
Fiber cabling models for SMF MPI Calculations

Addressing Comments #133-142 (Hai-Feng Liu) and #150-159 (Gary Nicholl)

Gary Nicholl - Cisco

IEEE P802.3bs Task Force, March 2016, Macau

Introduction

- This presentation is a summary of [nicholl_01_0216_smf.pdf](#) (Feb 16, 2016 SMF ad-hoc), and proposes reference fiber optic cabling models to be used in the calculation of MPI Penalty for the SMF PMDs; 400GBASE-DR4, 400GBASE-FR8, 400GBASE-LR8.
- The presentation is based upon earlier work done by Paul Kolesar in [kolesar_3bs_01_0514.pdf](#)
- The fiber optic cabling models in this presentation are used in liu_3bs_01_0316 in support of comments #133-142 (Hai-Feng Liu) and #150-159 (Gary Nicholl)

Supporters

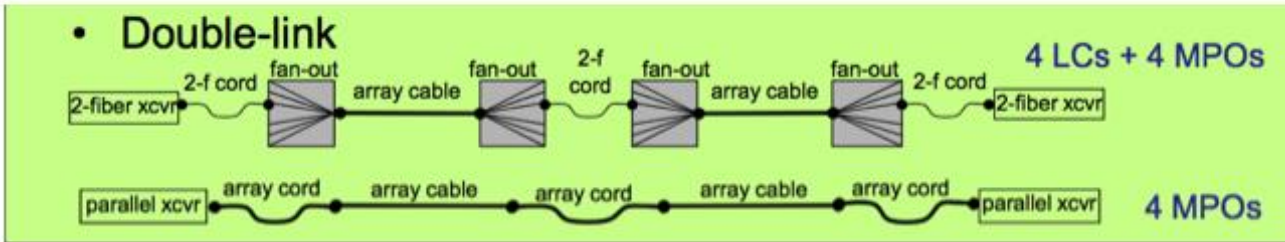
- Hai-Feng Liu, Intel
- Scott Schube, Intel
- Mark Kimber, Semtech
- Marco Mazzini, Cisco
- Mark Nowell, Cisco
- Vipul Bhatt, Inphi
- Brian Welch, Luxtera
- Brad Booth, Microsoft
- Tom Issenhuth, Microsoft
- Bernard Lee, Senko
- Bharat Tailor, Semtech
- Ralf-Peter Braun, Deutsche Telekom
- Paul Brooks, Viavi Solutions
- Kohichi Tamura, Oclaro
- Steven Swanson, Corning
- Thananya Baldwin, Ixia
- Kenneth Jackson, Sumitomo
- Scott Kipp, Brocade
- Pavel Zivny, Tektronix
- Rob Stone, Broadcom
- Vasudevan Parthasarathy, Broadcom
- Ed Ulrichs, Source Photonics
- Jeff Maki, Juniper
- Fadi Daou, MultiLane
- Matt Brown, APM

Supporters

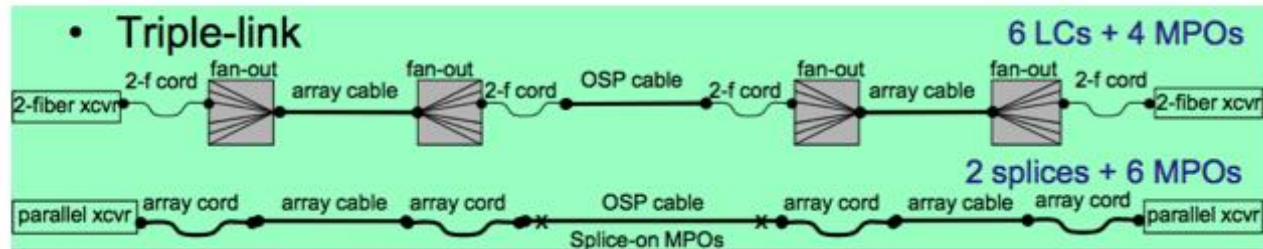
- Piers Dawe, Mellanox
- Winston Way, Neophotonics
- Nathan Tracey, TE
- David Lewis, Lumentum

