Proposed 100GBASE-DR Link Budget Changes

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Introduction

- This presentation is to follow the earlier proposal of considering the total of link loss and MPI penalty (vs. considering them separately) to recommend corresponding changes in 100GBASE-DR link budget.

Link Budget Based on Total Link Loss + MPI Penalty

1) **Methodologies used**
   - Referencing kolesar_3bs_01_0514 for MPO/LC loss statistics and model
     - Assume MPO mean loss = 0.35 dB (stdev = 0.25 dB), and
       LC mean loss = 0.2 dB (stdev = 0.15 dB).
   - Referencing anslow_03_1107.xls for SMF attenuation
   - Referencing king_01a_0116_smf for MPI calculation

2) **Key benefits of considering the total of link loss and MPI penalty**
   - No need to include another 0.2 dB into the link budget
   - Allow to cover more usage cases with the same total budget
   - Keep both Tx OMA(min) and Rx sensitivity unchanged from 400GBASE-DR specifications

Independent Link Loss & MPI Penalty vs. Total Budget

3.3 dB Total Budget (3 dB Loss + 0.3 dB MPI Penalty)

Loss only	0 MPO	1 MPO	2 MPO	3 MPO	4 MPO
0 LC	-	-	n.c.	n.c.	2.90
1 LC	-	n.c.	n.c.	2.65	3.16
2 LC	n.c.	n.c.	2.38	2.91	3.41
3 LC	n.c.	2.10	2.65	3.16	n.c.
4 LC	1.80	2.38	2.91	n.c.	n.c.
5 LC	2.09	2.65	3.17	n.c.	n.c.
6 LC	2.37	2.91	n.c.	n.c.	n.c.
7 LC	2.64	3.17	n.c.	n.c.	n.c.
8 LC	2.91	n.c.	n.c.	n.c.	n.c.

Green Cells: Meet both 3dB link loss and 0.3dB MPI Penalty

Orange cells: OK with 3dB link loss but MPI penalty > 0.3 dB

- Consistent with previous methods
- Less usage cases covered
- Different Tx $OMA_{(min)}$ and Rx sensitivity for DR (4xDR) and DR4

3.1 dB Total Budget

Loss+MPI	0 MPO	1 MPO	2 MPO	3 MPO	4 MPO
0 LC	-	-	n.c.	n.c.	3.00
1 LC	-	n.c.	n.c.	2.72	3.22
2 LC	n.c.	n.c.	2.51	3.02	3.53
3 LC	n.c.	2.30	2.84	3.34	n.c.
4 LC	n.c.	2.71	3.17	n.c.	n.c.
5 LC	n.c.	3.01	3.52	n.c.	n.c.
6 LC	2.92	3.34	n.c.	n.c.	n.c.
7 LC	3.19	n.c.	n.c.	n.c.	n.c.
8 LC	n.c.	n.c.	n.c.	n.c.	n.c.

Green Cells: Meeting 3.1 dB total budget

Yellow Cells: Can be covered with an extra 0.2 dB

- Consider the total budget of (loss + MPI penalty)
- More usage cases covered
- Same Tx $OMA_{(min)}$ and Rx sensitivity for DR (4xDR) and DR4

Optical Return Loss

- Field additions of all possible reflections including Rx (26 dB ORL) without link loss

# of -35 dB Discrete Reflectance	# -45 dB Reflectance MPO allowed	Optical Return Loss (dB)
0	4	22.8
1	3	21.4
2	3	19.8
3	2	18.8
4	1	17.9
5	1	16.8
6	0	16.1

Recommend to use 16.1 dB for the worst case as the optical return loss specification

Recommended Changes to Draft 1.0

Table 140–6—100GBASE-DR transmit characteristics

Description	Value	Unit
Signaling rate (range)	53.125 ± 100 ppm	GBd
Modulation format	PAM4	—
Wavelength (range)	1304.5 to 1317.5	nm
Side-mode suppression ratio (SMSR), (min)	30	dB
Average launch power (max)	4	dBm
Average launch power[a] (min)	–2.4	dBm
Outer Optical Modulation Amplitude (OMA_{outer}) (max)	4.2	dBm
Outer Optical Modulation Amplitude (OMA_{outer}) (min)[b]	–0.3	dBm
Launch power in OMA_{outer} minus TDECQ (min)	–1.3	dBm
Transmitter and dispersion eye closure for PAM4 (TDECQ) (max)	2.5	dB
Average launch power of OFF transmitter (max)	–20	dBm
Extinction ratio (min)	5	dB
$RIN_{21.4}OMA$ (max)	–142	dB/Hz
Optical return loss tolerance (max)	21.4	dB
Transmitter reflectance[c] (max)	–26	dB

→ Keep unchanged, same as in DR4

→ Keep unchanged, same as in DR4

→ Change to $RIN_{16.1}OMA$

→ Change to 16.1 dB

Recommended Changes to Draft 1.0

Table 140–7—100GBASE-DR receive characteristics

Description	Value	Unit
Signaling rate (range)	53.125 ± 100 ppm	GBd
Modulation format	PAM4	—
Wavelengths (range)	1304.5 to 1317.5	nm
Damage threshold[a]	6.5	dBm
Average receive power (max)	4	dBm
Average receive power[b] (min)	–5.4	dBm
Receive power (OMA_{outer}) (max)	4.2	dBm
Receiver reflectance (max)	–26	dB
Receiver sensitivity (OMA_{outer})[c] (max)	–4.4	dBm
Stressed receiver sensitivity (OMA_{outer})[d] (max)	–1.9	dBm
Conditions of stressed receiver sensitivity test:[e]		
Stressed eye closure for PAM4 (SECQ)	2.5	dB

→ Keep unchanged, same as in 400GBASE-DR4

→ Keep unchanged, same as in 400GBASE-DR4

Table 140–8—100GBASE-DR illustrative link power budget

Parameter	Value	Unit
Power budget (for max TDECQ)	5.6	dB
Operating distance	500	m
Channel insertion loss[a]	3	dB
Maximum discrete reflectance	See 140.10.2.2	dB
Allocation for penalties[b] (for max TDECQ)	2.6	dB
Additional insertion loss allowed	0	dB

→ 5.6 dB, same as in 400GBASE-DR4

→ 2.6 dB, same as in 400GBASE-DR4

Summary

- Proposed to use the total of link loss and MPI penalty in 100GBASE-DR link budget consideration, which would
  - resolve the issue of additional ~0.2 dB MPI penalty allocation
  - support more usage cases
  - keep the same Tx OMA(min) and Rx sensitivity as those in 400GBASE-DR4

- Calculated optical return loss for 100GBASE-DR usage cases which gave 16.1 dB as the worst case ORL

- Recommended changes in 100GBASE-DR link budget.

Backup

From 400GBASE-DR4 specs

Table 124–13—Maximum value of each discrete reflectance

Number of discrete reflectances above –55 dB	Maximum value for each discrete reflectance
1	–37 dB
2	–42 dB
4	–45 dB
6	–47 dB
8	–48 dB
10	–49 dB