PMD.
- There is room for increasing the margin with more experimental data.



*) Exp. data from wen_3bs_01_1114, converted to 53.2Gb/s and BER = 2e-4.

**) Simulation conditions presented later in slide 11.

Link power budget

Parameter	2km	10km	Unit
Power budget (for maximum TDP)	6.3	9.0	dB
Operation distance	2.0	10.0	km
Channel loss	4.0	6.0	dB
MPI penalty	0.5	0.5	dB
Maximum discrete reflectance	-26	-26	dB
Allocation for penalties (for maximum TDP)	1.8	2.5	dB

Transmit characteristics (duplex SMF)

Description	2km	10km	Unit
Signaling rate, each lane	53.125 +/-100 ppm	53.125 +/-100 ppm	GBd
Lane wavelengths	1272.55 to 1274.54 1276.89 to 1278.89 1281.25 to 1283.28 1285.65 to 1287.69 1294.53 to 1296.59 1299.02 to 1301.09 1303.54 to 1305.63 1308.09 to 1310.19	1272.55 to 1274.54 1276.89 to 1278.89 1281.25 to 1283.28 1285.65 to 1287.69 1294.53 to 1296.59 1299.02 to 1301.09 1303.54 to 1305.63 1308.09 to 1310.19	nm
Side-mode suppression ratio (SMSR), min	30	30	dB
Optical Modulation Amplitude (OMA), each lane (min)	-2.8	-1.5	dBm
Launch power in OMA minus TDP, each lane (min)	-3.8	-2.5	
TDP, each lane (max)	1.8	2.5	dB
Extinction ratio (min)	4.5	4.5	dB
RIN20 OMA (max)	-130.0	-130.0	dB/Hz
Optical return loss tolerance (max)	20.0	20.0	dB
Transmitter 3dB frequency (min)	TBD	TBD	

Receive characteristics (duplex SMF)

Description	2km	10km	Unit
Signaling rate, each lane	53.125 +/-100 ppm	53.125 +/-100 ppm	GBd
Operation BER	2.0E-4	2.0E-4	
Lane wavelengths	1272.55 to 1274.54 1276.89 to 1278.89 1281.25 to 1283.28 1285.65 to 1287.69 1294.53 to 1296.59 1299.02 to 1301.09 1303.54 to 1305.63 1308.09 to 1310.19	1272.55 to 1274.54 1276.89 to 1278.89 1281.25 to 1283.28 1285.65 to 1287.69 1294.53 to 1296.59 1299.02 to 1301.09 1303.54 to 1305.63 1308.09 to 1310.19	nm
Receiver reflectance (max)	-26	-26	dB
Receiver sensitivity (OMA), each lane (max)	-8.3	-9.0	dB

Wavelength assignment

Lane	Center frequency	Center wavelength	Wavelength range
L_0	235.4 THz	1273.55 nm	1272.55 to 1274.54 nm
L_1	234.6 THz	1277.89 nm	1276.89 to 1278.89 nm
L_2	233.8 THz	1282.26 nm	1281.25 to 1283.28 nm
L_3	233.0 THz	1286.66 nm	1285.65 to 1287.69 nm
L_4	231.4 THz	1295.56 nm	1294.53 to 1296.59 nm
L_5	230.6 THz	1300.05 nm	1299.02 to 1301.09 nm
L_6	229.8 THz	1304.58 nm	1303.54 to 1305.63 nm
L_7	229.0 THz	1309.14 nm	1308.09 to 1310.19 nm

Note

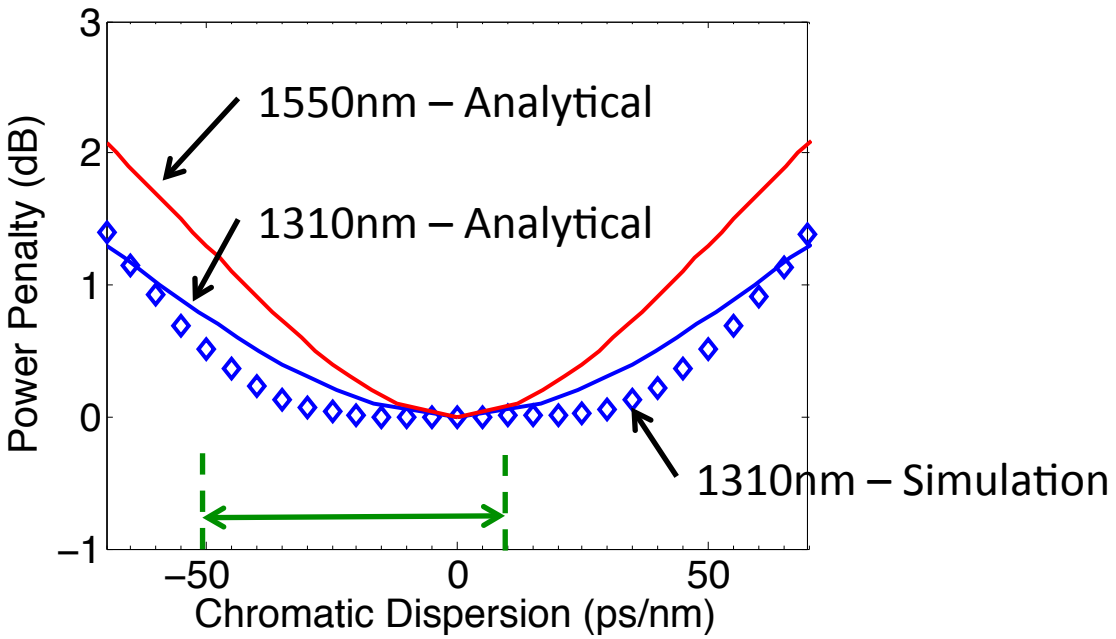
- Major changes from shirao_3bs_01d_1114 and shirao_3bs_02_114 are as follows

