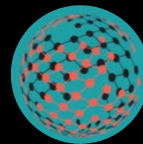




25GbE SMF 10km/40km Baseline Proposal

20160523

K. Tamura, N. Shibuya



Supporters

- Mark Nowell, Cisco
- Peter Jones, Cisco
- Vipul Bhatt, Inphi
- Ryan Latchman, MACOM
- Vineet Saluke, Cisco
- Matt Traverso, Cisco
- Kenneth Jackson, Sumitomo Electric Device Innovations USA
- Xu Yu, Huawei
- Ed Ulrich, Source Photonics
- Carlo Tossetti, Cisco
- Jan Filip, Maxim
- Mike Dudek, Qlogic
- David Malicoat, HPE
- Jon Lewis, Dell
- John D'Ambrosia, Futurewei
- Jeff Maki, Juniper Networks
- Vittal Balasubramani, Dell
- David Piehler, Dell
- Paul Brooks, Viavi
- Dale Murray, Light Counting
- Tom McDermott, Fujitsu
- Frank Effenberger, Huawei
- Brian Welch, Luxtera
- Scott Kipp, Brocade
- Jonathan King, Finisar
- Salvatore Rotolo, ST Micro
- Hideki Isono, Fujitsu Optical Components
- David Ofelt, Juniper Networks
- Venugopal Balasubramonian, Marvell
- Zhigang Gong, O-Net
- Mark Kimber, Semtech
- Bharat Tailor, Semtech
- Hai-Feng Liu, Intel
- Scott Schube, Intel

Outline

1. This presentation is a baseline proposal for a retimed 25Gb/s PMD to address the following objective of P802.3cc:
 - Provide physical layer specification which support 25 Gb/s operation over at least 10 km on SMF.
 - Provide physical layer specification which support 25 Gb/s operation over at least 40 km on SMF.
 - Provide appropriate support for OTN.

2. P802.3cc also has the following foundational objectives, which are carried over from P802.3by:
 - Support a MAC data rate of 25 Gb/s
 - Support full-duplex operation only
 - Preserve the Ethernet frame format utilizing the Ethernet MAC
 - Preserve minimum and maximum Frame Size of current IEEE 802.3 standard
 - Support a BER of better than or equal to 10^{-12} at the MAC/PLS service interface (or the frame loss ratio equivalent)
 - Support optional Energy-Efficient Ethernet operation
 - Support OTN

Background

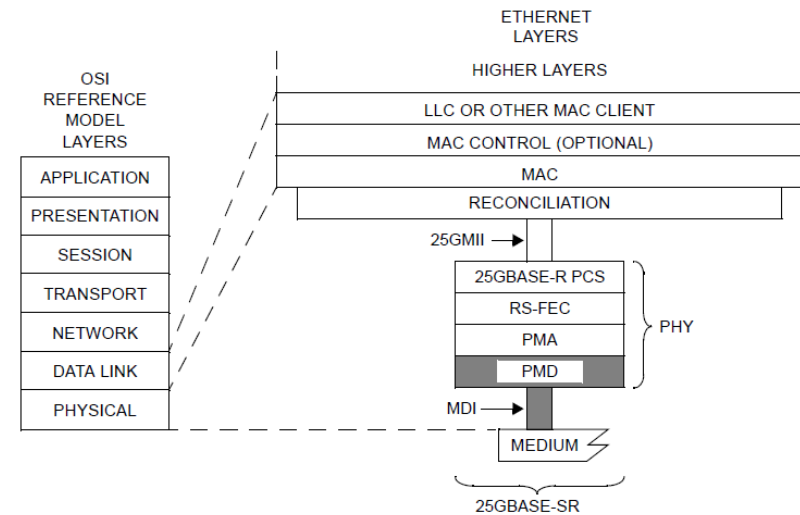
1. P802.3by defines 25GBASE-SR PMD as shown below (Ref: 8023by_D2p2.pdf)

Table 112-1—Physical Layer clauses associated with the 25GBASE-SR PMD

Associated clause	25GBASE-SR
106—RS	Required
106—25GMII ^a	Optional
107—PCS for 25GBASE-R	Required
108—RS-FEC ^b	Required
109—PMA for 25GBASE-R	Required
109A—25GAUI C2C	Optional
109B—25GAUI C2M	Optional
78—Energy Efficient Ethernet	Optional

^aThe 25GMII is an optional interface. However, if the 25GMII is not implemented, a conforming implementation must behave functionally as though the RS and 25GMII were present.