Proposed usage of reference link models

Proposed to use for 2km and below

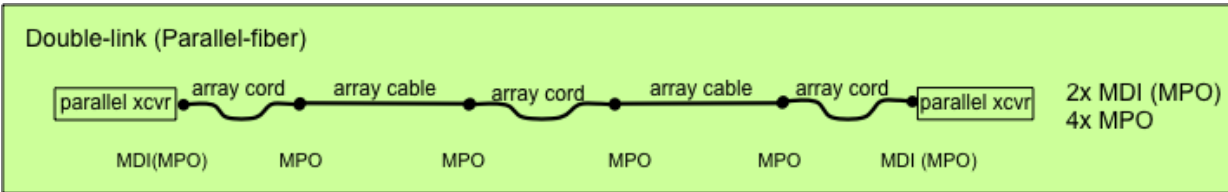


Proposed to use for 10 km and above

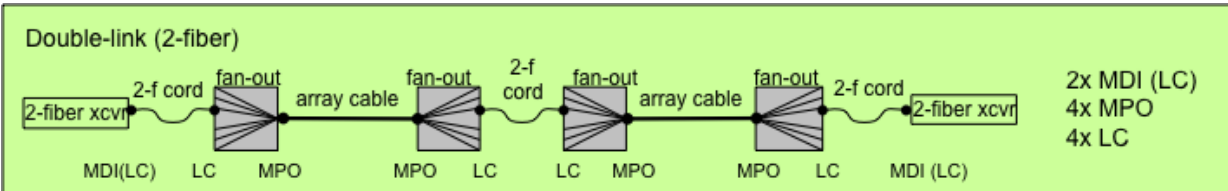


Proposed reference models for 802.3bs

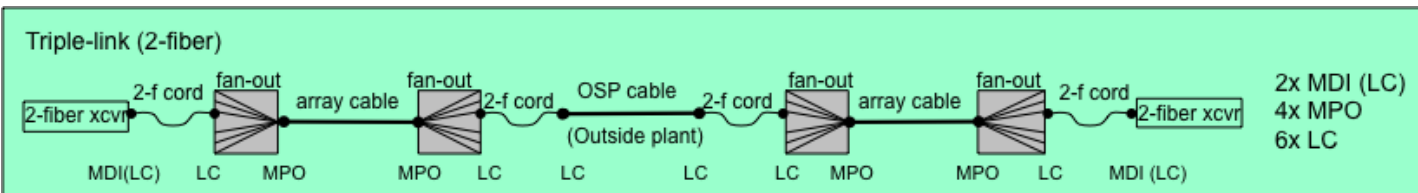
400GBASE-DR4 (500m):



400GBASE-FR8 (2km):



400GBASE-LR8 (10km):

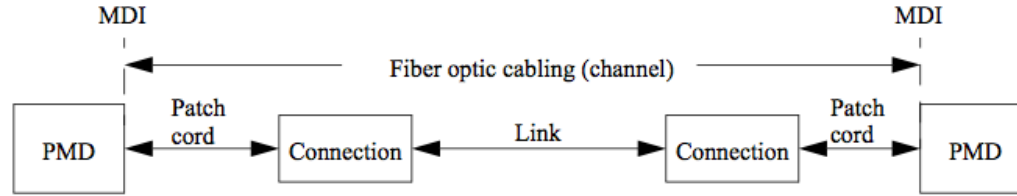


Recommendation

- The fiber cabling models contained in slide 5 be adopted as the worst case reference models to be used in the calculation of the MPI penalty for 400GBASE-DR4, 400GBASE-FR8 and 400GBASE-LR8 SMF PMDs.

Backup

Why is a fiber cabling model needed ?



Ref: 802.3bs_D1p1

Figure 123-3—Fiber optic cabling model

- PAM4 is more sensitive to reflections (MPI) than NRZ.
- MPI is heavily dependent on both the number and return loss specifications of the connectors in the end-to-end link.
- Current fiber cabling reference models (above) are too simplistic to be used for PAM4 (primarily because they don't include the number and type of connectors in the link).
- Just as channel models became critical for copper links (e.g. backplane) as speeds increased, so they are now starting to become critical for optical links.

