



40GbE Thoughts

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Objectives for IEEE 802.3ba: New 40GbE Items



PMD Support	40Gbit/s	100Gbit/s
Backplane (At least 1m)	√	
Copper Cable (At least 10m)	√	√
MMF (At least 100m OM3)	√	√
SMF (At least 10km)		√
SMF (At least 40km)		√

Two Basic Approaches

- Sped up "LX4"
- Serial (single λ)

Two Media

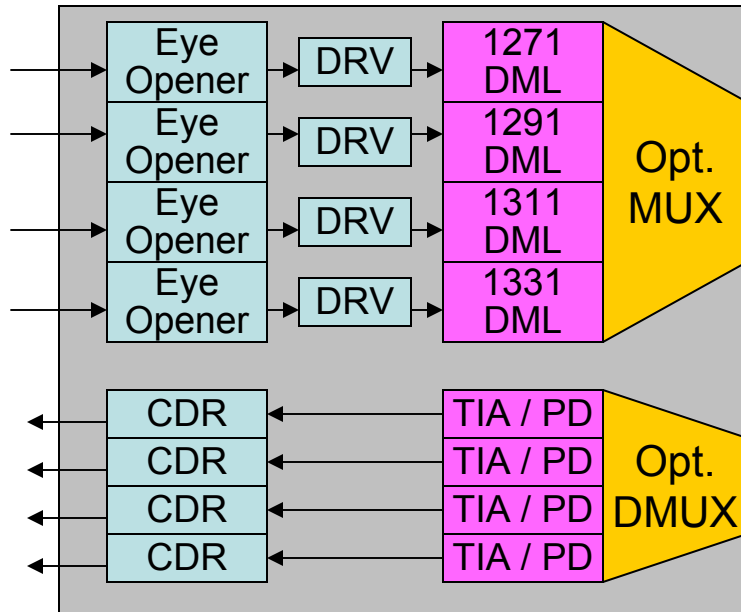
- **Ribbon:**
 - Spatial Multiplexing
- **Duplex Fiber**
 - Faster "LX4" + EDC
 - WDM: 8xx nm

Distance and media requirements for 40G

	10 - 40G	40 - 100G
Aggregation	OM-3 ribbon	OM-3 duplex
	OM-3 ribbon	OM-3 ribbon
Core	Single mode ~ 10km	Single mode ~ 10km

Source: barberi_01_0108.pdf

40GbE SMF: "Sped up LX4"



Almost same TX characteristics as 10GBASE-LR

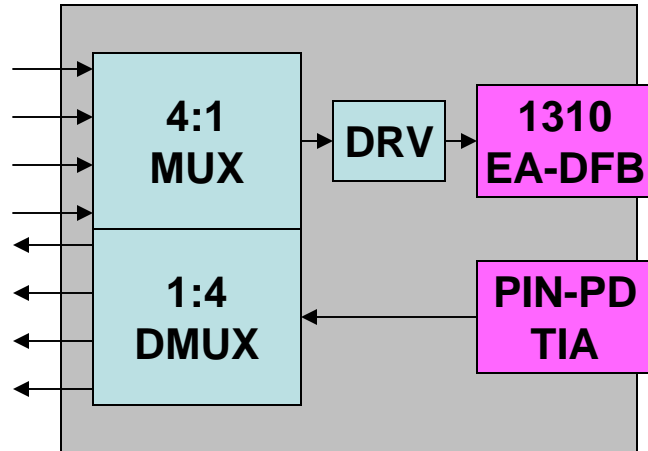
Basics	Input=	Bold	Ts(20-80)	35 ps
	Q=	7.04	Ts(10-90)	53 ps
	Base Rate=	10312.5 MBd	RIN(OMA)	-130 dB/Hz
Transmitter	Wavelength U _c	1264.5 nm	RIN at MinER	-137.3 dB/Hz
	U _w (see notes)	0.20 nm	RIN_Coef=	0.70
	Tx pwr OMA=	-3.2 dBm	Det.Jitter	6.0 ps inc.
	Min. Ext Ratio=	4.00 dB	DCD_DJ=	4.2 ps TP3
	"Worst" ave. TxPwr	-2.55 dBm	Effect. DJ=	0.02 (UI) ex
	Ext. ratio penalty	3.66 dBo	MPN k(OMA)	0
	Tx mask X1=	0.3 UI	Tx eye height	71.3%
	X2=	0.4 UI	Refl Tx	-12 dB
	Y1=	0.25	ModalNoisePen	0 dB
			Tx mask top	0.2 UI

