Merits of a 40GbE serial solution for the 40GbE 10km SMF PMD objective

IEEE 802.3ba Interim Session
Seoul, September 15-19, 2008

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Supporters (1)

Network Carrier

- Sam Sambasivan, AT&T
- Glenn Wellbrock, Verizon
- Osamu Ishida, NTT
- Shoukei Kobayashi, NTT
- Hidenori Takahashi, KDDI Labs
- Ralf-Peter Braun, Deutsche Telekom
- Dirk Breuer, Deutsche Telekom

System Supplier

- Hiroshi Onaka, Fujitsu
- Youich Akasaka, Fujitsu labs
- Satoshi Obara, Fujitsu
- Shinji Nishimura, Hitachi Ltd
- Hidehiro Toyoda, Hitachi Ltd
- Satomi Shioiri, NEC
- Mike Shahine, Ciena
- Sashi Thiagarajan, Ciena
- Li Zeng, Huawei

Transceiver Supplier

- Beck Mason, JDSU
- Mike Dudek, JDSU
- Atsushi Takai, Opnext
- Kiyohisa Hiramoto, Opnext
- Ed Cornejo, Opnext
- Tadashi Ikeuchi, Fujitsu Labs
- Ruai Yu, Gtran
- Jae Hwan Yoo, Gtran

Supporters (2)

Device Supplier

- Farzin Firoozmand, SMI
- Craig Hornbuckle, SMI
- Hideaki Horikawa, OKI
- Med Belhadj, Cortina
- Hitoshi Watanabe, Mitsubishi Electric
- Sosaku Sawada, Eudyna
- Keiji Sato, Eudyna
- Hao Feng, Eudyna
- Tetsuya Kinoshita, Kyocera
- Josh Castleberry, Kyocera
- Walter Crofut, Narda
- Med Belhadj, Cortina
- Jen Fiedler, U2T

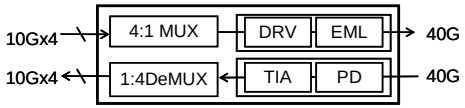
Device Supplier

- Frank Chang, Vitesse
- Keith Nellis, Inphi Corp
- David McCormick, Picometrix
- Janis Valdmanis, Picometrix
- Padraig O'Mathuna, Gigoptix

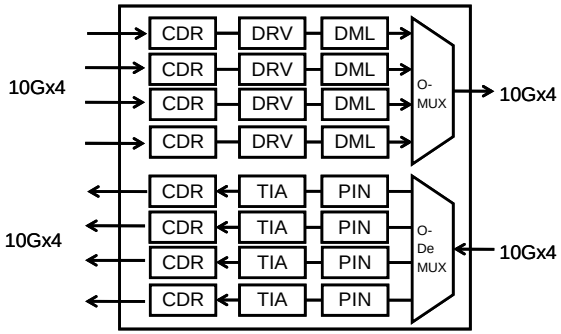
Introduction

- 40GbE over 10km of SMF was adopted as an Objective to address servers, datacenters and access interconnection (*barbieri_01_0308, simsarian_01_0308*)
- In the past two options have been discussed

Serial (*jewell_03_0508*)



CWDM 4x10G (*cole_03_0508*)



- Both options are technically feasible (*cole_04_0708*)
- Cost is the critical deciding factor in the selection process

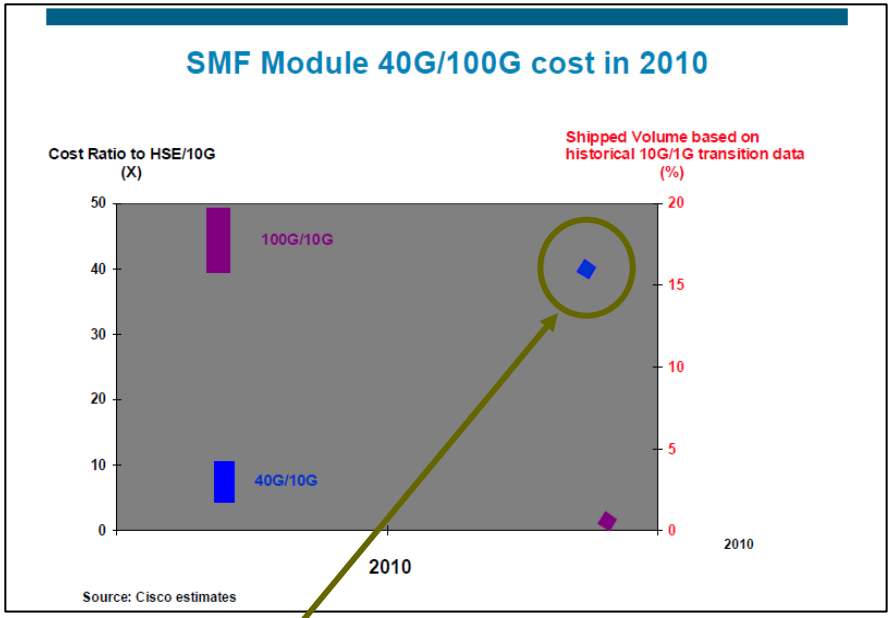
Agenda

- This presentation presents the merits of 40GbE serial in terms of;
  - cost
  - power consumption
  - availability
  - form factor evolution

Higher Volume for 40GE 10km SMF

	2010	2011	2012	
10GE Total	1600K	1800K	2500K	***Note1***
40/10 ratio	15%	20%	20%	***Note2***
40GE Total	240K	360K	500K	
40GE LR %	50%	50%	50%	***Note3***
40GE 10km	120K	180K	250K	

From “carter_40_01_0208.pdf”



