

40GE 10km SMF PMD Alternatives

IEEE 802.3ba Task Force

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Introduction

- Two alternatives under consideration for 40GE 10km SMF PMD objective are CWDM and Serial.
- The focus of the discussion to date has been CWDM cost based on available technology and Serial cost based on advanced technology.
- Common misconception has been that while initial CWDM cost is lower, long term it flattens out since no further innovation/cost reduction is possible.
- This presentation shows how significant long term CWDM cost reduction is achieved.

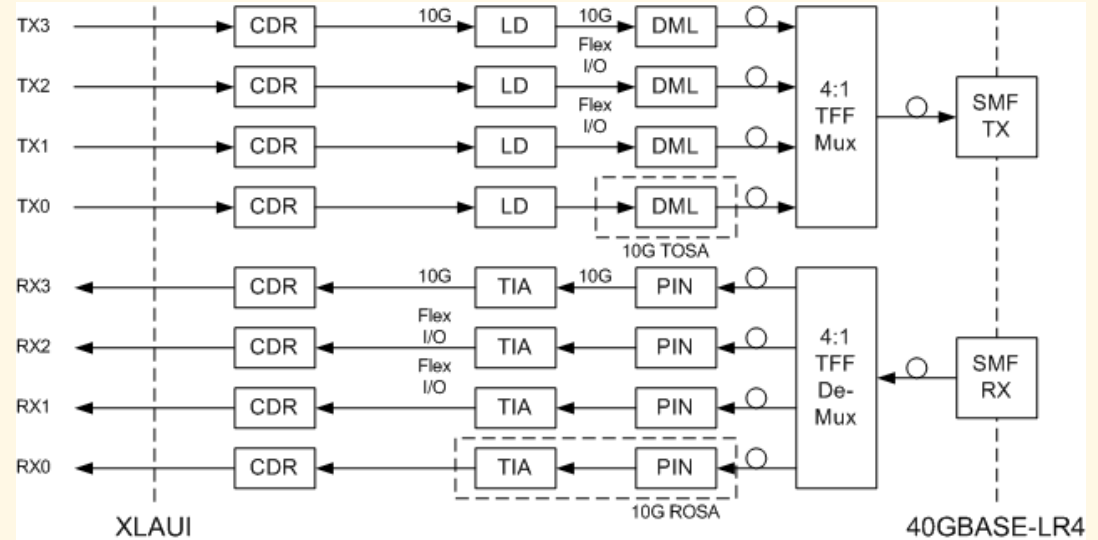
Outline

- Fair comparison of 40GE 10km SMF PMD alternatives examines technologies available at similar points in time and based on similar R&D investment.
- Table below makes such a fair comparison and is the presentation outline.

