40GbE SMF Technical & Economic Feasibility

opnext

WE *light* IT UP

Matt Traverso

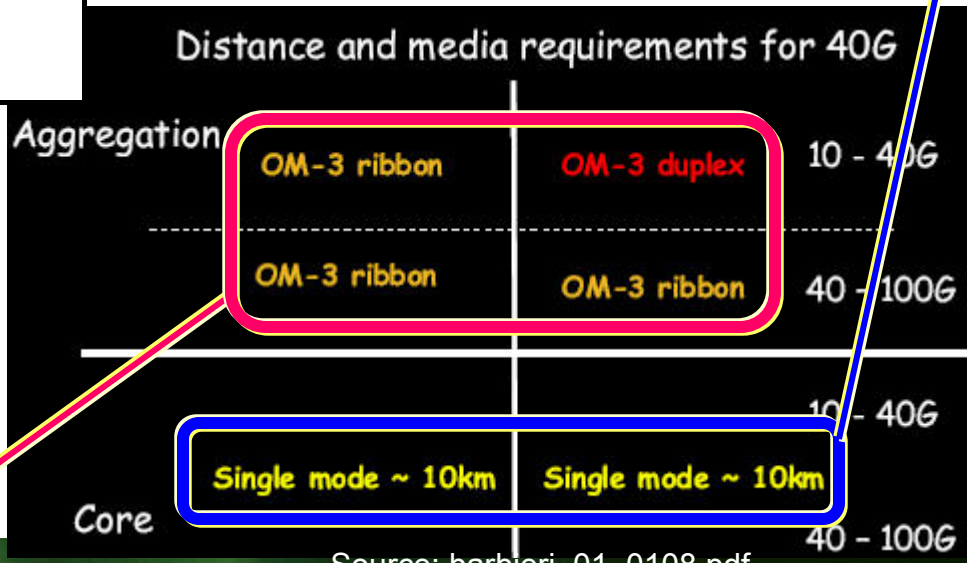
Objectives for IEEE 802.3ba: New 40GbE Items

opnext

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)		√

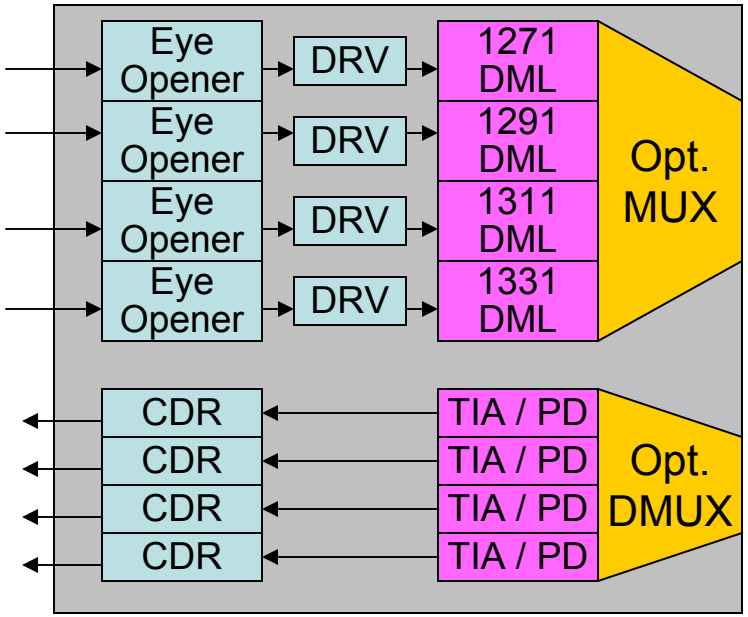
Two Basic Approaches
- Sped up "LX4"
- Serial (single λ)

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



Source: barbieri_01_0108.pdf

40GbE SMF: “Sped up LX4” (LX40?)