- FEC was changed from BCH to KP4
  - Corresponding BER threshold and baud rate were changed
- Wavelengths are fully aligned to cole_3bs_01_0115
- Link budget is fully aligned to cole_3bs_01_0115

Dispersion Penalty Study

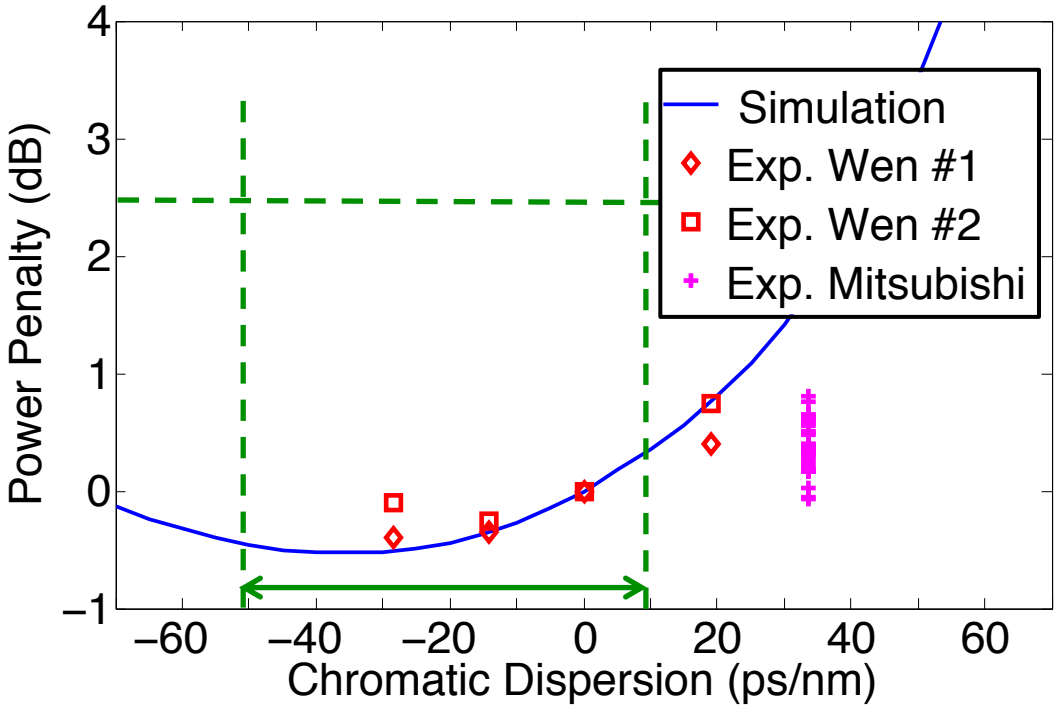
- Simulation Conditions
  - VPI Version 9.1 is used
  - EML model: Use voltage-dependent alpha parameter and transmittance, obtained from a typical 1310nm EML product for 28Gb/s
  - Rate: 53.2Gb/s
  - Extinction Ratio: 10 dB
  - Tr, Tf: 10ps
  - DJ: 1ps
  - PD Responsivity: 0.7 A/W
  - TIA Thermal Noise: 20 pA/√Hz
  - Rx BW: 35GHz, Bessel 4th order
  - Equalizer: Not used

Dispersion Penalty: 1310nm vs. 1550nm



- Here, zero chirp is assumed for all cases.
- No jitter included in the simulation.
- Analytical model is based on Gaussian pulses (ITU-T G.Suppl.39 Eq.9-4).
- For a given power penalty, much larger dispersion is allowed for 1310nm.
- There is a reasonable agreement between simulation and a simplified Gaussian pulse model.

Dispersion Penalty: Simulation vs. Experiment



Min. Dispersion
-50.83 ps/nm @ 1272.55 nm
Max. Dispersion
9.37 ps/nm @ 1310.19 nm

- Simulations at 53.2Gb/s were done using 1310nm EML measurement data (voltage-dependent positive alpha and transmittance).
- Exp. Wen #1 & 2 were measured using 1535nm EMLs*) @56Gb/s (wen_3bs_01_0914).
- Exp. Mitsubishi used 35 samples from 1535nm 43G EML product*) which were measured at 43 Gb/s, and multiplied by $(53.2/43)^2$.

*) To be conservative, conversion from 1535nm data to 1310nm was not used. If the conversion method (wen_3bs_01_1114) becomes a consensus, then chromatic dispersion values will be multiplied by $(1535/1310)^2 = 1.37$.

Power Consumption Estimation

	8x50G NRZ	Note
Laser Type	EML	
TOSA	6.6	50G EML+DRV: 0.57W/ch + Temp cont. 0.25W/ch
ROSA	2.4	50G TIA: 0.3W/ch
CDR	<2.0*	
Total	<11	

* Estimate by Credo Semiconductor

The rest of the table is from isono_3bs_01a_1114

Summary

- 50G NRZ baseline proposal is presented supporting 802.3bs SMF 2 km and 10 km objectives.
- KP4 FEC can be used for 50G NRZ with sufficient margin.
  - KR4 FEC may be used if desired.
- Dispersion penalty is not considered to be a major issue.
- Updated power consumption estimation is <11 W.