Baseline proposals for 200G/L PMD specifications for single wavelength 500 m and 2 km standards

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Caveats and Disclaimers

This presentation is only intended to present options for baseline proposals for transmitter, receiver, and channel specifications. It is not intended to recommend a specific PMD approach for accommodating the two FEC modes (common PMD or separate PMD)

Overview

Revisions relative to Welch_3dj_01_2307:

- Updates to nomenclature around FEC operation modes: Next Slide

- Updates to BER for inner_FEC: Revised to 4.8e-3
  - Previously tentatively indicated as 3e-3

- Updates to Reference EQ depth: Revised to TBD
  - Previously tentatively indicated as FFE9

FEC Definitions

- **Mode_FECo**: Optical link runs with RS(544,514) FEC protection.

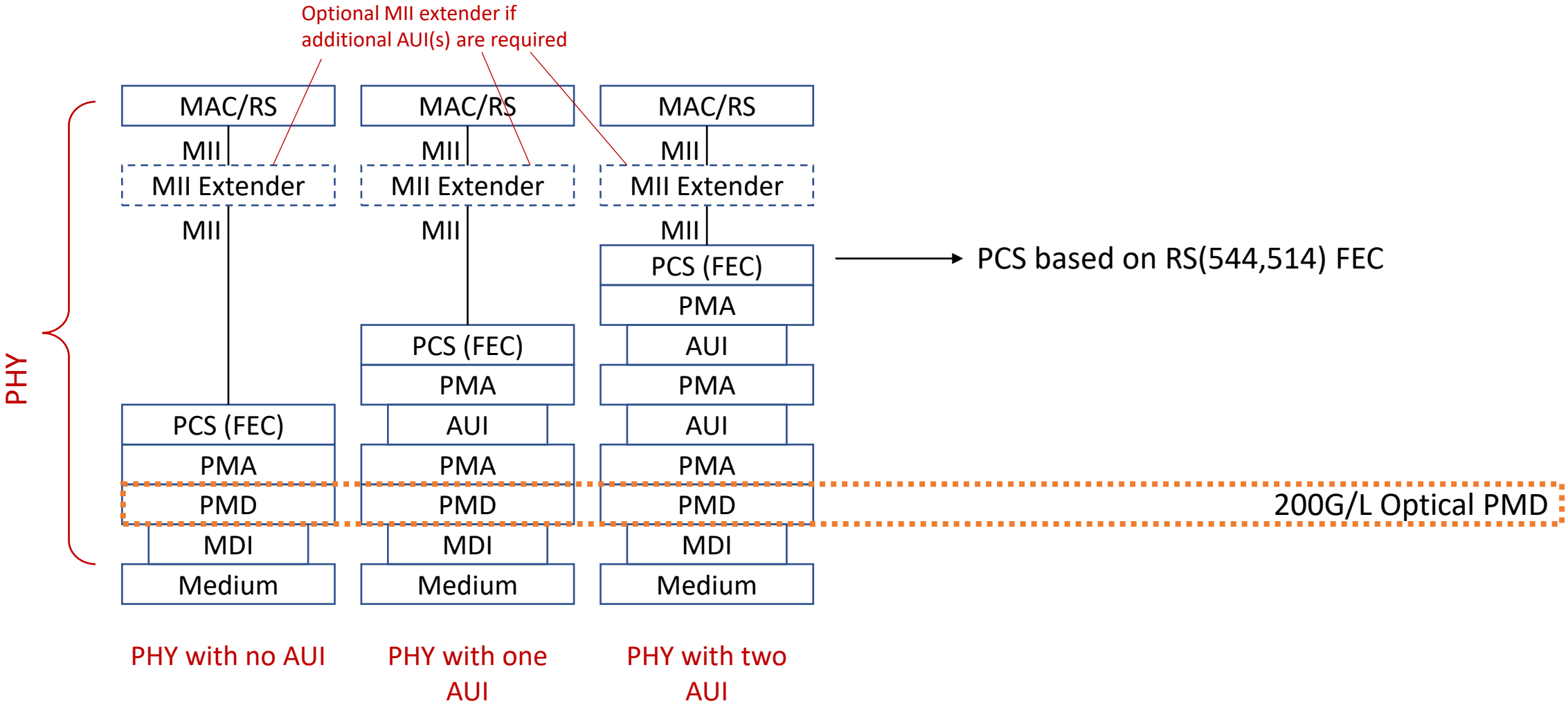
- **Mode_FECi**: Optical link runs with RS(544,514) FEC protection operating as an outer code, supplemented by Hamming(128,120) FEC protection operating as an inner code.