Almost same TX characteristics as 10GBASE-LR

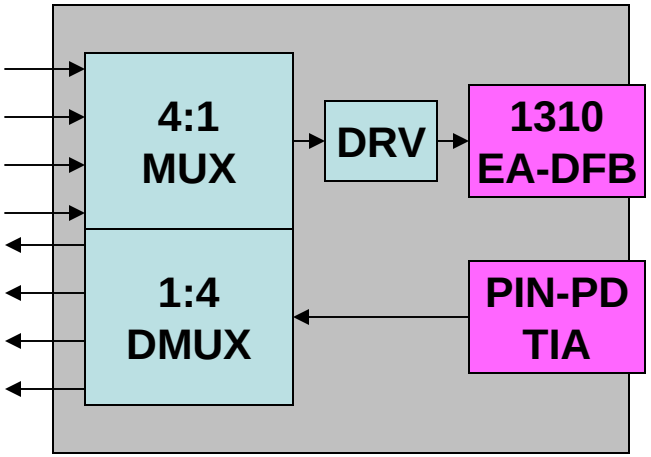
Basics	Input=	**Bold**	Ts(20-80)	**35** ps
	Q=	**7.04**	Ts(10-90)	53 ps
	Base Rate=	**10312.5** MBd	RIN(OMA)	**-130** dB/Hz
Transmitter			RIN at MinER	-137.3 dB/Hz
Wavelength Uc		**1264.5** nm	RIN_Coef=	**0.70**
Uw (see notes)		**0.20** nm	Det.Jitter	**6.0** ps inc.
Tx pwr OMA=		**-3.2** dBm	DCD_DJ=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