Propose **CWDM** λ rather than LX4 λ

Propose using same Rise time as 10GBASE-SR (slightly tougher than LR)

- All block diagram components exist
 - Laser λ 's need to be qualified = simple
 - Lasers & PDs need to be slightly higher spec than 10GBASE-LR (see next slide)
- To meet cost targets integration needed
 - Could combine above "blue" items to single IC
 - Could compact Opt. Mux/DMux & Optics

40GbE SMF: Serial



Wavelength	1300 to 1324	nm
SMSR	35	dB
TX OMA	+2.5	dBm
TX Avg.	+0.73	dBm
ER	8.5	dB
RIN	-132	dB/Hz
RX OMA	-6.5	dBm

10km is achievable

0.48dB margin at 10km

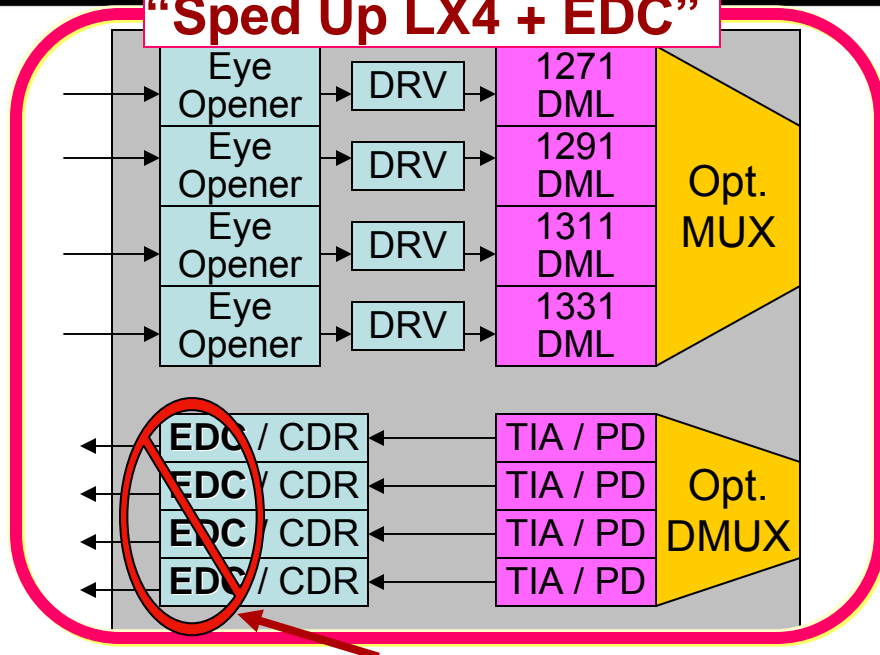
<i>Basics</i>	Input=	Bold	Ts(20-80)	10 ps
	Q=	7.04	Ts(10-90)	15 ps
	Base Rate=	41250 MBd	RIN(OMA)	-132 dB/Hz
<i>Transmitter</i>	Wavelength Uc	1300 nm	RIN at MinER	-134.5 dB/Hz
	Uw (see notes)	0.10 nm	RIN_Coef=	0.70
	Tx pwr OMA=	2.50 dBm	Det.Jitter	1.0 ps inc.
	Min. Ext Ratio=	8.50 dB	DCD_DJ=	1 ps TP3
	"Worst"ave.TxPwr	0.73 dBm	Effect. DJ=	0.00 (UI) ex
	Ext. ratio penalty	1.24 dBo	MPN k(OMA)	0
	Tx mask X1=	0.3 UI	Tx eye height	62.7%
	X2=	0.4 UI	Refl Tx	-12 dB
	Y1=	0.25	ModalNoisePen	0 dB
			Tx mask top	0.2 UI