40GbE is estimated to be 15% of the volume of 10GbE

Note1; LightCounting estimation for 2010 & 2011. Yr 2012 is estimate

Note2; Estimated from carter_40_01_0208.pdf (40GbE SMF Ad-hoc)

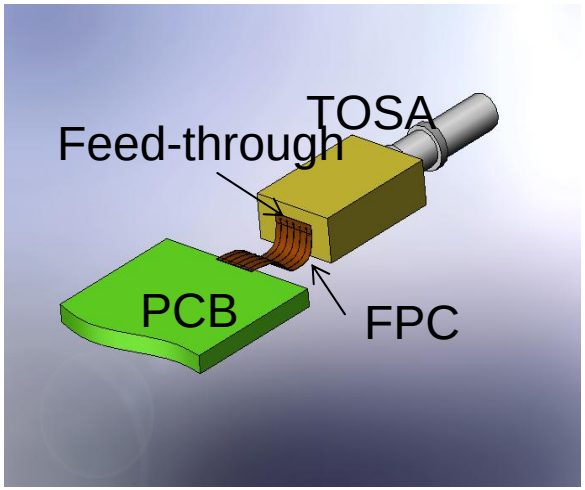
Note3; Ratio on distance is referred to “goergen_01_1107”, where around 50% for 10km category is reported.

Economic Feasibility

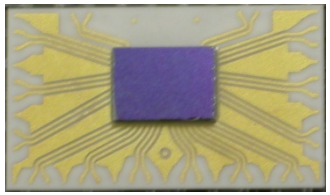
- The consensus generally and amongst CWDM advocates is that serial will be cost effective in long term.
- Recent survey among many optical and electronic component vendors suggests the serial will be MORE cost competitive than CWDM in mid 2010
- LX4 is NOT cost effective comparing to 10GBASE-LR, 10GBASE-SR and 10GBASE-LRM.
- CWDM will require significant investment in optical packaging. High Speed IC technology is amortized across all IC applications.

Main Drivers to Drop Serial Cost in 2010

(From "traverso_04_0308.pdf")

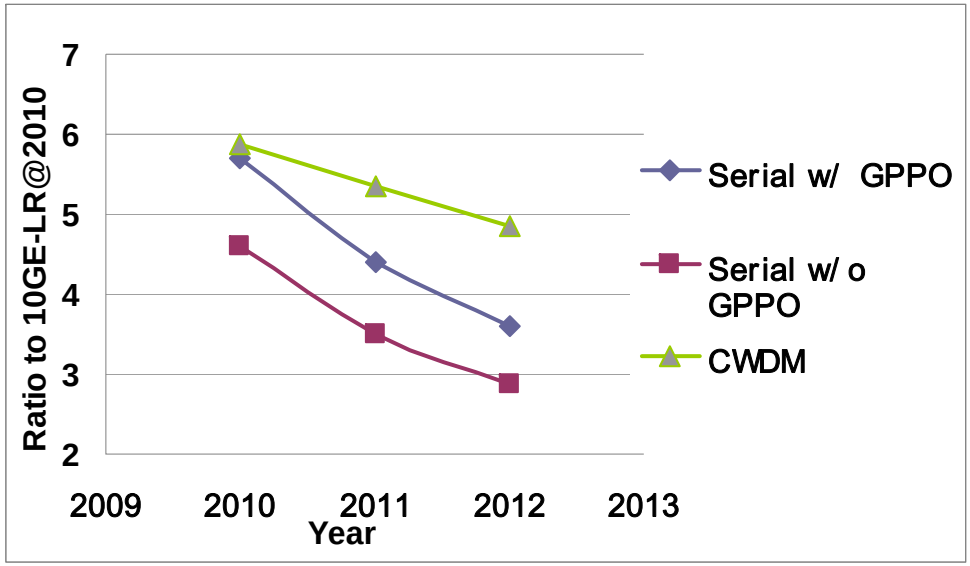


- Optics packaging
- 4:1 Serdes instead of 16:1 Serdes
- Low cost SerDes packaging



- Low cost RF interconnect
  - Substrate interconnection via micro-stripline or stripline
- High volume

Cost analysis versus 10GbE-LR for both 40G 10km CWDM & Serial



Serial provides a more cost-effective solution than CWDM after yr2010.

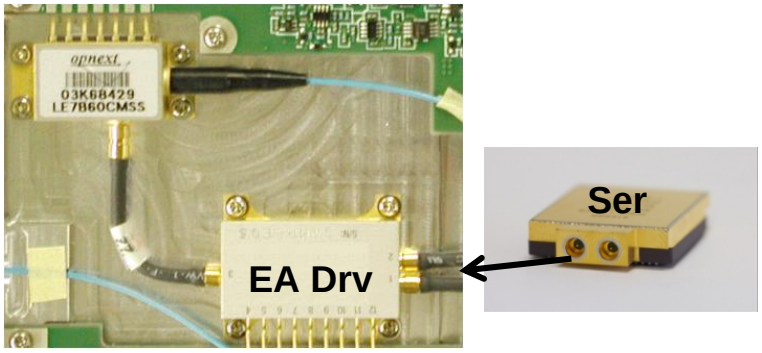
Estimated values are ratio referred to 10GE LR for each component respectively.