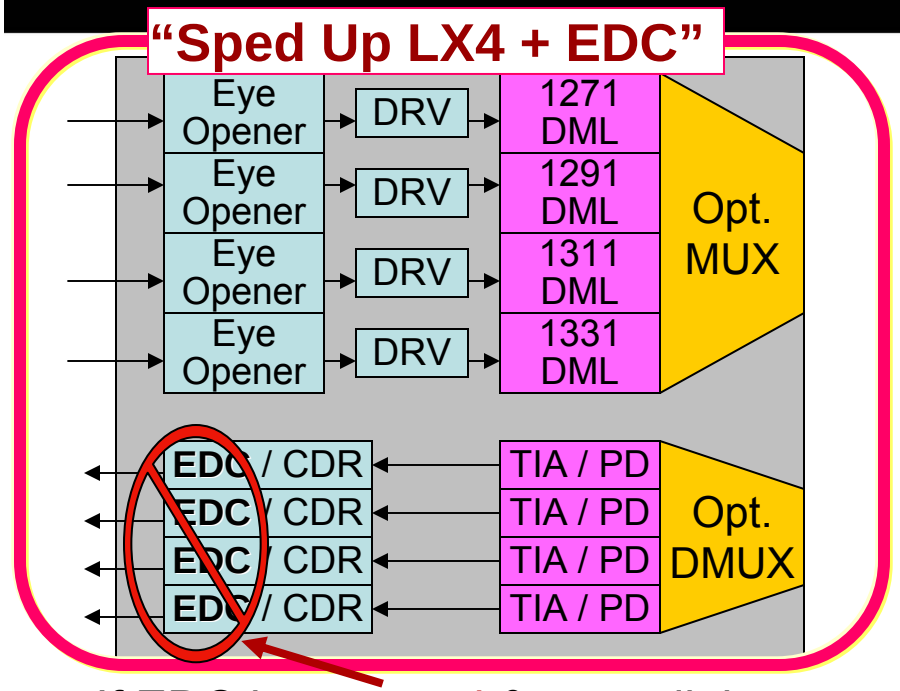
0.48dB margin at 10km

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

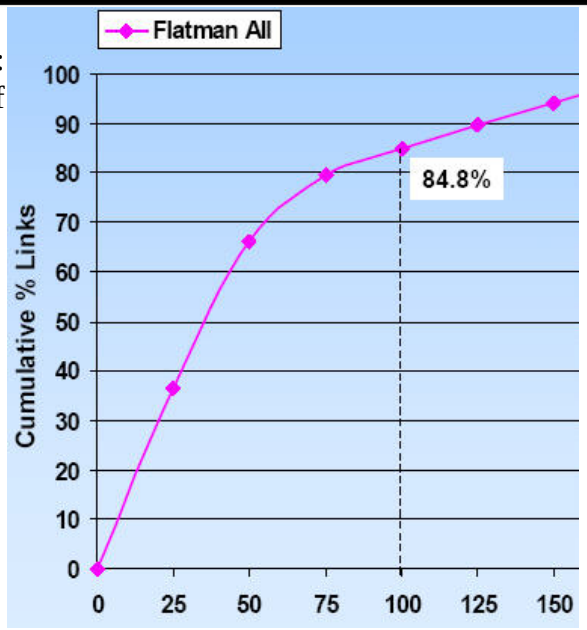
EA-DFB = Electro Absorption DFB Laser; also known as EML