PoIMD DGDmax = 7.3ps per ITU recommendation for 0.3UI for DGD

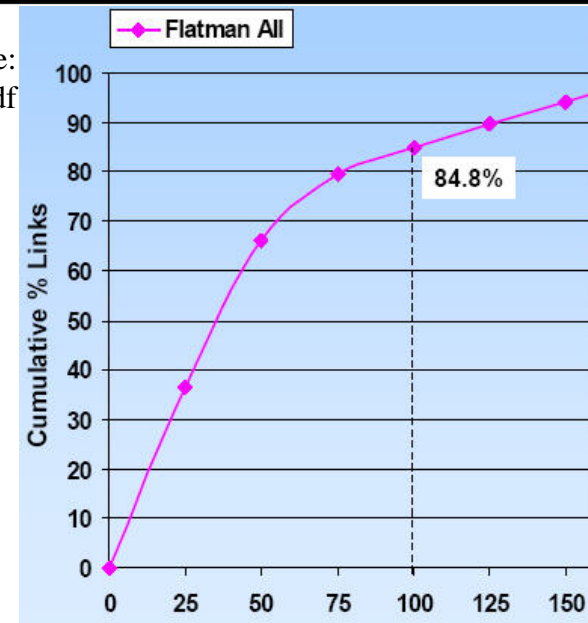
40GbE MMF: Duplex Fiber



“Sped Up LX4 + EDC”



Source:
Flatman_01_0108.pdf



- If EDC is **removed** & same link parameters are used as proposed above for LX4 “sped up” optics the Link Spreadsheet results in a margin for OM3 fiber of:
 - 100m => 2.37dB margin
 - 120m => 0.29dB margin
- If >100m is required then it is likely that some form of EDC would be necessary to close the link budget
 - According to kolesar_01_0906.pdf, 95% coverage is at 150m
 - According to flatman_01_0108.pdf, ~85% coverage at 100m for distribution to core links

