

400GBASE-LR4 Baseline Proposal

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Introduction

- We fully understand the desire of a 20 nm spaced CWDM grid as noted on slide 3 of http://www.ieee802.org/3/cu/public/cu_adhoc/cu_archive/stassar_cu_adhoc_041719.pdf because of the anticipated lowest device cost.
- Currently we are still not convinced that the shown results of CWDM devices are sufficient to support stable and “plug-and-play” capable BER performance.
- Therefore this presentation includes a follow-up proposal for a baseline specification on the basis of an 800 GHz DWDM grid (aka LAN-WDM grid).

Modifications from Salt Lake City proposal

- This presentation contains some modifications to the previous proposal submitted to the meeting in Salt Lake City, May 2019, in http://www.ieee802.org/3/cu/public/May19/stassar_3cu_01a_0519.pdf

- Max DGD = 5 ps (instead of 8 ps) taking into account

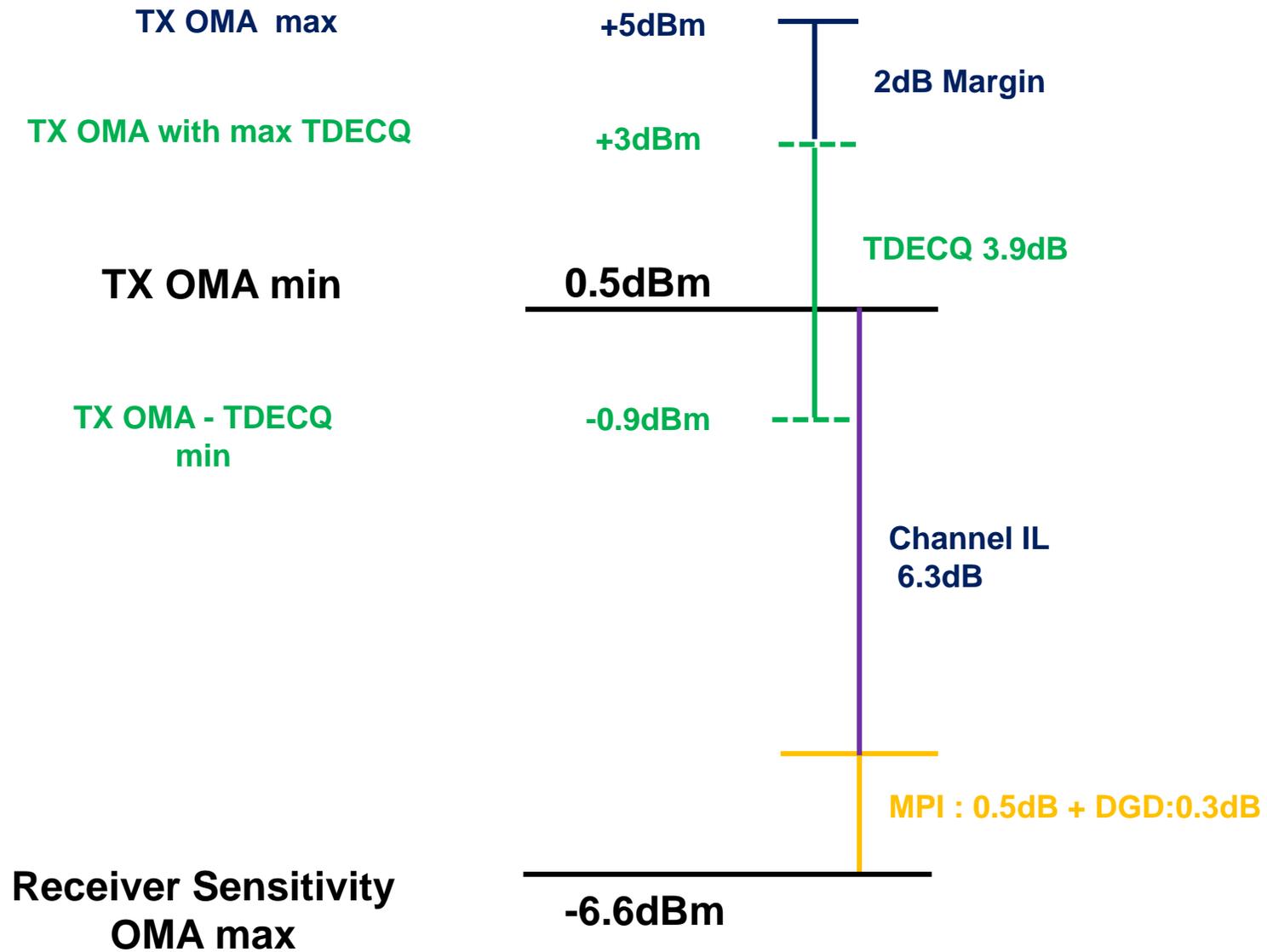
http://www.ieee802.org/3/cu/public/May19/anslow_3cu_01_0519.pdf