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

40GbE MMF: Duplex Fiber



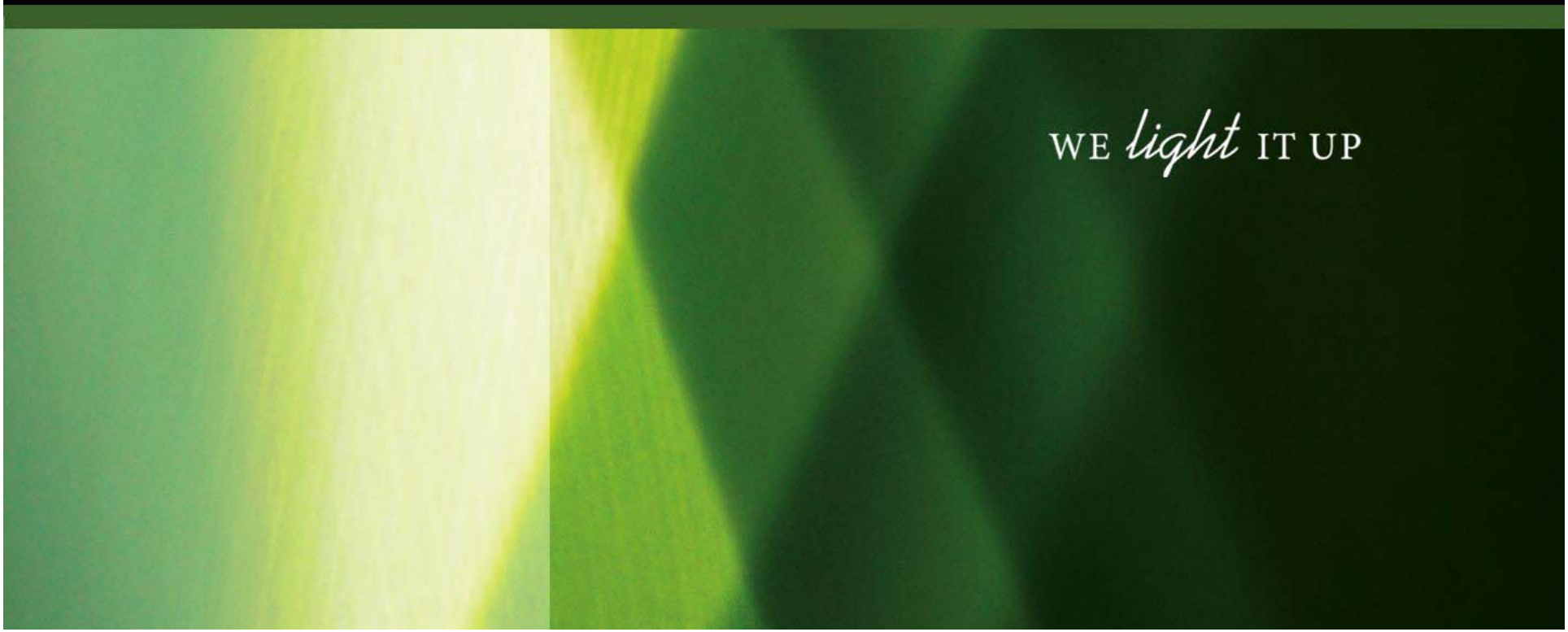
Source: Flatman_01_0108.pdf



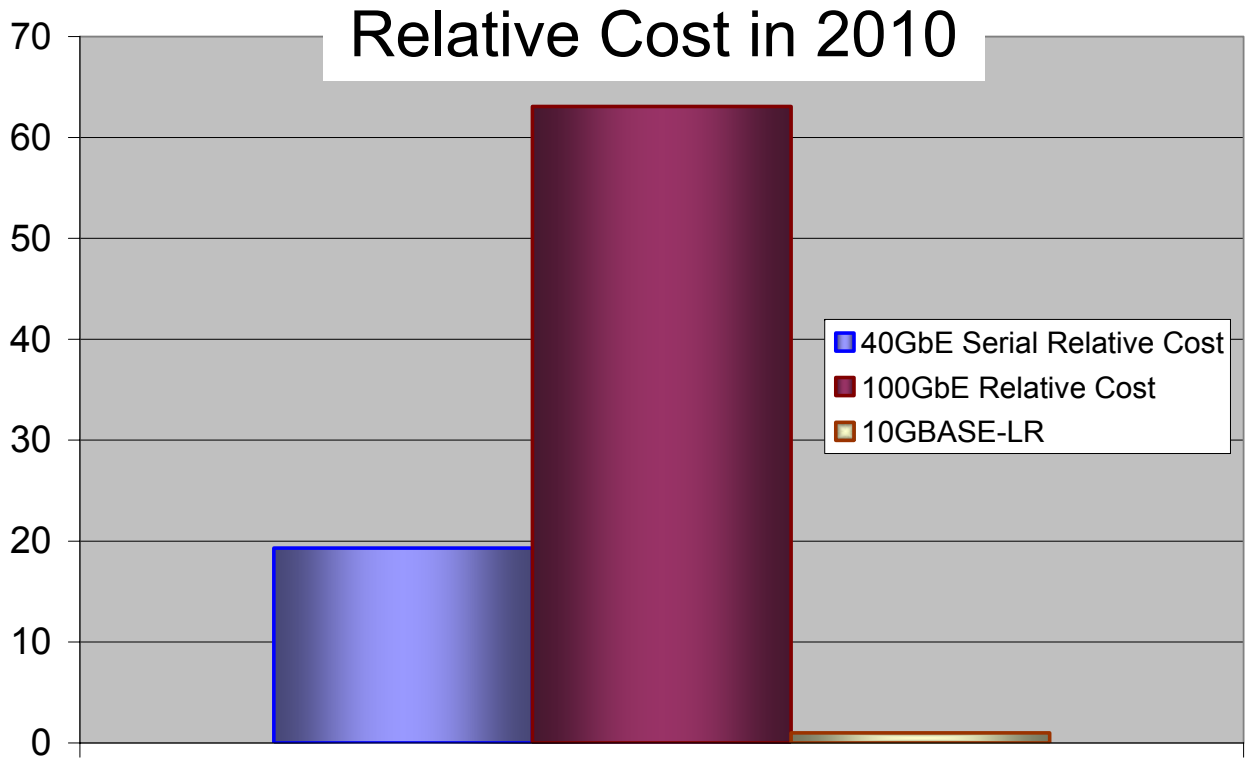
- If EDC is removed & same link parameters are used as proposed above for LX4 "sped up" optics the Link Spreadsheet results in a margin for OM3 fiber of:
  - 100m => 2.37dB margin
  - 120m => 0.29dB margin
- If >100m is required then it is likely that some form of EDC would be necessary to close the 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

