100G Parallel SMF Skew

John Petrilla: Avago Technologies

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Contributors

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Pete Anslow	Ciena
Paul Kolesar	CommScope

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Presentation Objectives:

•Provide an analysis of lane skew expected for 500 m of parallel SMF

Conclusion:

•A 500 m parallel SMF implementations fits within the skew constraints of 802.3ba and 802.3bj

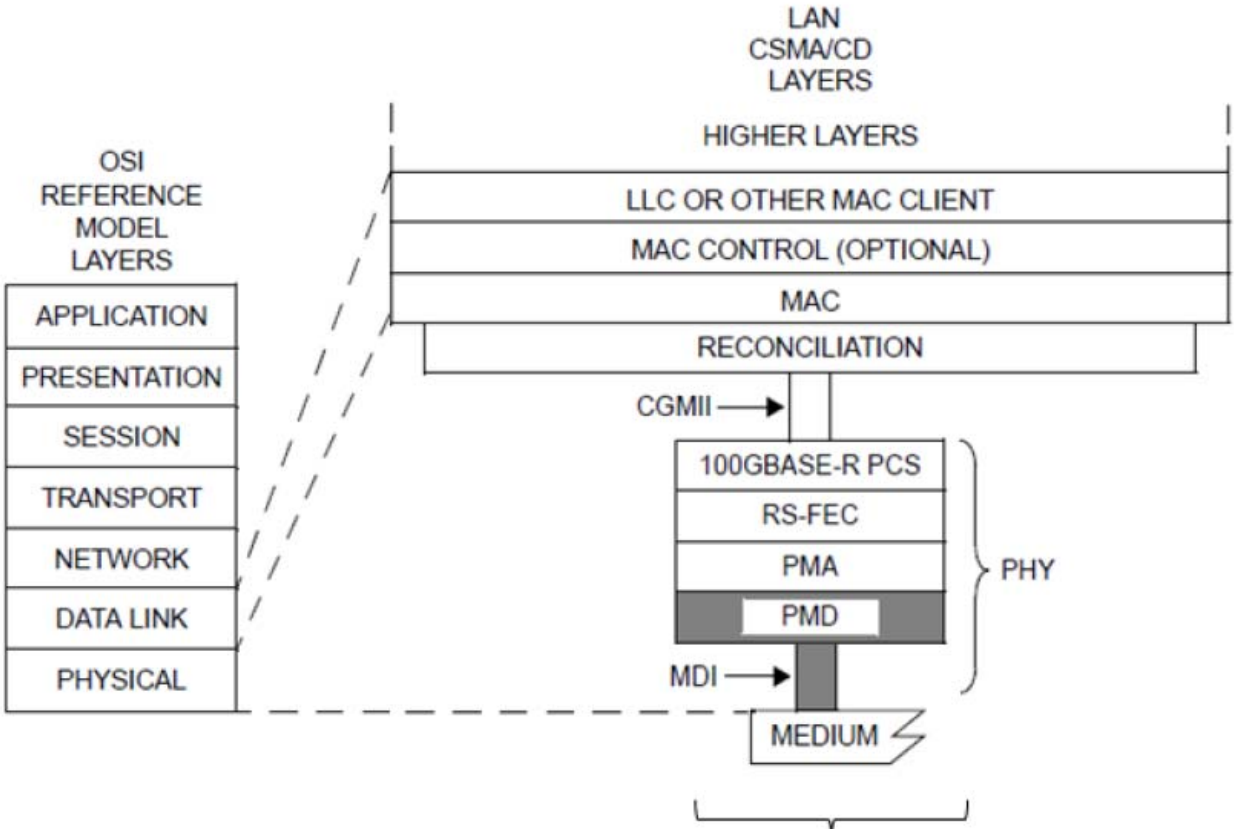
References

Fibre_characteristics_V_4_0_draft_2.xls (Pete Anslow author)

Kolesar_02_0508.xls (Skew model, Paul Kolesar author)