BER Requirements

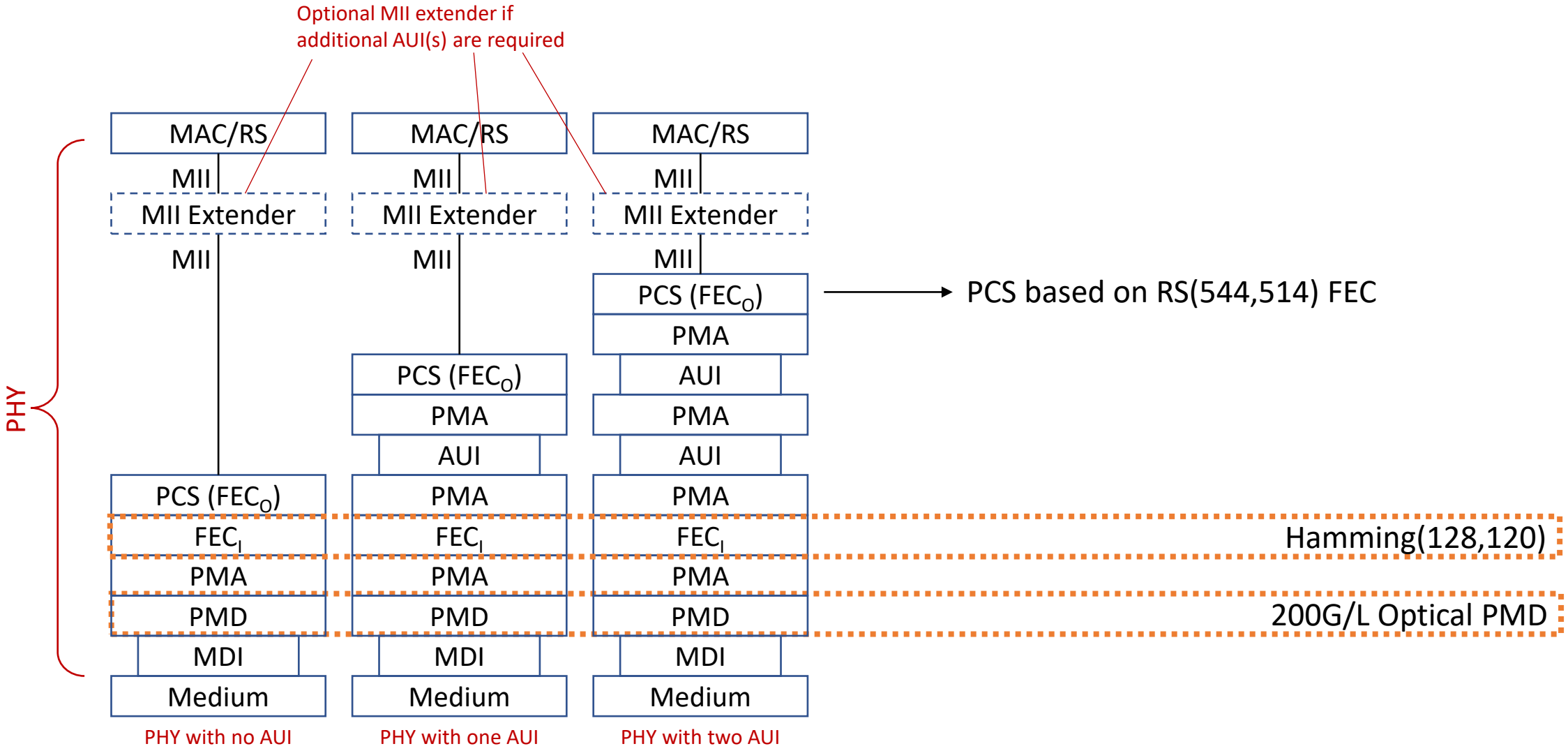
- **Mode_FECo** : The BER of the PMD link shall be less than **2.4×10^{-4}** provided that the error statistics are sufficiently random that this results in a frame loss ratio of less than 1.7×10^{-12} for 64-octet frames with minimum interpacket gap when processed with an 800GBASE-R/1.6TBASE-R PCS.

- **Mode_FECi** : The BER of the PMD link shall be less than **4.8×10^{-3}** provided that the error statistics are sufficiently random that this results in a frame loss ratio of less than 1.7×10^{-12} for 64-octet frames with minimum interpacket gap when processed with an 800GBASE-R/1.6TBASE-R PCS and inner code FEC sublayer.