Relative Cost Comparison

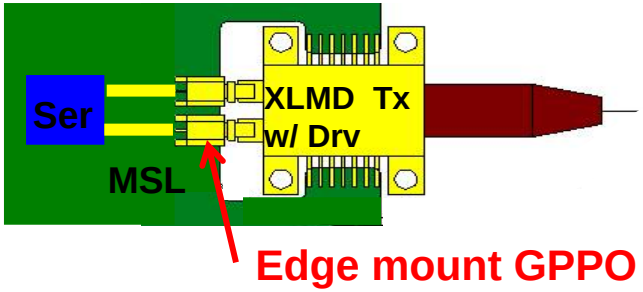
Component	10GE LR	Serial w/o GPPO			CWDM		
	2010	2010	2011	2012	2010	2011	2012
TOSA/ROSA w/O-Mux,Demux	1.0	5.9	4.4	3.4	8.4	7.5	6.8
CDR/SerDes	1.0	7.5	5.0	4.0	4.0	3.6	3.2
Other component	1.0	1.8	1.8	1.8	1.7	1.7	1.7
TEST	1.0	2.0	1.8	1.6	4.0	3.6	3.2
Total	1.0	4.6	3.5	2.9	5.9	5.3	4.9

RF Interconnection Methods

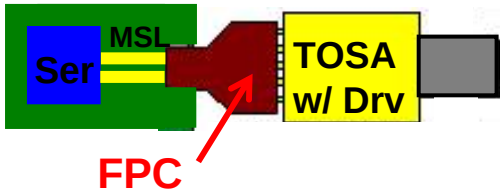
Current OC768

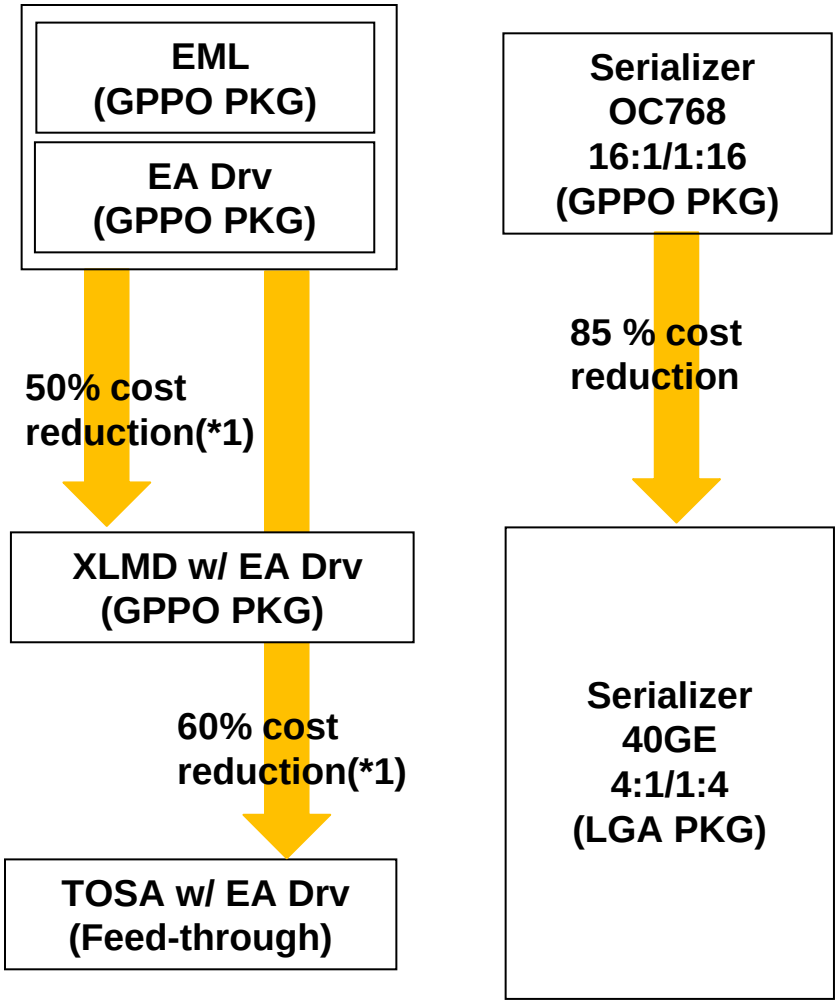


GPPO edge mount connectors



FPC interconnection



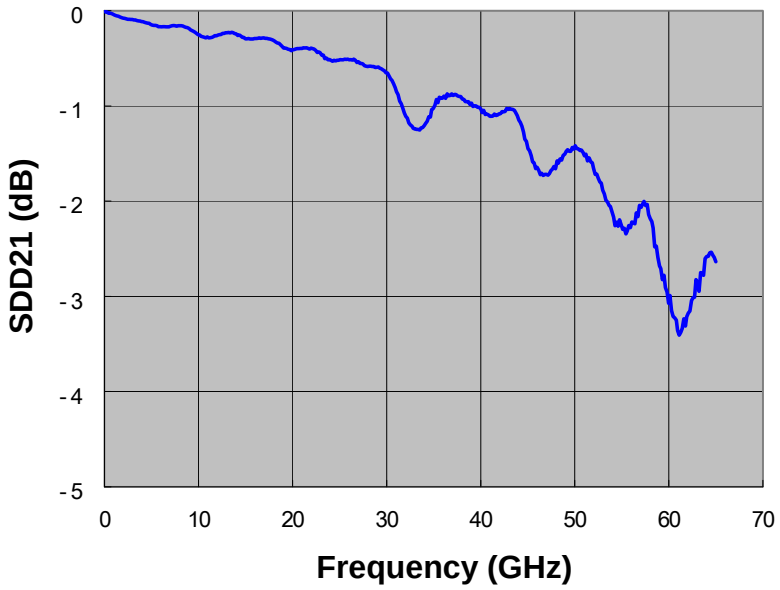


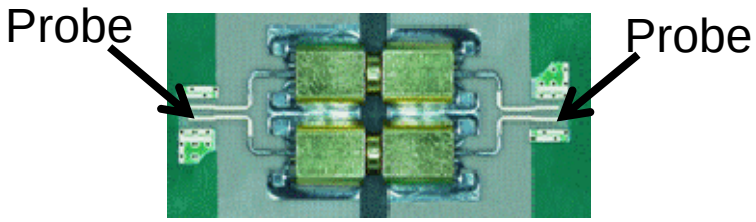
(*1) TOSA(w/ driver)+ROSA cost, not include volume effect
From traverso_01_0909