802.3 clause 80

•Proposed position in 802.3 architecture



•100GBASE-nR4

CGMII = 100 Gb/s 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

From anderson_01a_0313_optx

Fiber Optic Links Interfaces

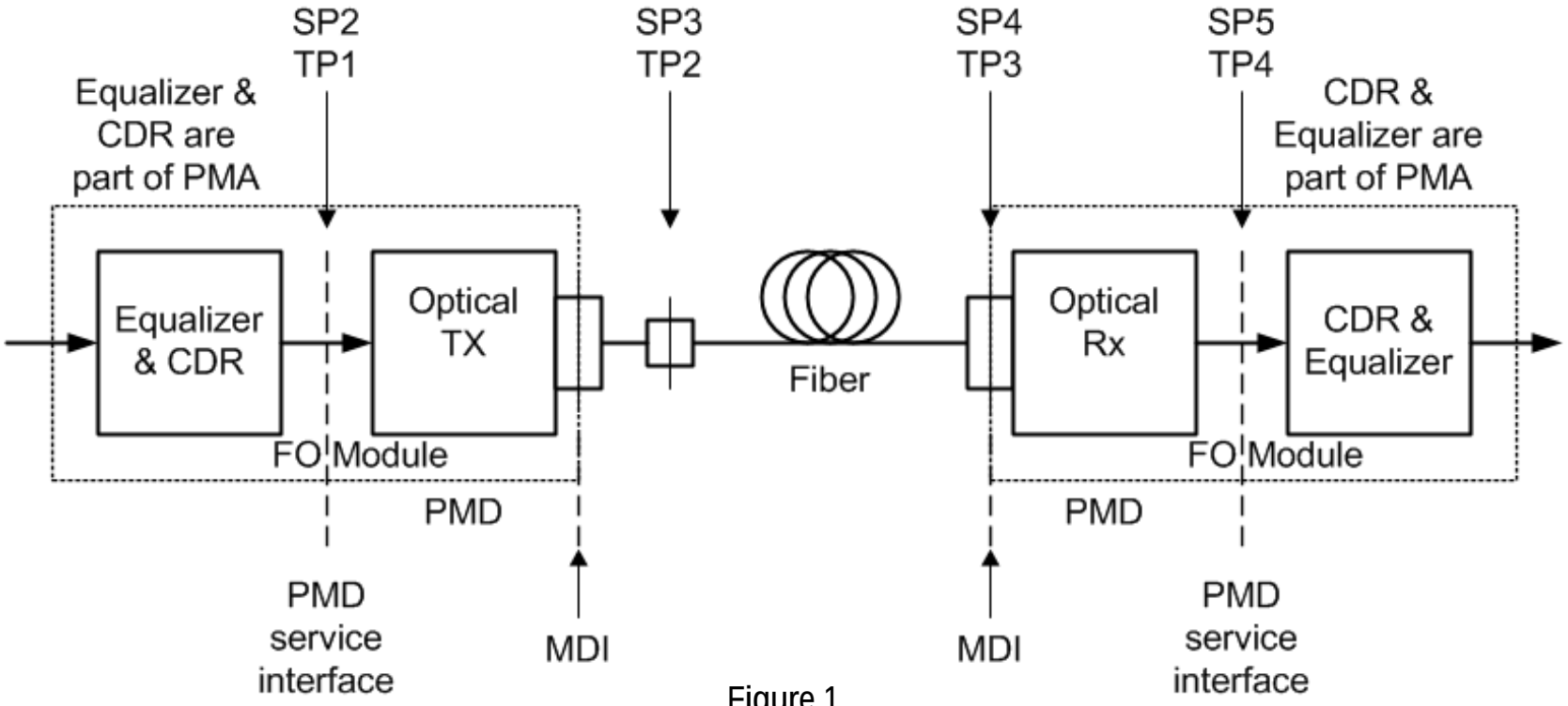


Figure 1

•Figure 1 identifies skew points, SP3 and SP4, relevant to optical interfaces.

•From 802.3 Cl 80.5, the skew at SP3 shall be less than 54 ns and the skew variation at SP3 shall be less than 600 ps.

• From 802.3 Cl 80.5, the skew at SP4 shall be less than 134 ns and the skew variation at SP3 shall be less than 3400 ps.

•The inclusion of RS-FEC (802.3bj Clause 91) does not change the maximum limits at SP3 and SP4 that were defined in 803.3ba Clause 80.5, Tables 80-4 and 80-5.

•Acceptable skew contributions from the optical cable are defined by the differences between SP4 and SP3 constraints.

•Optical cable lane skew must be less than 80 ns and lane skew variation must be less than 2800 ps.

From Fibre_characteristics_V_4_0_draft_2.xls

Parameter	Value	Unit
Aggregate bit rate after PCS coding	103.125	GBd
Link length	0.5	km
Fibre type (G.652.A&B (B1.1) or G.652.C&D (B1.3))	G.652.A&B	-
Minimum transmitter wavelength	1295	nm
Maximum transmitter wavelength	1325	nm
Maximum zero dispersion wavelength (l_0 max)	1324	nm
Minimum zero dispersion wavelength (l_0 min)	1300	nm
Maximum fibre dispersion slope	0.093	ps/(nm^2.km)
Maximum fiber loss for any wavelength	0.22	dB
Maximum dispersion for any wavelength	1.13	ps/nm
Minimum dispersion for any wavelength	-1.39	ps/nm
Maximum optical skew	20.0	ps
Maximum optical skew variation	40.0	ps

•Using a modified version of the fiber model tool found at http://www.ieee802.org/3/ba/public/tools/Fibre_characteristics_V_3_0.xls with entries relevant to a 500 m, 100G, parallel SMF application, due to the center wavelength range (1295 nm to 1325 nm), the max calculated skew is 20 ps (0.04 ps/m) and the max calculated skew variation is 40 ps (0.08 ps/m).
•Here the skew variation assumes that the fastest and slowest lanes in a parallel application can swap over. Hence the max skew variation can be twice the max skew.

From Kolesar_02_0508.xls

SMF cable skew factors				Skew (ps/m)
numerical aperture (NA) difference	NA, max 0.141	NA, min 0.139	cladding IoR, nom 1.457	0.45
strand length difference	Differential length factor 0.0050	Propagation delay (ps/m) 5000		25.0
cabling stress difference	Stress, max (kpsi) 50	Stress, min (kpsi) 0	stress-refraction coef. 2.61E-05	4.4
total maximum skew at 1310 nm				29.8
total maximum skew variation				4.4

- Using kolesar_02_0508 found at http://www.ieee802.org/3/ba/public/may08/kolesar_02_0508.xls with entries relevant to a 500 m, 100G, parallel SMF application, it can be seen that skew is dominated by differential lane length.
  - Skew due to DMD difference isn't applicable for SMF
  - Skew due to relative group delay is redundant – addressed in Fibre_characteristics_V_4_0_draft_2.xls
- For 500 m of parallel SMF,
  - max calculated skew is 500 m x 29.8 ps/m = 14.9 ps
  - max calculated skew variation is 500 m x 4.4 ps/m = 2230 ps
- Compared to clause 80 skew constraints
  - max calculated skew variation is 2230 ps (vs a max constraint of 2800 ps)
  - max calculated skew is 14.9 ns (vs a max constraint of 80 ns)
- The delta between the max calculated skew and tha max acceptable skew (80 -14.9) ns may permit an additional lane difference of approximately 13 m assuming a propagation delay of 5 ns/m.