Location in Ethernet Stack: Mode_FECo



Location in Ethernet Stack: Mode_FECi



Common Optical Specification

Single PMD

Common Optical Specification

- Transmitter is **allowed** to comply to **either** Mode_FECo or Mode_FECi operating condition

- Receiver is **required** to comply to **both** Mode_FECo and Mode_FECi operation conditions

Proposed Transmitter Specifications

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8		200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2		Unit
	Mode_FECo	Mode_FECi	Mode_FECo	Mode_FECi	
Signaling rate, each lane (range)	106.25 ± 50 ppm	113.4375 ± 50 ppm	106.25 ± 50 ppm	113.4375 ± 50 ppm	GBd
Modulation Format	PAM4		PAM4		
Lane wavelengths (range)	1304.5 to 1317.5		1304.5 to 1317.5		nm
Side-mode suppression ratio (SMSR), (min)	30		30		dB
Average launch power, each lane (max)	4		4		dBm
Average launch power, each lane (min)	-2.8		-2.1		dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(max)	4.2		4.2		dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(min) for TDECQ < 1.4 dB for 1.4 dB ≤ TDECQ ≤ TDECQ (max)	 0.2 -1.2 + TDECQ		 0.9 -0.5 + TDECQ		 dBm dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	3.4[a]	TBD[b]	3.4[a]	TBD[b]	dB
TECQ (max)	3.4[a]	TBD[b]	3.4[a]	TBD[b]	dB
|TDECQ - TECQ| (max)	2.5[a]	TBD[b]	2.5[a]	TBD[b]	dB
Average launch power of OFF transmitter, each lane (max)	-15		-15		dBm
Extinction ratio, each lane, (min)	3.5		3.5		dB
Transmitter transition time (max)	8		8		ps
Transmitter over/under-shoot (max)	22		22		%
RIN_xOMA (max)	-139		-139		dB/Hz
Optical return loss tolerance (max)	21.4 (15.5 for DR1)		21.4 (17.1 for FR1)		dB
Transmitter reflectance (max)	-26		-26		dB

[a] Measured with FFETBD reference equalizer with SER = 4.8e-4
[b] Measured with FFETBD reference equalizer with SER = 9.6e-3

Proposed Receiver Specifications

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8		200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2		Unit
	Mode_FECo	Mode_FECi	Mode_FECo	Mode_FECi	
Signaling rate, each lane (range)	106.25 ± 50 ppm	113.4375 ± 50 ppm	106.25 ± 50 ppm	113.4375 ± 50 ppm	GBd
Modulation Format	PAM4		PAM4		
Lane wavelengths (range)	1304.5 to 1317.5		1304.5 to 1317.5		nm
Damage threshold, each lane	5		5		dBm
Average receive power, each lane (max)	4		4		dBm
Average receive power, each lane (min)	-5.8		-6.1		dBm
Receive power, each lane (OMA_{outer}) (max)	4.2		4.2		dBm
Receiver reflectance (max)	-26		-26		dB
Receiver sensitivity (OMA_{outer}), each lane (max) for TECQ < 1.4 dB for 1.4 dB ≤ TECQ ≤ SECQ	 -2.9 -4.3 + TECQ		 -3.5 -4.9 + TECQ		 dBm dBm
Stressed receiver sensitivity (OMA_{outer}), each lane (max)	-0.9[a]	TBD[b]	-1.5[a]	TBD[b]	dBm
Conditions of stressed receiver sensitivity test:					
SECQ	3.4[a]	TBD[b]	3.4[a]	TBD[b]	dB
OMA_{outer} of each aggressor lane[c]	4.2		4.2		dBm

[a] Measured with FFETBD reference equalizer with SER = 4.8e-4
[b] Measured with FFETBD reference equalizer with SER = 9.6e-3
[C] No aggressors needed for 200GBASE-DR1 or 200GBASE-FR1

Proposed Link Budget

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8		200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2		Unit
	Mode_FECo	Mode_FECi	Mode_FECo	Mode_FECi	
Power budget (for max TDECQ)	6.5	TBD	7.8	TBD	dB
Operating distance	500		2000		m
Channel insertion loss	3		4		dB
Maximum discrete reflectance	-35		-35		dB
Allocation for penalties (for max TDECQ)	3.5	TBD	3.8	TBD	dB
Additional insertion loss allowed	0		0		dB

Separate Optical Specifications

Separate PMDs

Separate Optical Specifications

- Distinct PMD/PHY specifications for Mode_FECo and Mode_FECi
  - Each with unique transmitter, receiver, and link specifications

- No IEEE requirement for interoperability between the two
  - Ie, Mode_FECi receiver does not have to interoperate with Mode_FECo transmitters.
  - Informative interoperability specs may still be advantageous

- **Note**: This isn't a nomenclature presentation. As such "mode" designations are presently being used in the case of separate PMD/PHYs to avoid confusion.