opnext



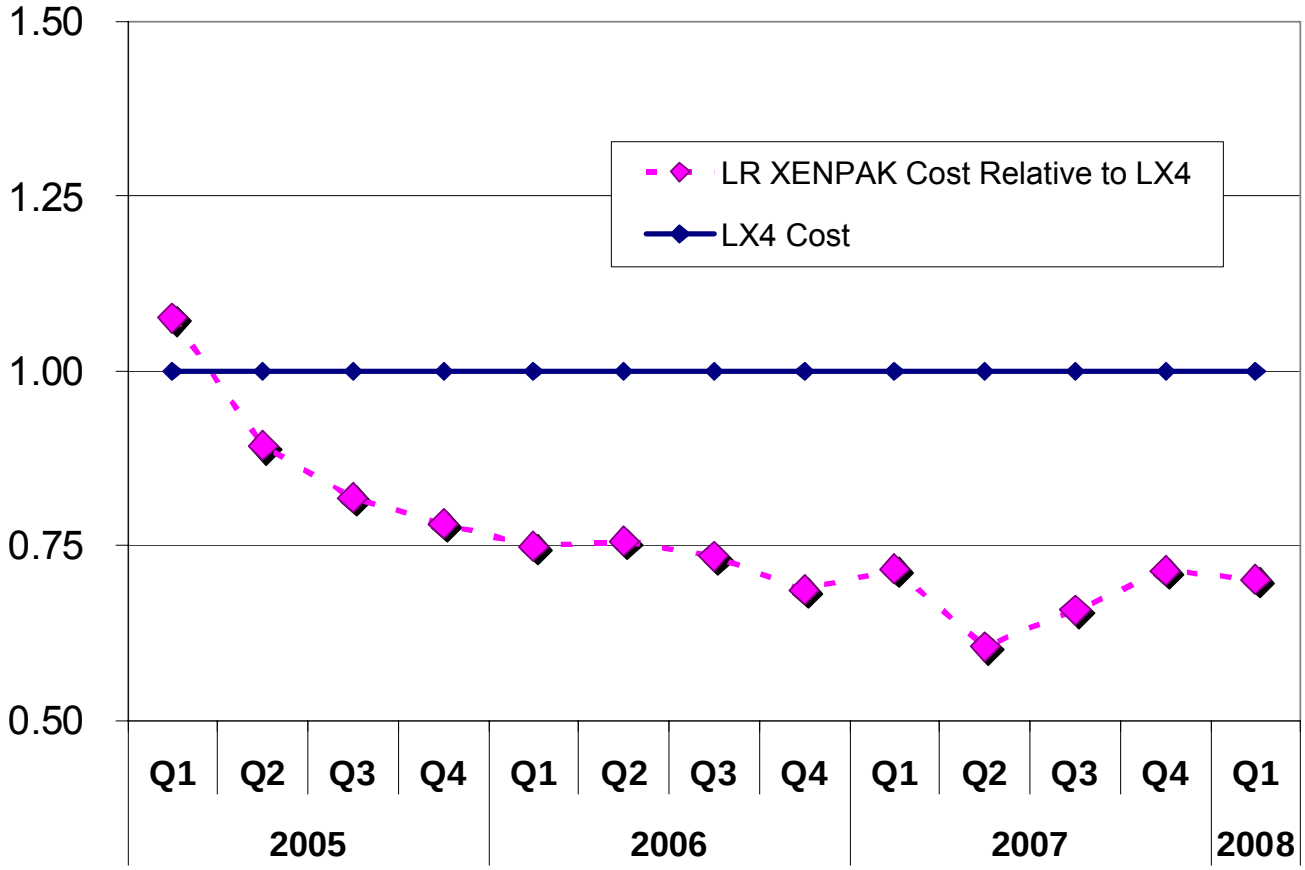
Relative cost of 10km Reach by Rate in 2010



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)

