

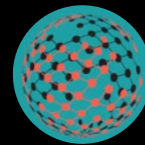


## An Approach To 25GbE SMF 40km Specification

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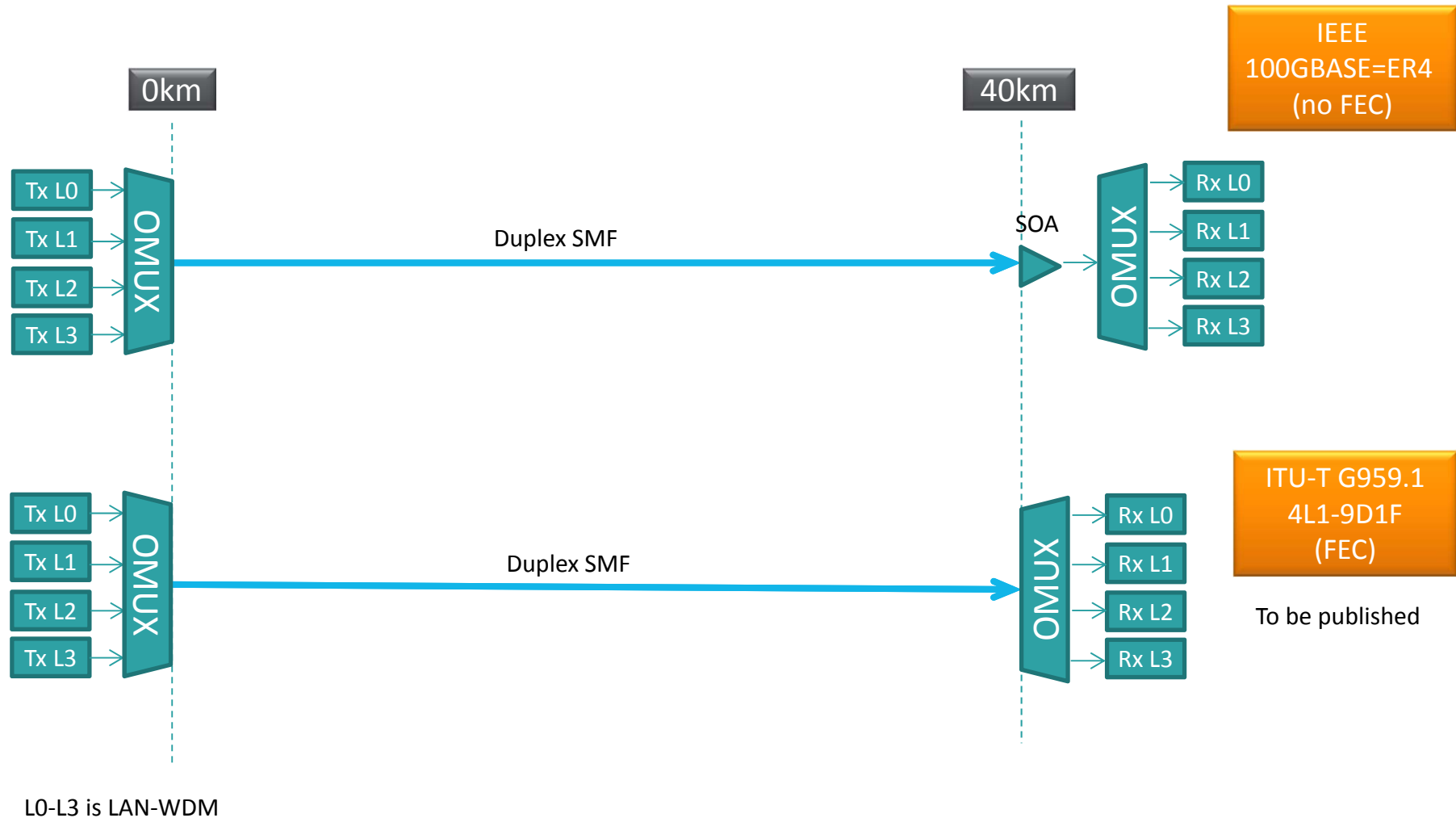
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# Outline

1. Review existing 25G/lane standards at 40km
  1. 100GBASE-ER4
  2. ITU-T G959.1 4L1-9D1F
2. Discuss technical feasibility of 25GbE-40km with FEC
  1. EML + APD
  2. DML + APD
3. Summary