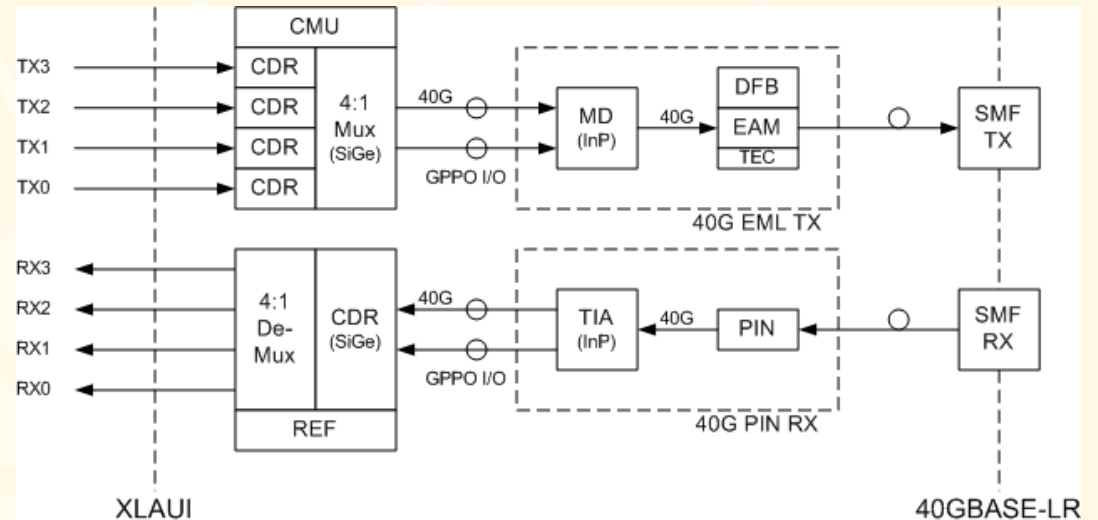
40GE 10km SMF PMD alternative	<ul style="list-style-type: none"> ■ <u>Gen1</u>: fast time to market ■ 2009 delivery ■ moderate R&D costs ■ available technology 	<ul style="list-style-type: none"> ■ <u>Gen2</u>: lowest cost, size, pwr. ■ Long term delivery ■ large R&D costs ■ advanced technology
40GE-CWDM (4x10G)	<ul style="list-style-type: none"> ■ 4 sets of discrete XFP 10G ICs & 10G OSAs ■ TFF Mux/Demux ■ ~2 x XENPAK size 	<ul style="list-style-type: none"> ■ Un-retimed quad ~SFP+ I/O ■ Quad 10G ICs & 10G OSAs ■ Integrated OSAs using PLC Mux/Demux technology ■ QSFP size
40GE-Serial (1x40G)	<ul style="list-style-type: none"> ■ 2 GPPO I/O SiGe 40G SerDes ICs ■ 2 GPPO I/O 40G OSAs (ex. XLMD) ■ ~2 x XENPAK size 	<ul style="list-style-type: none"> ■ 2 PCB RF I/O CMOS 40G SerDes ICs ■ 2 Flex I/O (with PCB RF interconnect) 40G OSAs ■ QSFP size