^bThe option to bypass the Clause 108 RS-FEC correction function is not supported.



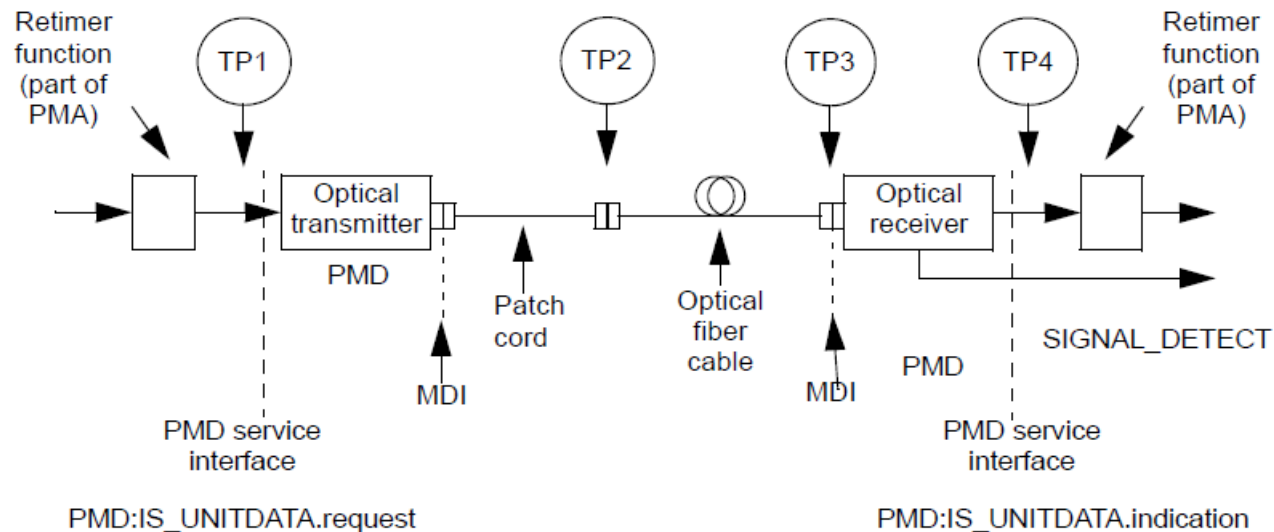
25GMII = 25 GIGABIT MEDIA INDEPENDENT INTERFACE
 LLC = LOGICAL LINK CONTROL
 MAC = MEDIA ACCESS CONTROL
 MDI = MEDIUM DEPENDENT INTERFACE
 PCS = PHYSICAL CODING SUBLAYER

PHY = PHYSICAL LAYER DEVICE
 PMA = PHYSICAL MEDIUM ATTACHMENT
 PMD = PHYSICAL MEDIUM DEPENDENT
 RS-FEC = REED-SOLOMON FORWARD ERROR
 CORRECTION
 SR = PMD FOR MULTIMODE FIBER

Figure 112-1—25GBASE-SR PMD relationship to the ISO/IEC Open Systems Interconnection (OSI) reference model and the IEEE 802.3 Ethernet model

Proposal For 25GbE SMF

1. **Logical and Electrical** Layer clauses as associated with 25GBASE-SR
2. Specify PMD and MDI suitable for 25Gb/s Ethernet over 10km and 40km of duplex SMF (see diagram)
 - Transmitter specification at TP2
 - Receiver specification at TP3
 - TP1 and TP4 informative (not accessible)