Proposed Transmitter Specifications

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8		200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2		Unit
	Mode_FECo	Mode_FECi	Mode_FECo	Mode_FECi	
Signaling rate, each lane (range)	106.25 ± 50 ppm	113.4375 ± 50 ppm	106.25 ± 50 ppm	113.4375 ± 50 ppm	GBd
Modulation Format	PAM4	PAM4	PAM4	PAM4	
Lane wavelengths (range)	1304.5 to 1317.5	1304.5 to 1317.5	1304.5 to 1317.5	1304.5 to 1317.5	nm
Side-mode suppression ratio (SMSR), (min)	30	30	30	30	dB
Average launch power, each lane (max)	4	4	4	4	dBm
Average launch power, each lane (min)	-2.8	-2.8	-2.1	-2.1	dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(max)	4.2	4.2	4.2	4.2	dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(min) for TDECQ < 1.4 dB for 1.4 dB ≤ TDECQ ≤ TDECQ (max)	 0.2 -1.2 + TDECQ	 0.2 -1.2 + TDECQ	 0.9 -0.5 + TDECQ	 0.9 -0.5 + TDECQ	 dBm dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	3.4[a]	TBD[b]	3.4[a]	TBD[b]	dB
TECQ (max)	3.4[a]	TBD[b]	3.4[a]	TBD[b]	dB
|TDECQ - TECQ| (max)	2.5[a]	TBD[b]	2.5[a]	TBD[b]	dB
Average launch power of OFF transmitter, each lane (max)	-15	-15	-15	-15	dBm
Extinction ratio, each lane, (min)	3.5	3.5	3.5	3.5	dB
Transmitter transition time (max)	8	8	8	8	ps
Transmitter over/under-shoot (max)	22	22	22	22	%
RIN_xOMA (max)	-139	-139	-139	-139	dB/Hz
Optical return loss tolerance (max)	21.4 (15.5 for DR1)	21.4 (15.5 for DR1)	21.4 (17.1 for FR1)	21.4 (17.1 for FR1)	dB
Transmitter reflectance (max)	-26	-26	-26	-26	dB

[a] Measured with FFETBD reference equalizer with SER = 4.8e-4
[b] Measured with FFETBD reference equalizer with SER = 9.6e-3

Proposed Receiver Specifications

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8		200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2		Unit
	Mode_FECo	Mode_FECi	Mode_FECo	Mode_FECi	
Signaling rate, each lane (range)	106.25 ± 50 ppm	113.4375 ± 50 ppm	106.25 ± 50 ppm	113.4375 ± 50 ppm	GBd
Modulation Format	PAM4	PAM4	PAM4	PAM4	
Lane wavelengths (range)	1304.5 to 1317.5	1304.5 to 1317.5	1304.5 to 1317.5	1304.5 to 1317.5	nm
Damage threshold, each lane	5	5	5	5	dBm
Average receive power, each lane (max)	4	4	4	4	dBm
Average receive power, each lane (min)	-5.8	-5.8	-6.1	-6.1	dBm
Receive power, each lane (OMA_{outer}) (max)	4.2	4.2	4.2	4.2	dBm
Receiver reflectance (max)	-26	-26	-26	-26	dB
Receiver sensitivity (OMA_{outer}), each lane (max) for TECQ < 1.4 dB for 1.4 dB ≤ TECQ ≤ SECQ	 -2.9 -4.3 + TECQ	 -2.9 -4.3 + TECQ	 -3.5 -4.9 + TECQ	 -3.5 -4.9 + TECQ	 dBm dBm
Stressed receiver sensitivity (OMA_{outer}), each lane (max)	-0.9[a]	TBD[b]	-1.5[a]	TBD[b]	dBm
Conditions of stressed receiver sensitivity test:					
SECQ	3.4[a]	TBD[b]	3.4[a]	TBD[b]	dB
OMA_{outer} of each aggressor lane[c]	4.2	4.2	4.2	4.2	dBm

[a] Measured with FFETBD reference equalizer with SER = 4.8e-4
[b] Measured with FFETBD reference equalizer with SER = 9.6e-3
[C] No aggressors needed for 200GBASE-DR1 or 200GBASE-FR1

Proposed Link Budget

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8		200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2		Unit
	Mode_FECo	Mode_FECi	Mode_FECo	Mode_FECi	
Power budget (for max TDECQ)	6.5	TBD	7.8	TBD	dB
Operating distance	500	500	2000	2000	m
Channel insertion loss	3	3	4	4	dB
Maximum discrete reflectance	-35	-35	-35	-35	dB
Allocation for penalties (for max TDECQ)	3.5	TBD	3.8	TBD	dB
Additional insertion loss allowed	0	0	0	0	dB

Summary

- Baseline proposals for all 200G/L single wavelength objectives at 500m and 2km have been proposed.

- Proposals contain requirements for operation with and without an inner FEC

Thank You