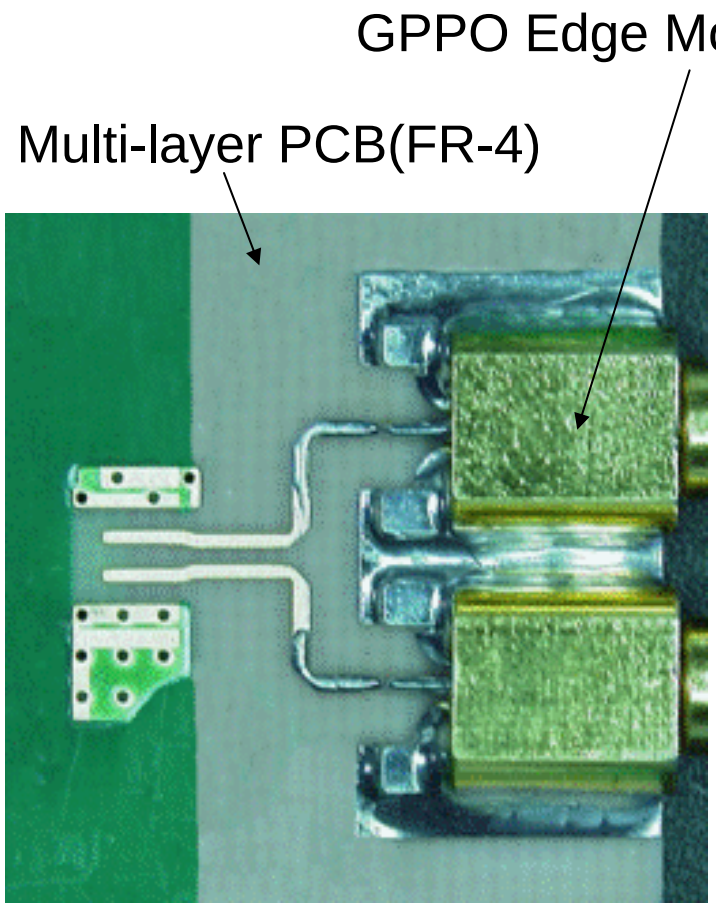
Edge Mount GPPO Method

Transmission loss = 1.0dB@40GHz

f_{-3dB} bandwidth = 60GHz





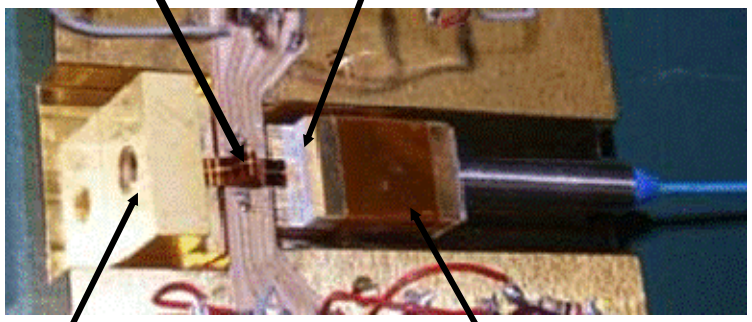


Available today

FPC Interconnection Method

FPC film
(10mm, R=0.75, 90deg bend)

Ceramic feed-through



GPPO connector

Driver IC integrated EML module

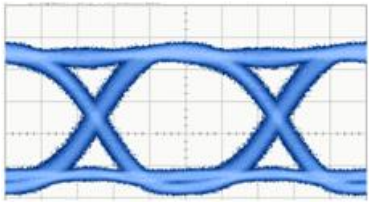
(*OECC 2008, WeC-1)

Available 2009

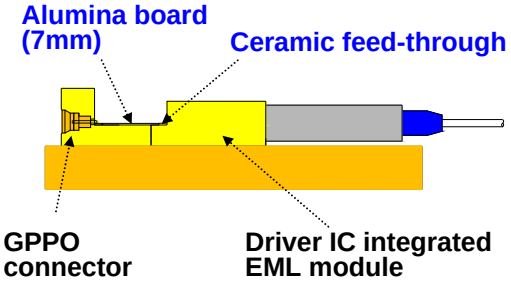
Bit rate : 39.8Gb/s
Data pattern : PRBS31

X-point	50.1 %
Jitter p-p	4.01 ps
Jitter rms	0.64 ps
Eye amp.	1.2 V
Tr	7.11 ps
Tf	7.44 ps

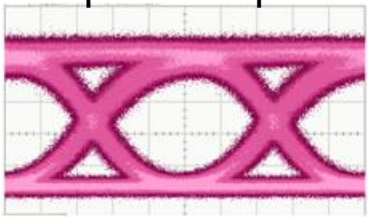
Input waveform



1. Alumina board connection(Reference)

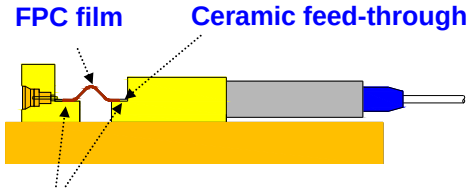


Optical output



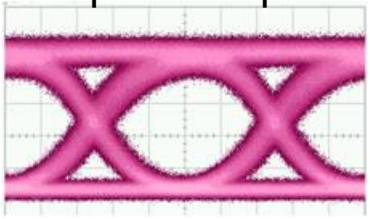
X-point	50.0 %
Ext. ratio	10.5 dB
Jitter p-p	7.56 ps
Jitter rms	1.13 ps