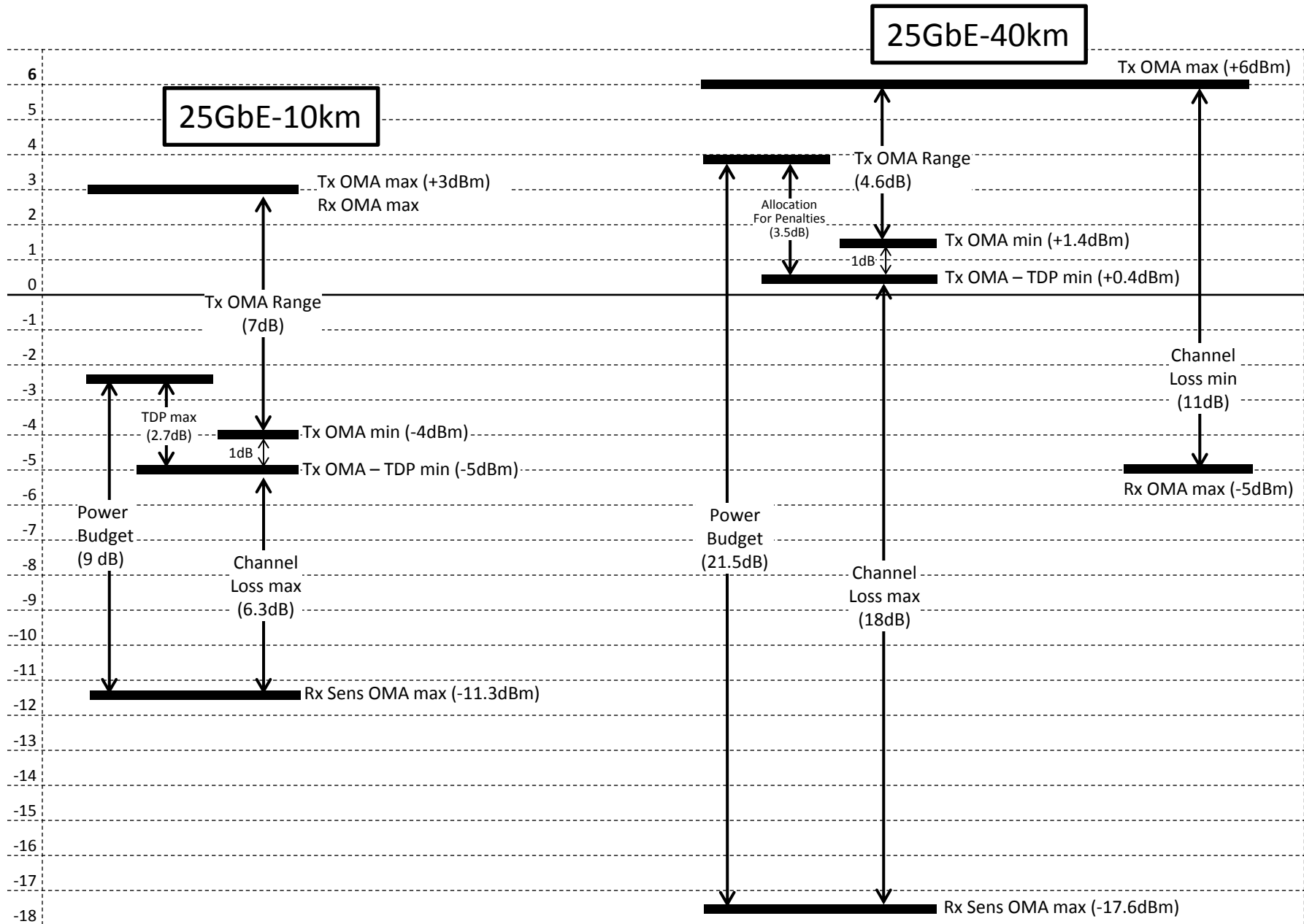


For clarity, only one direction of transmission is shown

Approach To 25GbE SMF Specification

1. For 10km, use approach outlined in tamura_160314f_10km_25GSMF.pdf and leverage work in 32G FibreChannel, 100G-CWDM4, and 100G-PSM4.
2. For 40km, use approach outlined in tamura_160314e_40km_25GSMF.pdf and leverage work in ITU-T G.959.1 for application code 4L1-9D1F (100G 40km with APD)
3. Reference 100GBASE-LR4 and 100GBASE-ER4 specifications where appropriate
4. Make adjustments where reasonable

25GbE SMF Link Budget Summary



Channel Characteristics

Description	25GbE-LR	25GbE-ER		Unit
		30	40	
Operating distance (max)	10	30	40	km
Channel insertion loss ^{a, b} (max)	6.3	18		dB
Channel insertion loss (min)	0	11		dB
Positive dispersion ^b (max)	23	28	36	ps/nm
Negative dispersion ^b (min)	-28	-84	-114	ps/nm
DGD_max ^c	8	10.3	10.3	ps
Optical return loss (min)	21	21		dB

a. These channel insertion loss values include cable, connectors, and splices.

b. Over the wavelength range 1295nm to 1325nm for 25GbE-LR and 1295nm to 1310nm for 25GbE-ER.