2009 Moderate R&D 40GE PMD Alternatives

Gen1 40GE-CWDM Module using available technology

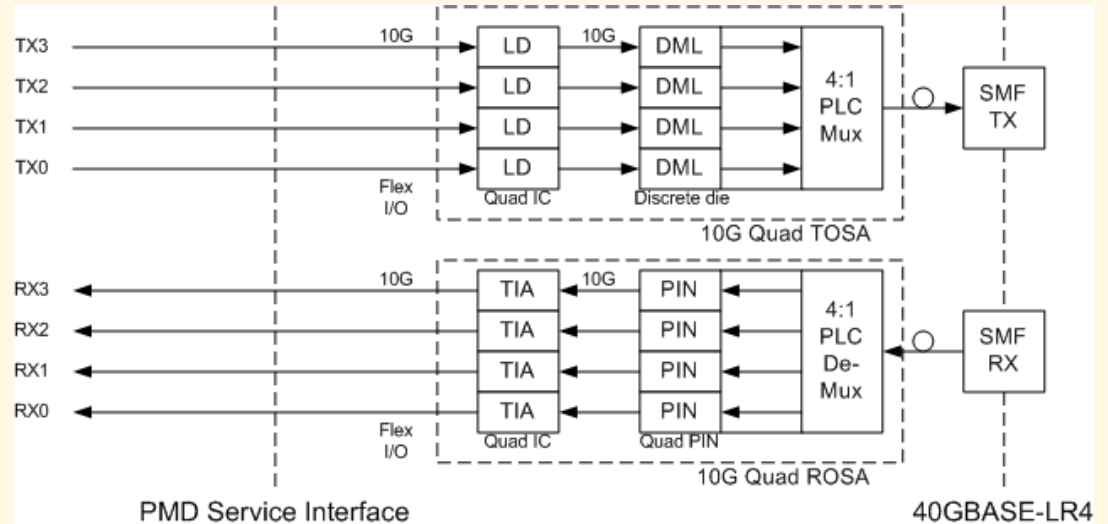


Gen1 40GE-Serial Module using available technology



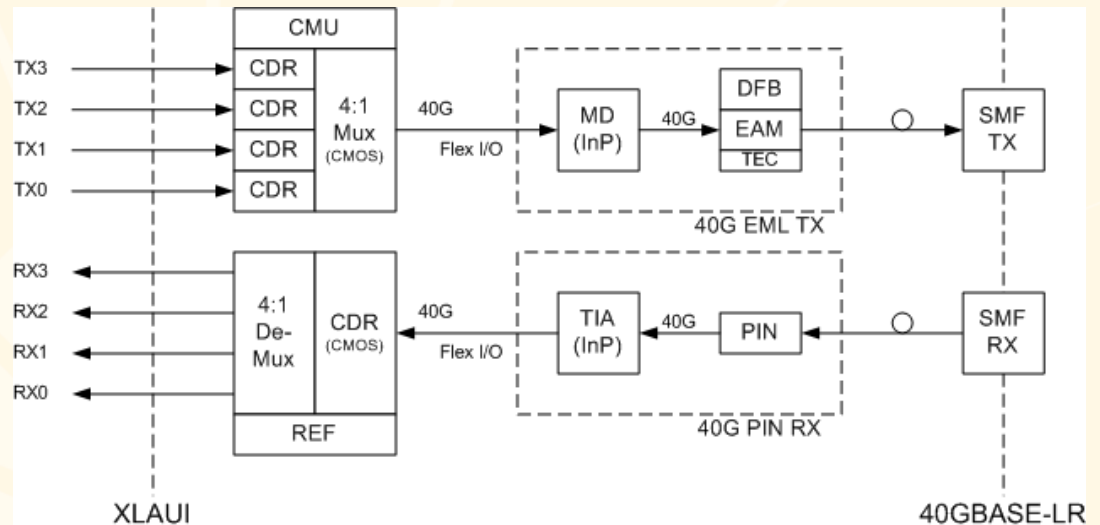
Long term Large R&D 40GE PMD Alternatives

Gen2 40GE-CWDM Module using advanced technology



Gen2 40GE-Serial Module using advanced technology

(True 40GE-Serial Module requires Gen3 technology: no SerDes, only 40G CDRs. It is only possible if XLAUI is replaced by 40G serial electrical I/O; >8 years out.)



40GE 10km SMF PMD Alternatives Cost

- Gen1 40GE-CWDM (per cole_04_0708 and traverso_02_0708)
≈ 6x → 4x 10GE LR XFP cost exponentially decreasing with time
(802.3ba consensus agreement on this cost projection)
- Gen1 40GE-Serial (per cole_04_0708 and traverso_04_0308)
≈ 40G 300-pin OC768 VSR serial cost exponentially decreasing with time
(802.3ba consensus agreement in March on this cost projection,
disagreement starting in May on this cost projection)
- Gen2 40GE-CWDM
≈ 3x → 2x 10GE LR XFP cost exponentially decreasing with time
(see next page for details)
- Gen2 40GE-Serial (per traverso_04_0308 and traverso_02_0708)
≈ 4x → 3x 10GE LR XFP cost exponentially decreasing with time
(802.3ba disagreement on when this cost is achievable)

(All market cost data in this presentation is from Lightcounting, based on actual transceiver sales confidentially shared by 21 optics vendors with Lightcounting.)

Gen2 40GE-CWDM Long Term Cost

- Gen2 40GE-CWDM 4x10G PMD Long Term cost using integrated optics
- Volume assumption for 2012 and later: >200K