2. FPC film connection



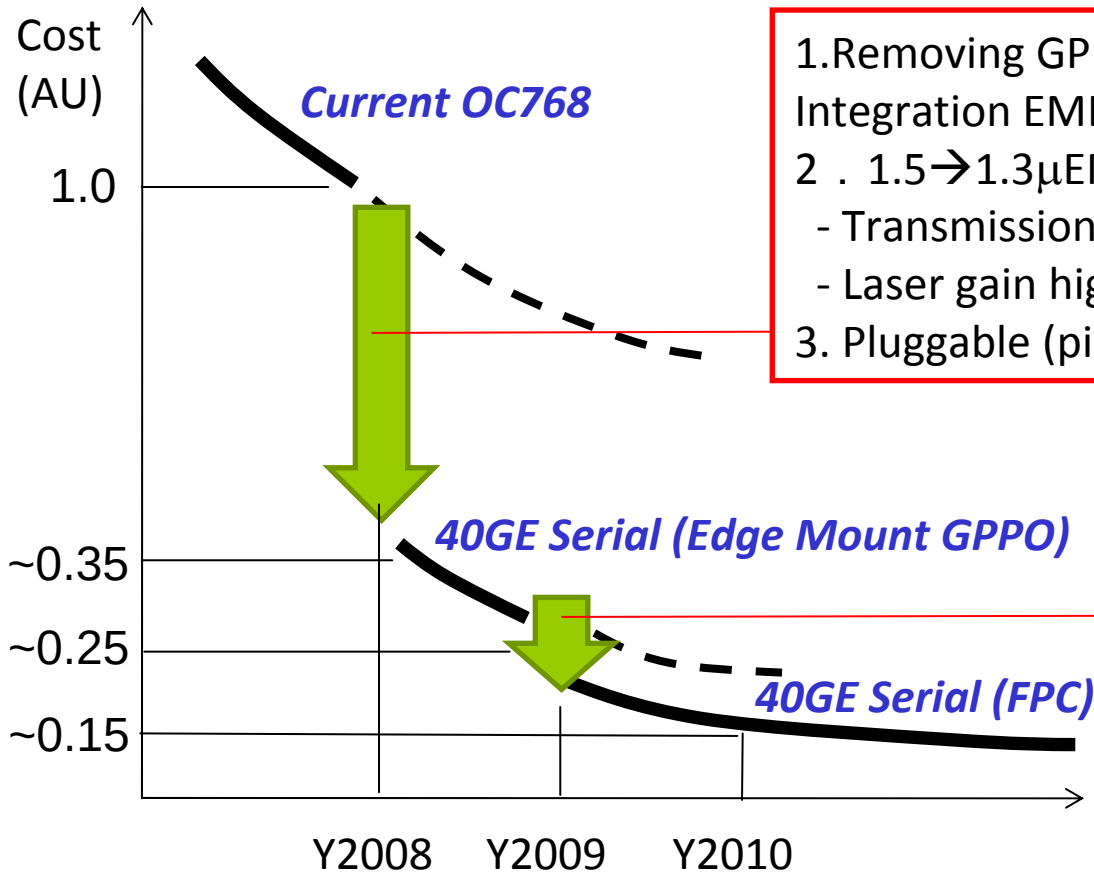
Solder Joint

Optical output



X-point	50.3 %
Ext. ratio	10.8 dB
Jitter p-p	7.56 ps
Jitter rms	1.09 ps

Cost projection from technical point



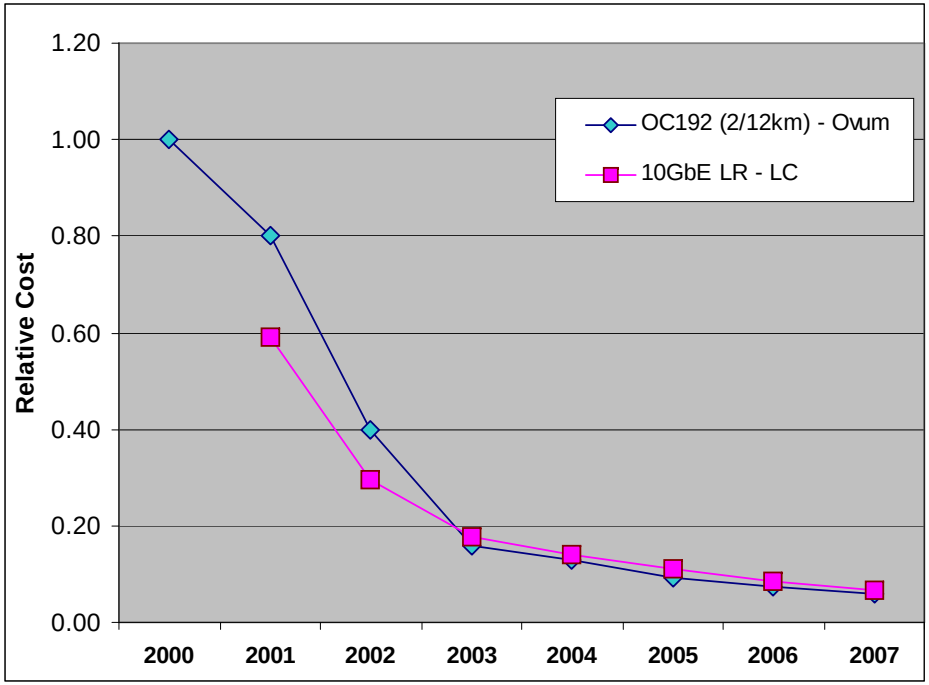
1.Removing GPPO from SerDes PKG Integration EML and EA-Drv
2 . 1.5→1.3μEML applicable
- Transmission characteristics improved
- Laser gain higher
3. Pluggable (pig-tail not necessary)

Removing GPPO from TOSA/ROSA

From technology point of view, drastic cost reduction, usually observed in initial development stage, is achievable.