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.

Operating Ranges

PMD type	Required operating range
25GbE-LR	2m to 10km
25GbE-ER	2m ^b to 30km
	2m ^b to 40km ^a

- a. Links longer than 30km for the same link power budget are considered engineered links. Attenuation for such links needs to be less than the worst case specified B1.1, B1.3, or B6_a single mode fiber.
- b. For short distances with low channel loss, optical attenuators are required in order to not exceed the maximum power specifications of the receiver.

Transmit Characteristics (Essential)

Description	25GbE-LR	25GbE-ER	Unit
Signaling rate (range)	25.78125 \pm 100ppm		GBd
Operating BER (max)	5x10 ⁻⁵		
Wavelength (range)	1295 to 1325	1295 to 1310	nm
Average launch power (max)	2.0	6.0	dBm
Average launch power (min)	-6.5	2.0	dBm
Optical Modulation Amplitude (OMA), (max)	3.0	6.0	dBm
Optical Modulation Amplitude (OMA), (min)	-4	1.4	dBm
Launch power in OMA minus TDP (min)	-5	0.4	dBm
Transmitter and dispersion penalty (TDP), (max)	2.7	2.7	dB
Extinction ratio (min)	3.5	4	dB

Transmit Characteristics (Other)

Description	25GbE-LR	25GbE-ER	Unit
Side-mode suppression ratio (SMSR), (min)	30		dB
Average launch power of OFF transmitter (max)	-30		dBm
RIN ₂₀ OMA (max)	-130		dB/Hz
Optical return loss tolerance (max)	20		dB
Transmitter reflectance (max)	-12		dB
Transmitter eye mask definition (X1, X2, X3, Y1, Y2, Y3)	{0.31, 0.4, 0.45, 0.34, 0.38, 0.4}		

Receive Characteristics (Essential)

Description	25GbE-LR	25GbE-ER	Unit
Signaling rate (range)	25.78125 ± 100ppm		GBd
Operating BER (max)	5 x 10 ⁻⁵		
Wavelength (range)	1295 to 1325	1295 to 1325	nm
Damage threshold (min)	5.5	TBD	dBm
Receiver sensitivity (OMA) (max)	-11.3	-17.6	dBm
Stressed receiver sensitivity (OMA) (max)	TBD	TBD	dBm
Conditions of stressed receiver sensitivity test:			
Vertical eye closure penalty	TBD	TBD	dB
Stressed eye J2 Jitter	TBD	TBD	UI
Stressed eye J4 Jitter	TBD	TBD	UI
SRS eye mask definition (X1, X2, X3, Y1, Y2, Y3)	TBD	TBD	

Receive Characteristics (Other)

Description	25GbE-LR	25GbE-ER	Unit
Average receive power (max)	2.0	-5.0	dBm
Average receive power (min)	-12.8	-16.0	dBm
Receive power(OMA) (max)	3.0	-5.0	dBm
Receiver reflectance (max)	-26		dB
Receiver 3 dB electrical upper cutoff frequency (max)	31	31	GHz

Illustrative Link Power Budget

Parameter	25GbE-LR	25GbE-ER		Unit
Power budget (for max TDP)	9	21.5		dB
Operating distance	10	30	40	km
Channel insertion loss (max)	6.3	15	18	dB
Channel insertion loss (min)	0	11		dB
Maximum discrete reflectance	-26	-26		dB
Allocation for penalties (for max TDP)	2.7	-		dB
Allocation for penalties	-	3.5		
Additional insertion loss allowed	0	3	0	dB

Summary

1. Baseline proposals summarized for 25GbE over 10km (LR) and 40km (ER).
2. **Logical and Electrical Layer** clauses are the same as 25GBASE-SR, which adds 25GbE-LR and 25GbE-ER PMDs to existing 25GbE ports.