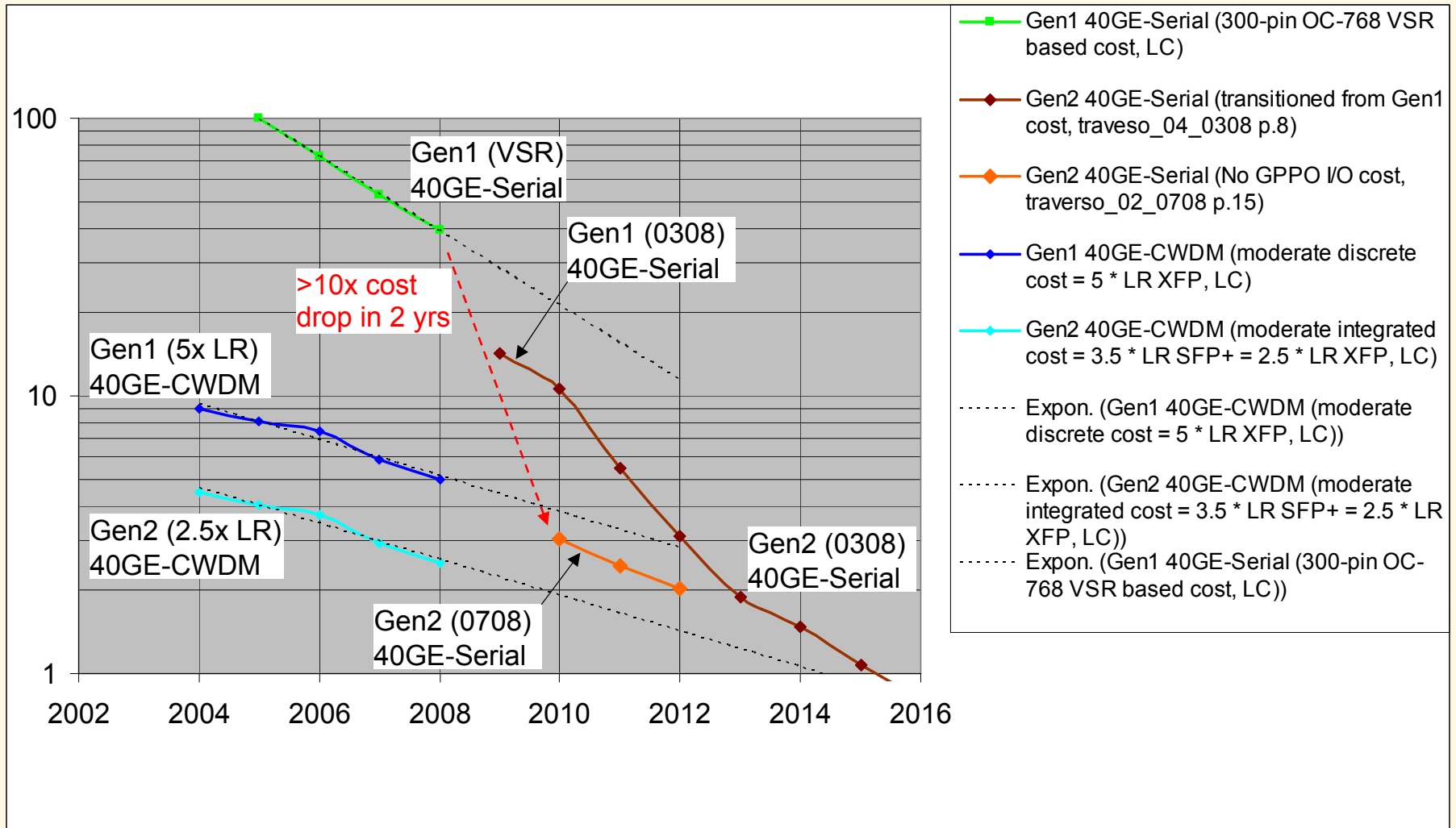
Component	10GE LR SFP+	Component	40GE LR4 QSFP
LD die	1	Quad LD die	2
TIA die	1	Quad TIA die	2
DFB TOSA	1	4 DFB PLC w/ Mux TOSA	2 → 3.5
PIN ROSA	1	Quad PIN PLC ROSA	3 → 4
Other	1	Other	1
Test	1	Test	2
TOTAL	1	TOTAL	2.6 → 4

- 2008 10GE LR XFP cost / 2008 10GE LR SFP+ cost (LC) = 1.4
- 10GE LR XFP cost / 10GE LR SFP+ cost projections (LC) ≈ 1.4
- Gen2 40GE-CWDM = 4x → 2.6x 10GE LR SFP+ (table above)
 ≈ 3x → 2x 10GE LR XFP cost exponentially decreasing with time

(LC = Lightcounting)

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40GE 10km SMF PMD Alternatives Cost Graph



All costs relative to 2008 10GE LR XFP cost (LC = Lightcounting)

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Conclusions

- Gen1 40GE-CWDM based on available technology offers a low risk, quick time to market (2009 delivery) 10km SMF PMD, at 3x to 4x lower cost than Gen1 40GE-Serial based on available technology and similar quick time to market development.
- Based on historical cost data and reasonable component cost assumptions, aggressive cross-over of Gen1 (available technology) 40GE-CWDM PMD cost by Gen2 (advanced technology) 40GE-Serial PMD cost is in 2013 with more likely cross-over after 2016 (i.e. Gen1 CWDM will have a long lifecycle.)
- With similar R&D investment, Gen2 (advanced technology) 40GE-CWDM cost will be lower than Gen2 (advanced technology) 40GE-Serial cost.
- 40GE-CWDM is the best technology choice for the 40GE 10km SMF PMD baseline, based on both near term and long term cost advantages.