- Max DGD penalty assumed 0.3 dB instead of 0.6 dB

- Max TDECQ of 3.9 dB instead of 3.4 dB taking into account

http://www.ieee802.org/3/cu/public/May19/anslow_3cu_02a_0519.pdf

Specification Highlights



Transmitter Specifications

Description	Value	Unit
PAM4 Signaling rate, each lane (range)	53.125 ± 100 ppm	GBd
Lane wavelengths (range)	1294.53 to 1296.59	nm
	1299.02 to 1301.09	
	1303.54 to 1305.63	
	1308.09 to 1310.19	
Side-mode suppression ratio (SMSR), (min)	30	dB
Total average launch power (max)	10	dBm
Average launch power, each lane (max)	4	dBm
Average launch power, each lane ^a (min)	-2.5	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane (max)	5	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane ^b (min)	0.5	dBm
Difference in launch power between any two lanes (OMA _{outer}) max	4	dB
Launch power in OMA _{outer} minus TDECQ, each lane (min): for extinction ratio ≥ 4.5 dB for extinction ratio ≥ 4.5 dB	-0.9 -0.8	dBm
Transmitter and dispersion penalty eye closure for PAM4 (TDECQ), each lane (max)	3.9	dB
TDECQ – 10*log ₁₀ (C _{eq}), each lane (max) ^d	3.9	dB
Average launch power of OFF transmitter, each lane (max)	-20	dBm
Extinction ratio (min)	3.5	dB
Transmitter transition time (max)	17	ps
RIN _{15,6} OMA (max)	-136	dB/Hz
Optical return loss tolerance (max)	15.6	dB
Transmitter reflectance ^c (max)	-26	dB

Transmitter Compliance channel (for TDECQ test)

Type	Dispersion (ps/nm)		Insertion Loss	Optical Return Loss	Max Mean DGD
	Minimum	Maximum			
400GBASE-LR4	$0.2325 \cdot \lambda \cdot [1 - (1324/\lambda)^4]$	$0.2325 \cdot \lambda \cdot [1 - (1300/\lambda)^4]$	Minimum	15.6 dB	0.8 ps

Fiber optic cabling (channel) characteristics

Description	Value	Unit
Operating distance (max)	10	km
Channel insertion loss ^{a,b} (max)	6.3	dB
Channel insertion loss (min)	0	dB
Positive dispersion ^b (max)	9.5	ps/nm
Negative dispersion ^b (min)	-28.4	ps/nm
DGD_max ^c	5	ps
Optical Return Loss (min)	22	dB
a These channel loss values include cable, connectors and splices		
b Over the wavelength range 1294.53 to 1310.19 nm.		
c Differential Group Delay (DGD) is the time difference at reception between the fractions of a pulse that were transmitted in the two principal states of polarization of an optical signal. DGD_max is the maximum differential group delay that the system must tolerate.		

Optical fiber and cable characteristics

Description	Value	Unit
Nominal fiber specification wavelength	1310	nm
Cable optical fiber attenuation (max)	0.47 ^a or 0.5 ^b	dB/km
Zero dispersion wavelength (λ_0)	$1300 \leq \lambda_0 \leq 1324$	nm
Dispersion slope (max) (S_0)	0.093	ps/nm ² km
^a The 0.47dB/km attenuation for optical fiber cables is derived from Appendix I of ITU-T G.695. ^b The 0.5dB/km attenuation is provided for Outside Plant cables as defined in ANSI/TIA 568-C.3.		