# Existing 25G/Lane Specifications At 40km



Note: Diagrams are of implementations assumed in specification

# Channel Characteristics Of 100GBASE-ER4

**Table 88–14—Fiber optic cabling (channel) characteristics**

Description	100GBASE–LR4	100GBASE–ER4		Unit
		30	40	
Operating distance (max)	10	30	40	km
Channel insertion loss <sup>a, b</sup> (max)	6.3	18	18	dB
Channel insertion loss (min)	0	0		dB
Positive dispersion <sup>b</sup> (max)	9.5	28	36	ps/nm
Negative dispersion <sup>b</sup> (min)	–28.5	–85	–114	ps/nm
DGD_max <sup>c</sup>	8	10.3	10.3	ps
Optical return loss (min)	21	21	21	dB

<sup>a</sup>These channel insertion loss values include cable, connectors, and splices.

<sup>b</sup>Over the wavelength range 1294.53 nm to 1310.19 nm

<sup>c</sup>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.

# 25GbE (802.3by/D2.2)

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

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

<sup>a</sup>The 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.

<sup>b</sup>The option to bypass the Clause 108 RS-FEC correction function is not supported.

## 112.1.1 Bit error ratio

The bit error ratio (BER) shall be less than  $5 \times 10^{-5}$  provided that the error statistics are sufficiently random that this results in a frame loss ratio (see 1.4.223) of less than  $6.2 \times 10^{-10}$  for 64-octet frames with minimum interpacket gap when processed according to Clause 108.

If the error statistics are not sufficiently random to meet this requirement, then the BER shall be less than that required to give a frame loss ratio of less than  $6.2 \times 10^{-10}$  for 64-octet frames with minimum interpacket gap when processed according to Clause 108.

Ref: 802.3by, Draft 2.2

# Example Of 112G 40km Specification With APD Receiver

Parameters	Unit	Proposed to ITU In 4L1-9D1F* (One Lane)	
		Low ER	High ER
$T_X$ OMA (min)	dBm	1.85	1.85
$T_X P_{avg}$ (min)	dBm	<b>2.5</b>	<b>0.6</b>
$T_X$ ER (min)	dB	<b>4</b>	<b>7</b>
$R_X$ OMA (min)	dBm	-16.1	-16.1
$R_X P_{avg}$ (min)	dBm	<b>-15.5</b>	<b>-17.4</b>
$R_X$ Sens OMA (max)	dBm	-17.6	-17.6
$R_X$ Sens $P_{avg}$ (max)	dBm	<b>-17.0</b>	<b>-18.9</b>
Penalties	dB	<b>1.5</b>	<b>1.5</b>
Loss Budget	dB	<b>18</b>	<b>18</b>

\* With G.709 FEC

Could use same OMA specifications (green) for 25GbE over 40km

**Red bold:** Explicit spec.

Black: Inferred spec.

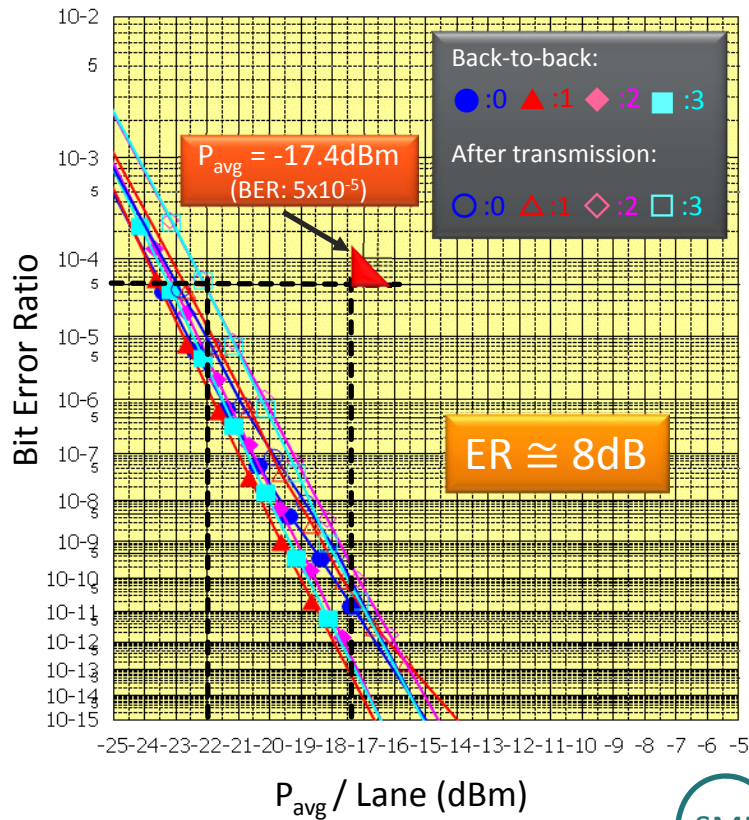
Note: ITU spec not finalized.