Recap - kolesar_3bs_01_0514

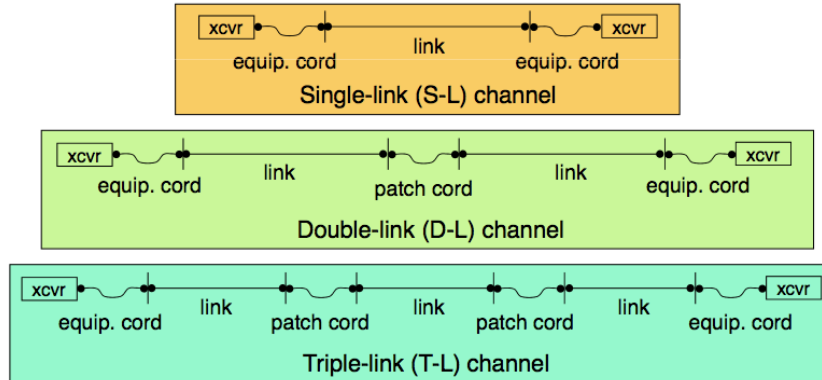
Cabling Terminology

Cords: used to administer temporary connectivity from:

1. equipment (transceivers) to patch panel, called equipment cords
2. patch panel to patch panel, called patch cords

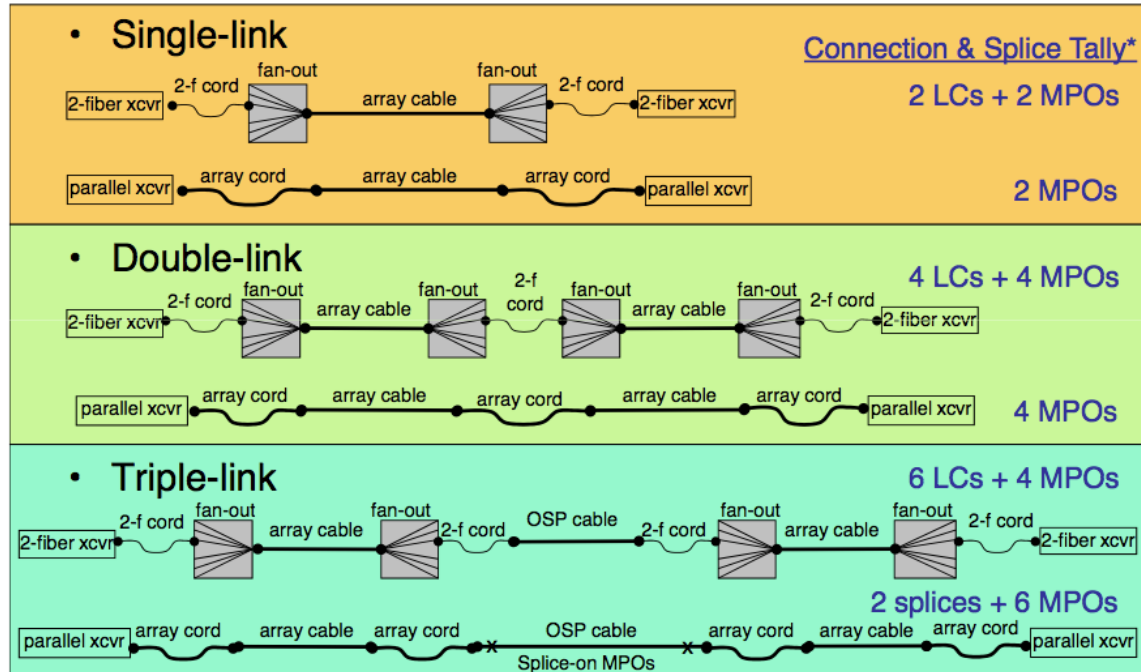
Links: permanent cabling between two patch panels

Channels: complete end-to-end connectivity between equipment, consisting of concatenations of (temporary) cords and (permanent) links