Receiver Specifications

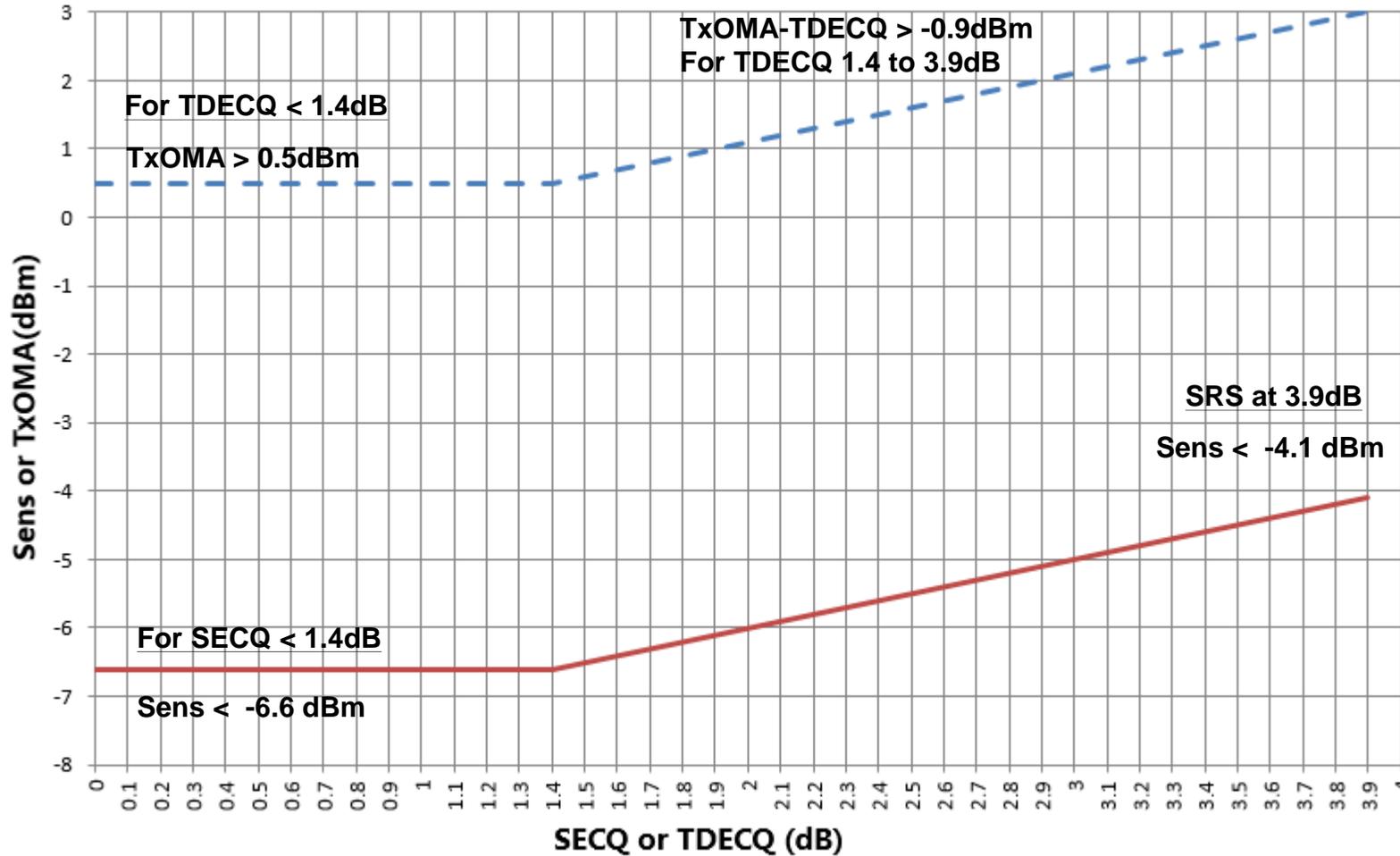
Description	Value	Unit
PAM4 Signaling rate, each lane (range)	53.125 ± 100 ppm	GBd
Lane wavelengths (range)	1294.53 to 1296.59	nm
	1299.02 to 1301.09	
	1303.54 to 1305.63	
	1308.09 to 1310.19	
Damage threshold, each lane (min) ^a	5.0	dBm
Average receive power, each lane (max)	4.0	dBm
Average receive power, each lane ^b (min)	-8.8	dBm
Receive power, each lane (OMA _{outer}) (max)	5	dBm
Difference in receive power between any two lanes (OMA _{outer}) (max)	4.1	dB
Receiver reflectance (max)	-26	dB
Receiver sensitivity (OMA _{outer}), each lane ^c (max)	MAX(-6.6,SECQ-8.0)	
Stressed receiver sensitivity (OMA _{outer}), each lane ^d (max)	-4.1	dBm
Conditions of stressed receiver sensitivity test:		
Stressed eye closure for PAM4 (SECQ), lane under test	3.9	dB
SECQ – 10*log ₁₀ (C _{eq}), lane under test (max) ^e	3.9	dB
OMA _{outer} of each aggressor lane	0	dBm

Power Budget

Description	Value	Unit
Power budget (for max TDECQ) for extinction ratio ≥ 4.5 dB for extinction ratio < 4.5 dB	11 11.1	dB
Operating distance	10.0	km
Channel insertion loss ^a	6.3	dB
Maximum discrete reflectance	See Table Below	dB
Allocation for penalties ^b (for max TDECQ) for extinction ratio ≥ 4.5 dB for extinction ratio < 4.5 dB	4.7 4.8	dB
Additional insertion loss allowed	0	dB
<p>^a The channel insertion loss is calculated using the maximum distance specified in Table 2-2 and cabled optical fiber attenuation of 0.43 dB/km plus an allocation for connection and splice loss given in 5.2.1.</p> <p>^b Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.</p>		

Number of discrete reflectance above -55dB	Maximum value for each discrete reflectance	Unit
1	-22	dB
2	-29	dB
4	-33	dB
6	-35	dB
8	-37	dB
10	-39	dB

Illustration of receiver sensitivity mask



Recommendation

**Propose to adopt the proposed baseline specification for
400GBASE-LR4**