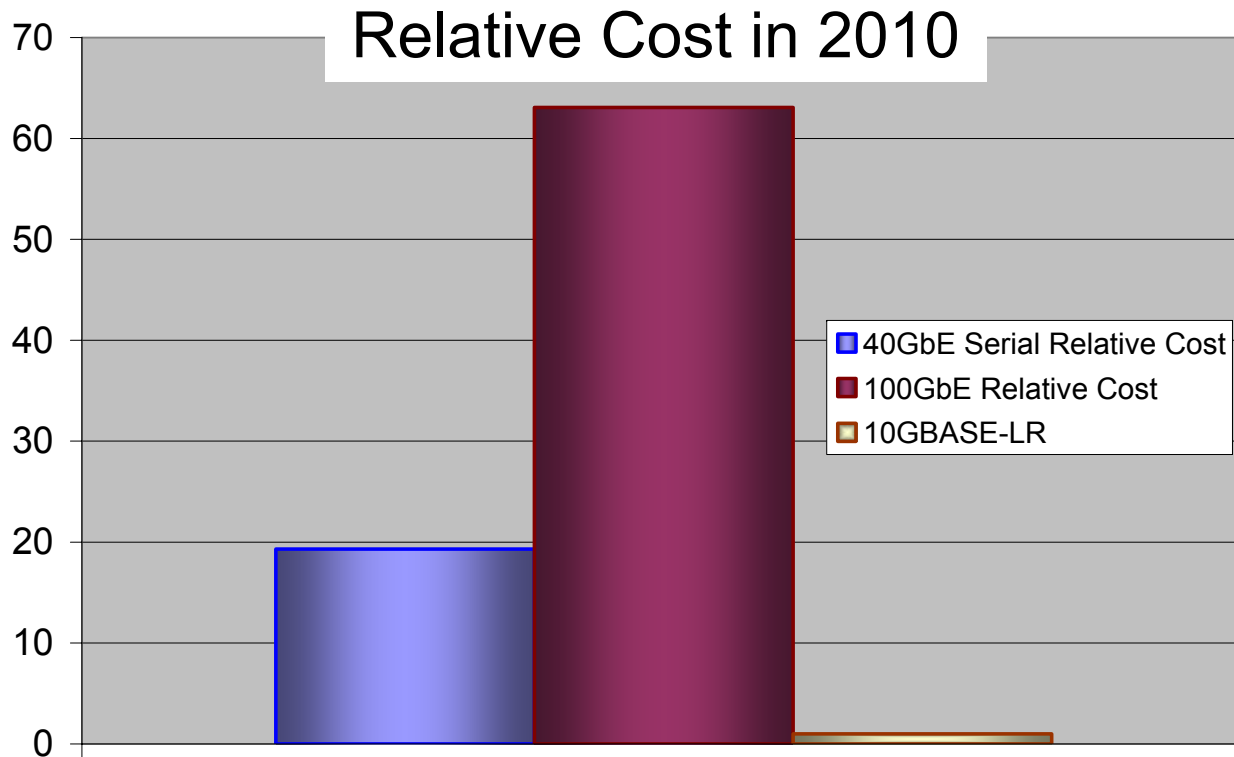


Economic Factors for 40GbE

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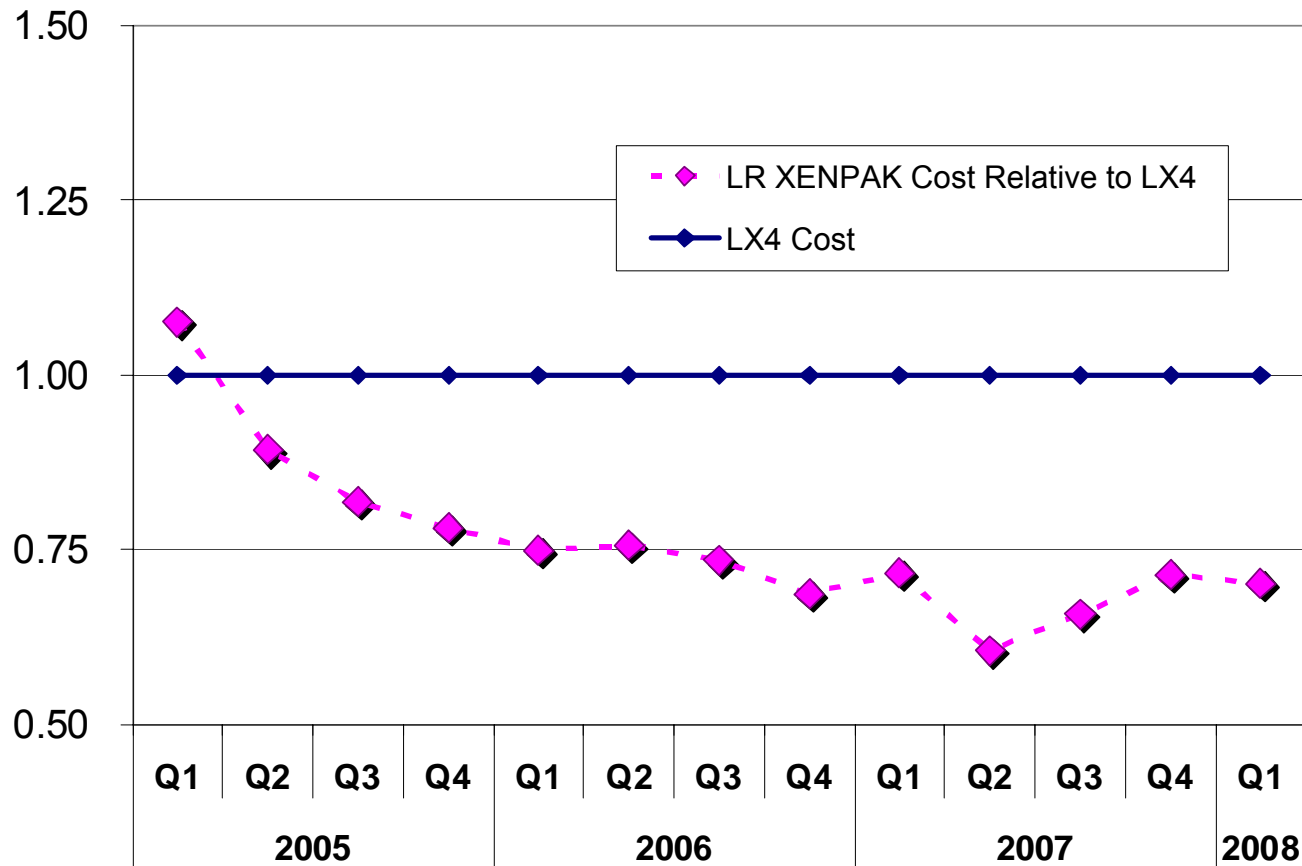
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By 2012, the ratio between serial 40GbE versus 100GbE has widened

- Exercise is somewhat contrived as the “perception” of volumes is different
 - IC & sub-component manufacturers are providing outlook based on their relative expectations for 40GbE vs. 100GbE volumes
 - For 2010 the volumes of the 40GbE & 100GbE are artificially “equalized”. 10GBASE-LR is at projected volume level