Ref: tamura\_25gsmf\_01\_0116.pdf, IEEE Interim Meeting, Atlanta, Jan 17-22, 2016.

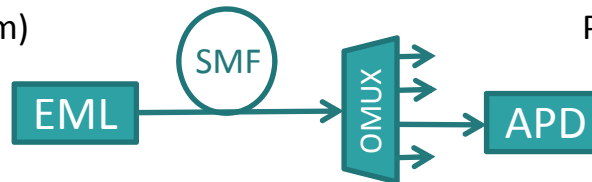
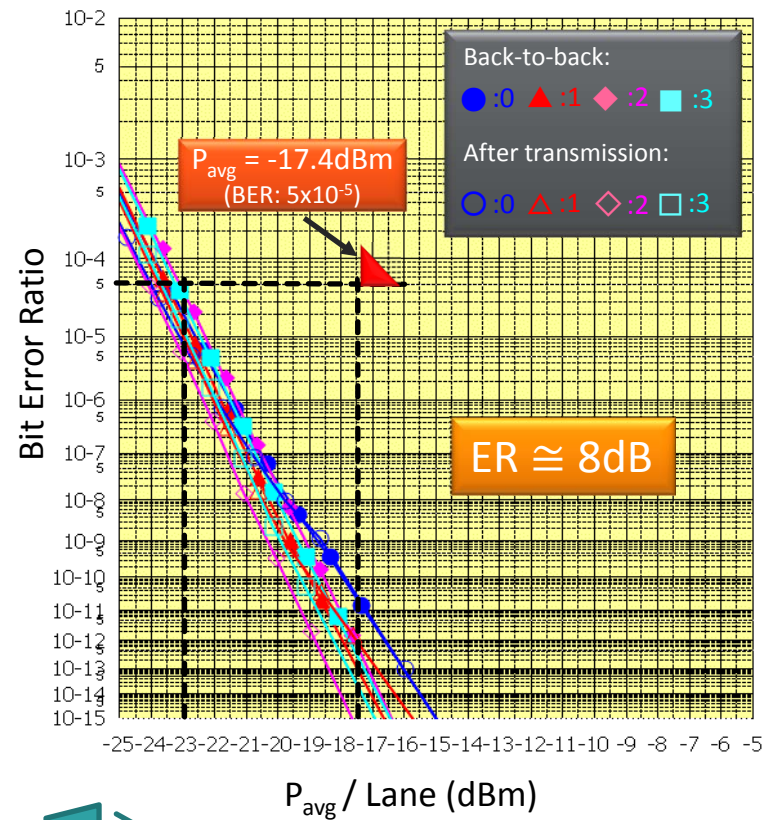
# Technical Feasibility Of 40km With EML + APD