Cost projection driven by volume

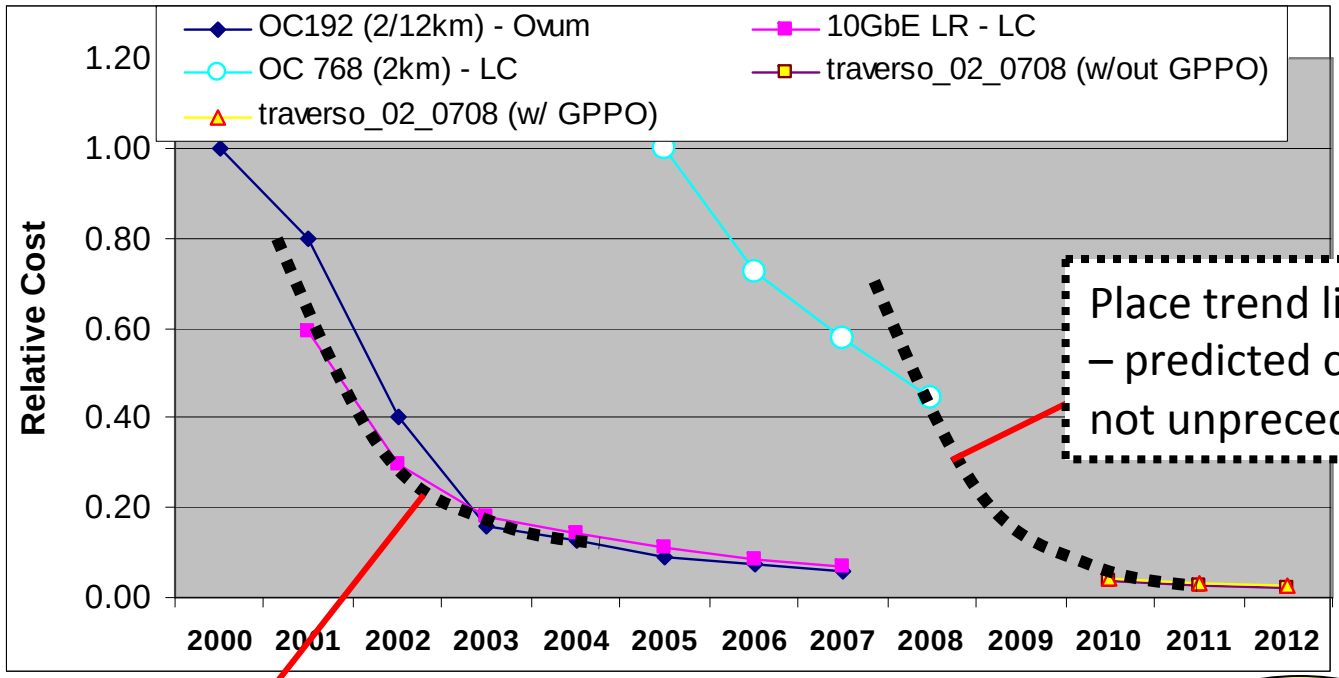
- A reasonable historical reference point is that of OC192 (2 km) and 10GbE LR



Source: Ovum-RHK & Lighcounting

- Within two years of the adoption of the 10GbE LR standard, OC192 costs had dropped ~6X
- **Under a similar scenario, 40GE serial solution will be more cost effective than CWDM in mid 2010**

Cost Projections – Comparing OC768 w/ 40GbE Serial – Linear



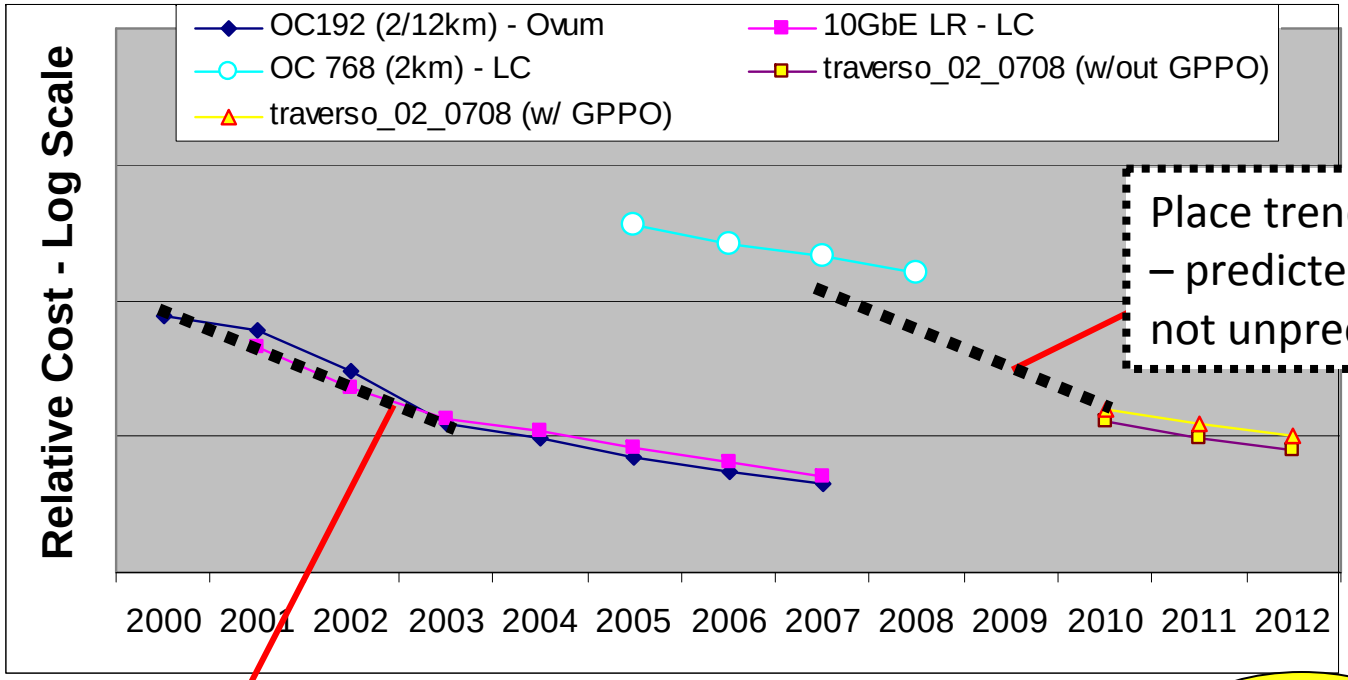
Place trend line over 40G curve – predicted cost reduction is not unprecedented…