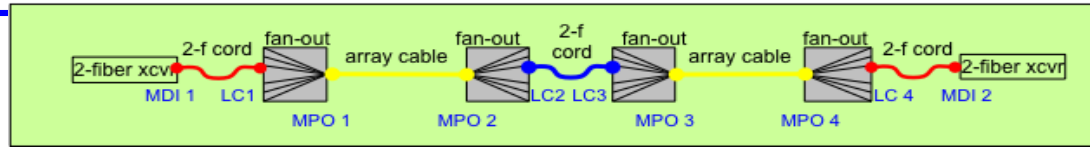
Recap - kolesar_3bs_01_0514

Common Channel Implementations (both 2-fiber and parallel transceivers)



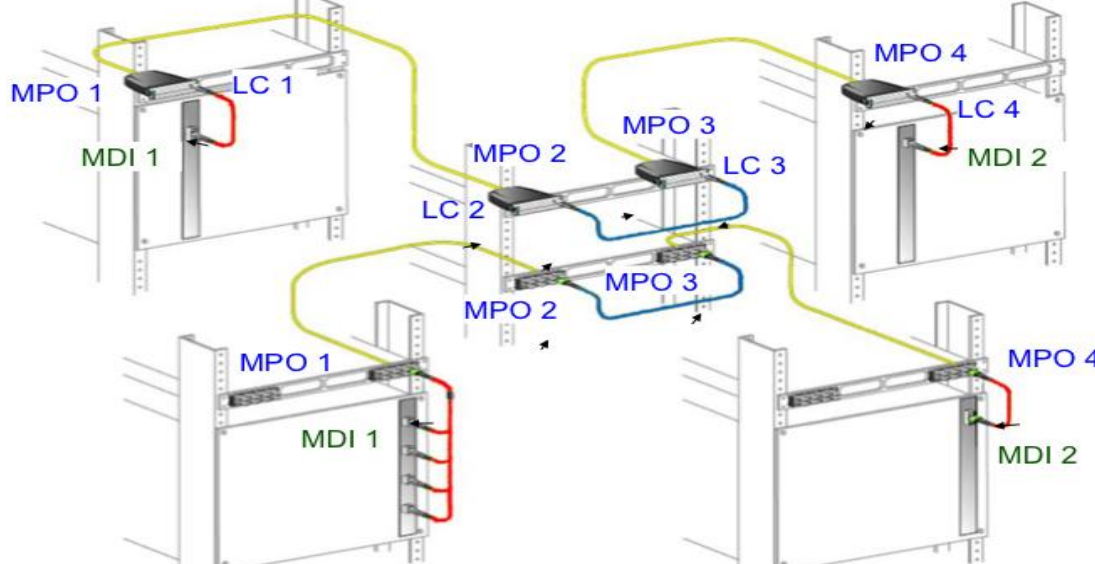
Note: Connections to transceivers (at MDI) are not included in Connection Tally.

Recap - kolesar_3bs_01_0514 (Example)



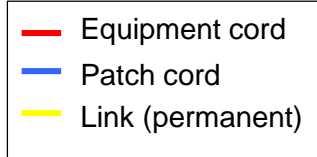
2-fiber
Double-Link
Channel

2x MDI
4x LC
4x MPO



Parallel-fiber
Double-Link
Channel

2x MDI
4x MPO



Loss Limited Fiber Reach

Channel	Fiber Type	Connector Loss (dB) ^{***}	100GBASE-DR4 (3dB Link Budget)		100GBASE-FR8 (4dB Link Budget)		100GBASE-LR8 (6.3dB Link Budget)	
			Fiber Loss (dB)	Fiber* Reach (km)	Fiber Loss (dB)	Fiber* Reach (km)	Fiber Loss (dB)	Fiber* Reach (km)
Single-Link	2-Fiber	2.13			1.87	3.74 ^{**}	4.17	8.34
	Parallel-Fiber	1.58	1.42	2.84 ^{**}				
Double-Link	2-Fiber	3.66			0.34	0.68	2.64	5.28
	Parallel-Fiber	2.65	0.35	0.7 ^{**}				
Triple-Link	2-Fiber	4.15			NA	NA	2.15	4.3
	Parallel-Fiber	3.78	NA	NA				

* Loss limited fiber reach based on 0.5dB/km

** Loss limited fiber reach exceeds target reach

*** Ref: [kolesar_3bs_01_0514.pdf](#)