

400GBASE-LR4

Link Budget Proposal

P802.3cu 100 Gb/s and 400 Gb/s over SMF at
100 Gb/s per Wavelength Task Force Ad Hoc

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FINISAR[®]

Introduction

- At the May Interim, there was discussion of alternatives to 400G LR4 spec based on worst case 10km SMF link
 - What's so special about 10km?
http://www.ieee802.org/3/cu/public/May19/cole_3cu_02c_0519.pdf
 - Two SMF Spec Limit Types for 802.3 PMDs Proposal
http://www.ieee802.org/3/cu/public/May19/cole_3cu_01a_0519.pdf
- At the July Plenary, one of the considered paths for moving forward was to reduce the 400G LR4 10km reach objective
- While 10km has some operating advantages, end users are not willing to pay an significant cost premium for this exact reach over a shorter reach with same link and loss budget
- The first version of this presentation was discussed on the August Ad Hoc call
http://www.ieee802.org/3/cu/public/cu_adhoc/cu_archive/cole_3cu_adhoc_082119.pdf

Cost is King

- CWDM grid has technical cost advantages:
 - No TEC, and associated simpler assembly techniques
 - Simpler WDM filters
- However, main cost drivers are:
 - Volume
 - Manufacturing margin
- 400G FR4 in 3+ years is expected to be a high volume interface in the cloud datacenter
- Based on TF contributions, worst case 10km SMF link CWDM4 spec does not have good manufacturing margin
- Ideal spec leverages the FR4 volume and has good manufacturing margin (multiple sigmas)

100GBASE-LR4 Link Budget Proposal

Illustrative Link Power Budget		
Description	400GBASE-LR4	Unit
Power budget (for max TDECQ)	10.5	dB
Operating distance	6	km
Channel insertion Loss	5.0	dB
Allocation for penalties (for max TDECQ)	4.2	dB
Additional insertion loss allowed	1.3	dB

Leaves unaddressed the problem identified by Brian of how to prevent bad transmitters (excessive transmitter penalty) for middle wavelengths

L (LONG) 802.3 Reach, Budget Comparisons

Code	Illustrative Power Budget dB	Total Channel Insertion Loss dB	Operating Distance km
1000 LX	8.0	4.7	5
1000 LX10	10.5	8.0	10
10G LR	9.4	6.2	10
40G LR4	9.3	6.7	10
100G LR4	8.5	6.3	10
200G LR4	10.2	6.3	10
400G LR8	10.1	6.3	10
Proposed 400G LR4	10.5	6.3	6

E (Extended) has been used by 802.3 to designate 30, 40km reaches

S (Short) 802.3 Reach Comparisons

Code	Minimum modal bandwidth @ 850 nm (MHz·km)	Operating range max (meters)
1000BASE-SX	160, 200	220, 275
	400, 500	500, 550
10GBASE-SR	160 / 200	26 / 33
	400 / 800	66 / 82
	2000	300
40GBASE-SR4 100GBASE-SR10	2000	100
	4700	150
100GBASE-SR4 400GBASE-SR16 50GBASE-SR 100GBASE-SR32 200GBASE-SR4	2000	70
	4700	100

L, S, VSR ITU-T Name & Reach Approach

- In G.959.1 application codes:
 - L indicates long haul (22dB span attenuation)
 - S indicates short haul (11dB span attenuation)
 - Reach is function of budget, fiber type and rate
- In G.695 application codes:
 - L indicates long-haul span distance
 - S indicates short-haul span distance
 - Reach is function of budget, fiber type and rate
- In G.693 application codes:
 - VSR600, VSR1000 and VSR2000, indicates target distances of 0.6 km, 1 km and 2 km, respectively
 - Attenuation categories of 4 dB, 6 dB, 12 dB, 16dB
 - Reach is function of budget, fiber type and rate

This Issue Will Come Up Again

- There will be future 200 Gb/s and 400 Gb/s per wavelength specs. (hopefully we will write them when industry is ready)
- It is unreasonable to expect that regardless of technology break-points, we continue to insist on 10km reach objective
- 400G is a good rate to start dealing with changing LR reach

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Thank You