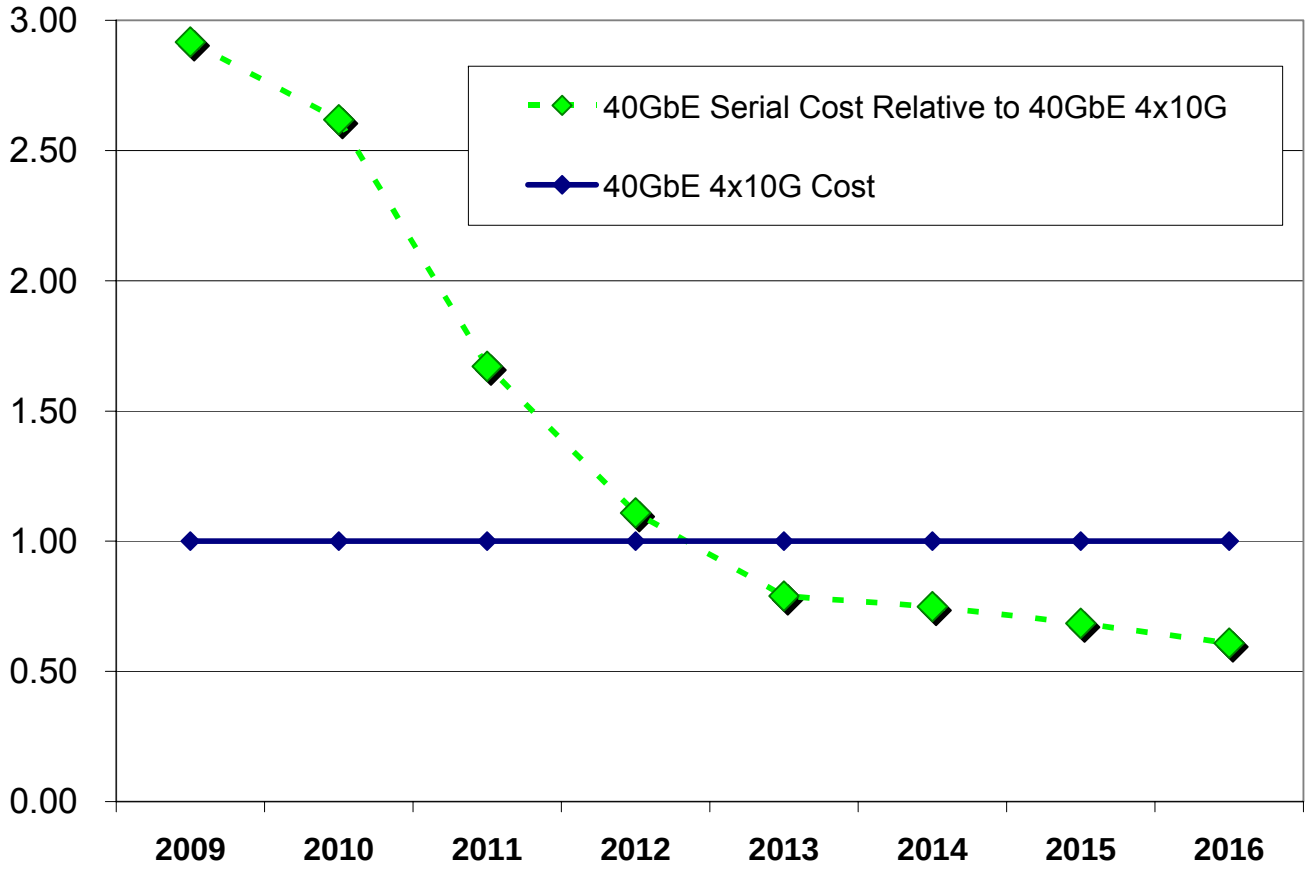


Source: Opnext data

- 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, WWDM has been shown to be less cost competitive than serial**

40GbE SMF: Serial vs. WWDM (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, WWDM has been shown to be less cost competitive than serial**