- Data reviewed by ITU-T SG15 for 4L1-9D1F in G.959.1

## Positive Dispersion Limit



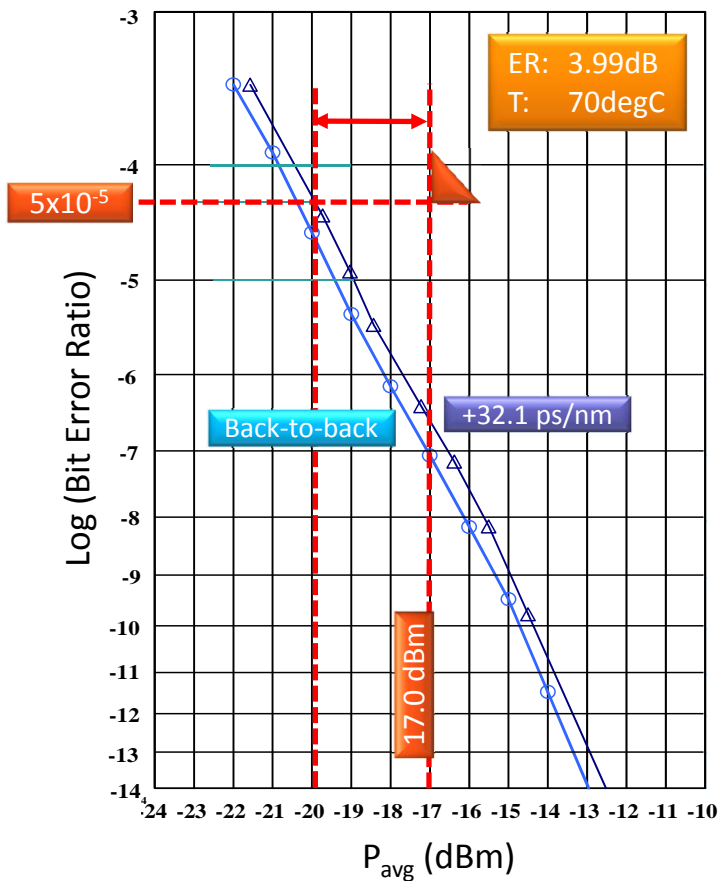
## Negative Dispersion Limit



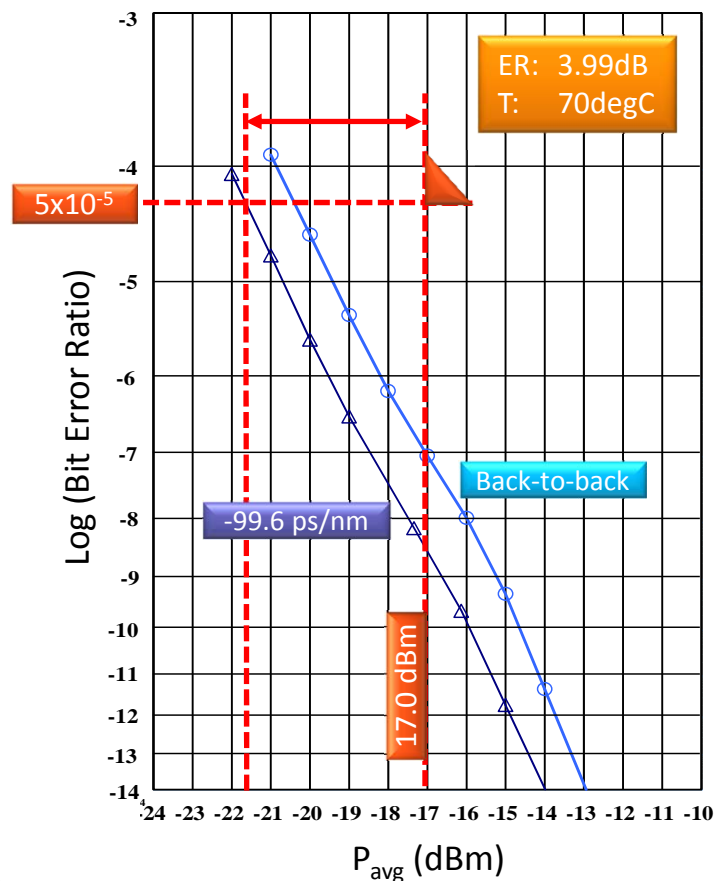
Ref: tamura\_25gsmf\_01\_0116.pdf, IEEE Interim Meeting, Atlanta, Jan 17-22, 2016.

# Technical Feasibility Of 40km With DML + APD

Positive Dispersion Limit



Negative Dispersion Limit





## Summary

1. One lane of 100G 40km specification in ITU-T can be used as starting point for 25GbE 40km specification with FEC.
2. ITU-T discussed two Tx ER specifications (4dB and 7dB), where lower ER specification would widen choice of transmitter technology.
3. Data presented on technical feasibility of 25.78125 Gbps over 40km within LAN-WDM window (1294.53-1310.19nm) using DML transmitter with APD receiver at ER=4dB.
4. Should be able to choose Tx ER = 4dB specification for 25GbE 40km.