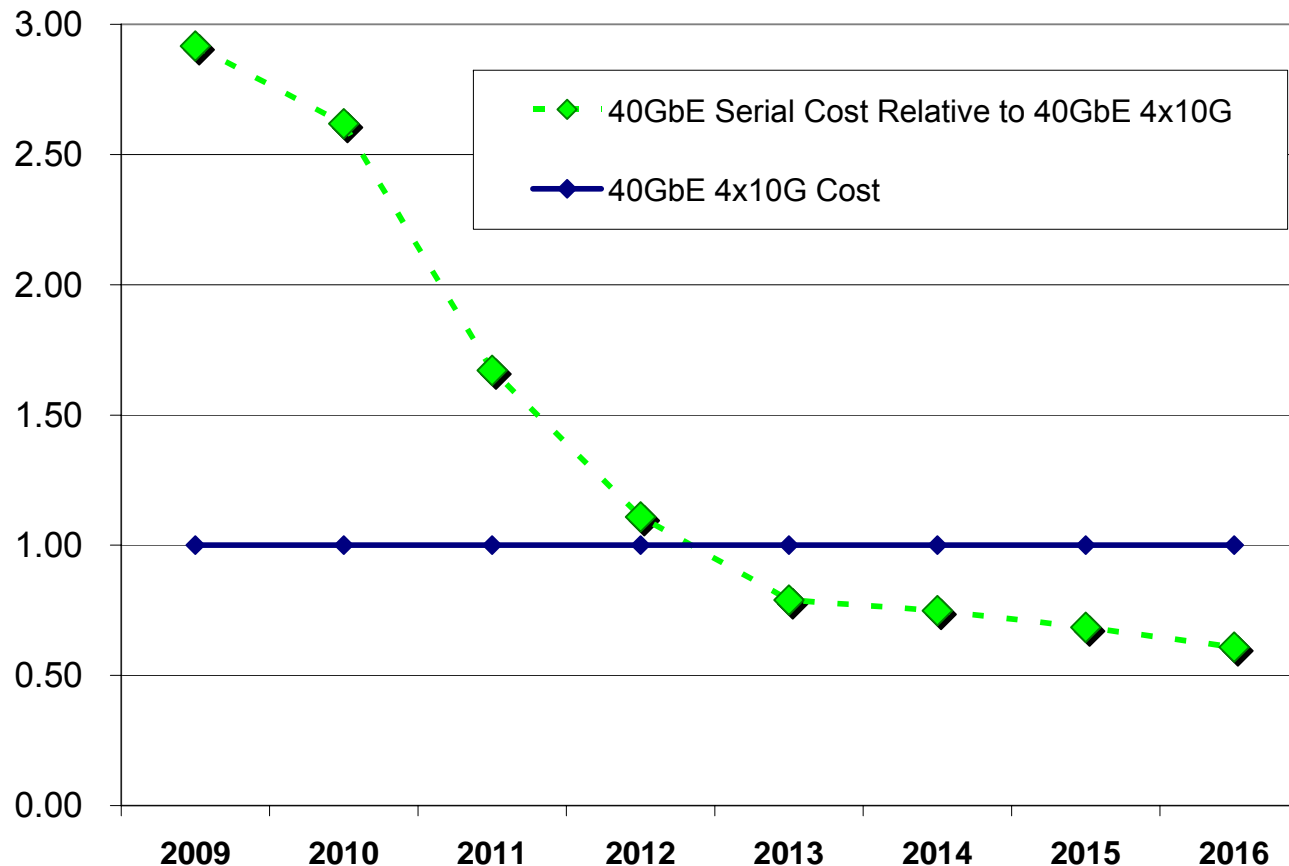
History on LX4 versus LR (XENPAK)



Source: Opnext data

- XENPAK form factor considered
- Obviously lower cost 10GBASE-LR form factors exist which would make the ratio more in favor of LR
- Lumpiness in curve is due to product introductions and generation mismatch
- **In SMF, parallel has been shown to be less cost competitive than serial**

40GbE SMF: Serial vs. Parallel (LX40) Relative Cost



- “Same” volumes considered
- Volume of 40GbE assumed to be “small” in 2009 thru 2010
- As 40GHz interfaces become feasible in CMOS, the 40GbE will drop in cost significantly
- Reuse of 10G elements is not practical to achieve significant relative cost reduction
- **In SMF, parallel has been shown to be less cost competitive than serial**