Draw Trend line approximating cost reduction

This "cost" analysis compares a 40Gbit/s 1550nm EML with a 40Gbit/s 1310nm EML – and treats the two wavelengths the same. This is not accurate! Treating the two lambdas as equal is PESSIMISTIC !

Notes:
Ovum Historical cost data used
Lighcounting (LC) historical cost data used
10G costs relative to yr 2000 OC192
40G costs relative to yr 2005

Cost Projections – Comparing OC768 w/ 40GbE Serial – Logarithmic



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Notes:
Ovum Historical cost data used
Lighcounting (LC) historical cost data used
Costs are actual
Horizontal lines are powers of 10

Power Comparison -- Serial vs. CWDM

From “jewell_03_0508.pdf”

40G 10km Serial	Y2009 Power (W)	Y2011 Power (W)	40G 10km CWDM	Y2009* Power (W)	Y2011** Power (W)
EML TOSA TEC + Laser Bias	1.5	1.0	DML TOSA/Mux	0	0
EML Driver	0.8	0.6	4X DML Driver	2.1	1.7
4:1 / 1:4 MUX/DMUX/CDR	2.0†	1.5††	XFI CDR	1.8	1.0
PIN/TIA	0.4	0.3	4XPIN/TIA ROSA	0.7	0.5
Other	0.1	0.1		0.4	0.4
Total Power	4.8	3.5		5.0	3.6
Ratio to CWDM	0.96	0.97		1	1

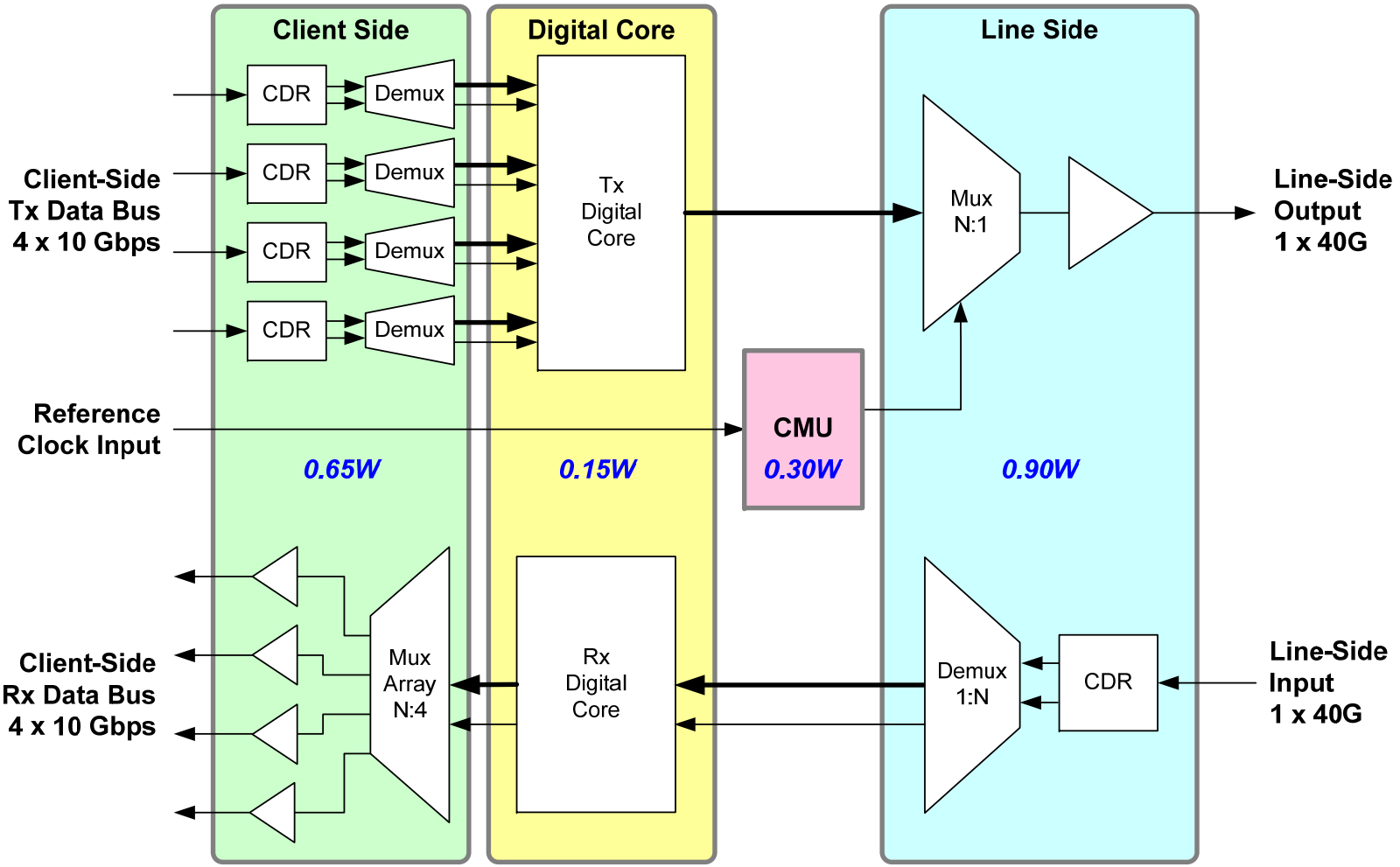
* Intermediate between “Now” and “2010” values from Tsumura’s presentation to the 40GbE SMF Ad-hoc

** Slightly reduced from the “2010” values from Tsumura - 40GbE SMF Ad-hoc

† SiGe

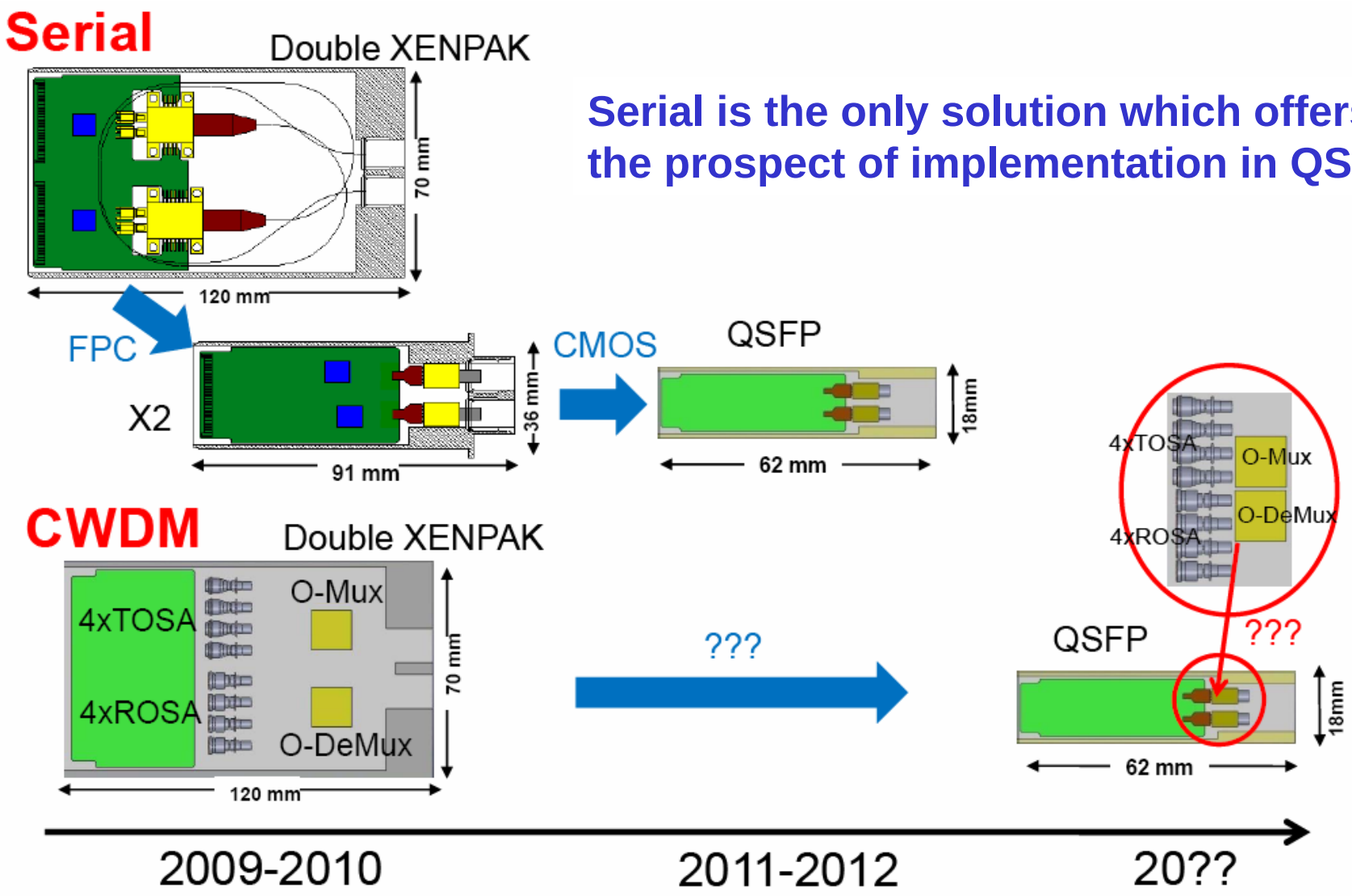
†† CMOS

YR2009 1x40G SerDes Power Summary



0.65 + 0.15 + 0.30 + 0.90 = 2.0 Watts

Form Factor Evolution



Serial is the only solution which offers the prospect of implementation in QSFP

Summary

- Recommend the 802.3ba task force to adopt 40GbE Serial PMD for 10Km SMF:
  - Is the only viable long term solution
  - It is the only solution that could potentially be implemented in the QSFP form factor
  - Technical feasibility
    - Packaging technology – Available today
    - Process technology – Available today
    - Power consumption – Lower than CWDM
  - Economic feasibility
    - Lower cost than CWDM when volume ramps (mid 2010)
    - Serial PMD cost reduction follows silicon cost reduction path
  - Accelerates the deployment of high volume 40Gb Ethernet
  - Eliminates standardization of two PMDs