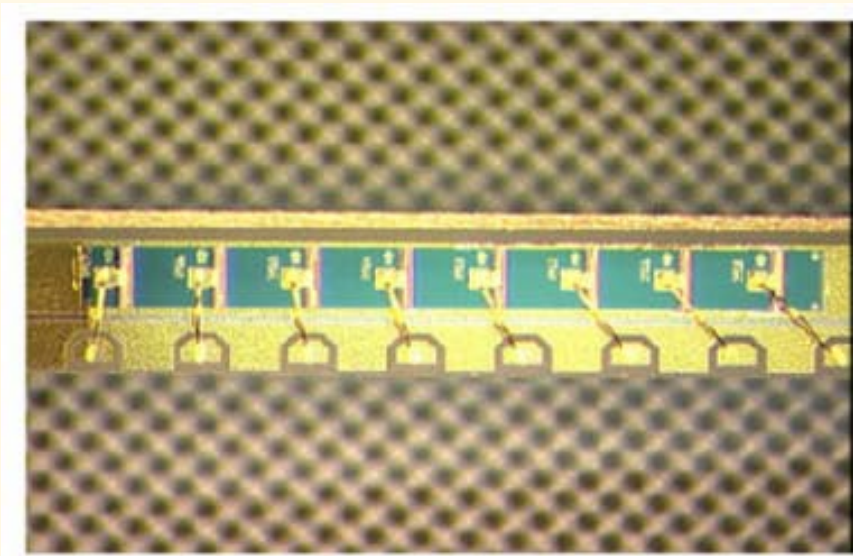
Appendix 1: Optical Integration References

The following HSSG and 802.3ba Task Force presentations discussed technical feasibility of various optical integration approaches:

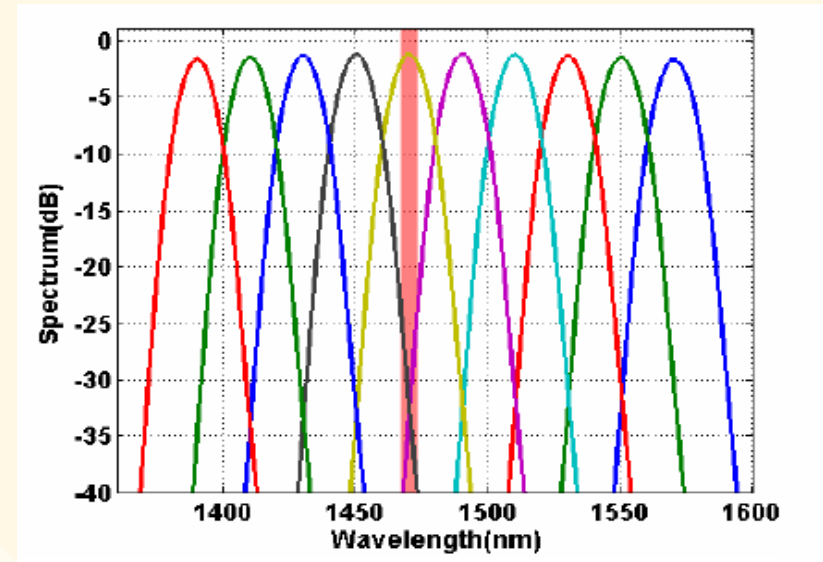
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- martin_01_0307
- nagarajan_01_1107
- johnson_01_0108
- cole_02_0308
- schrans_01_0508

Appendix 2: Example 8x10G CWDM PLC

From IEEE Higher Speed Study Group Tutorial, p.47, November 12, 2007:

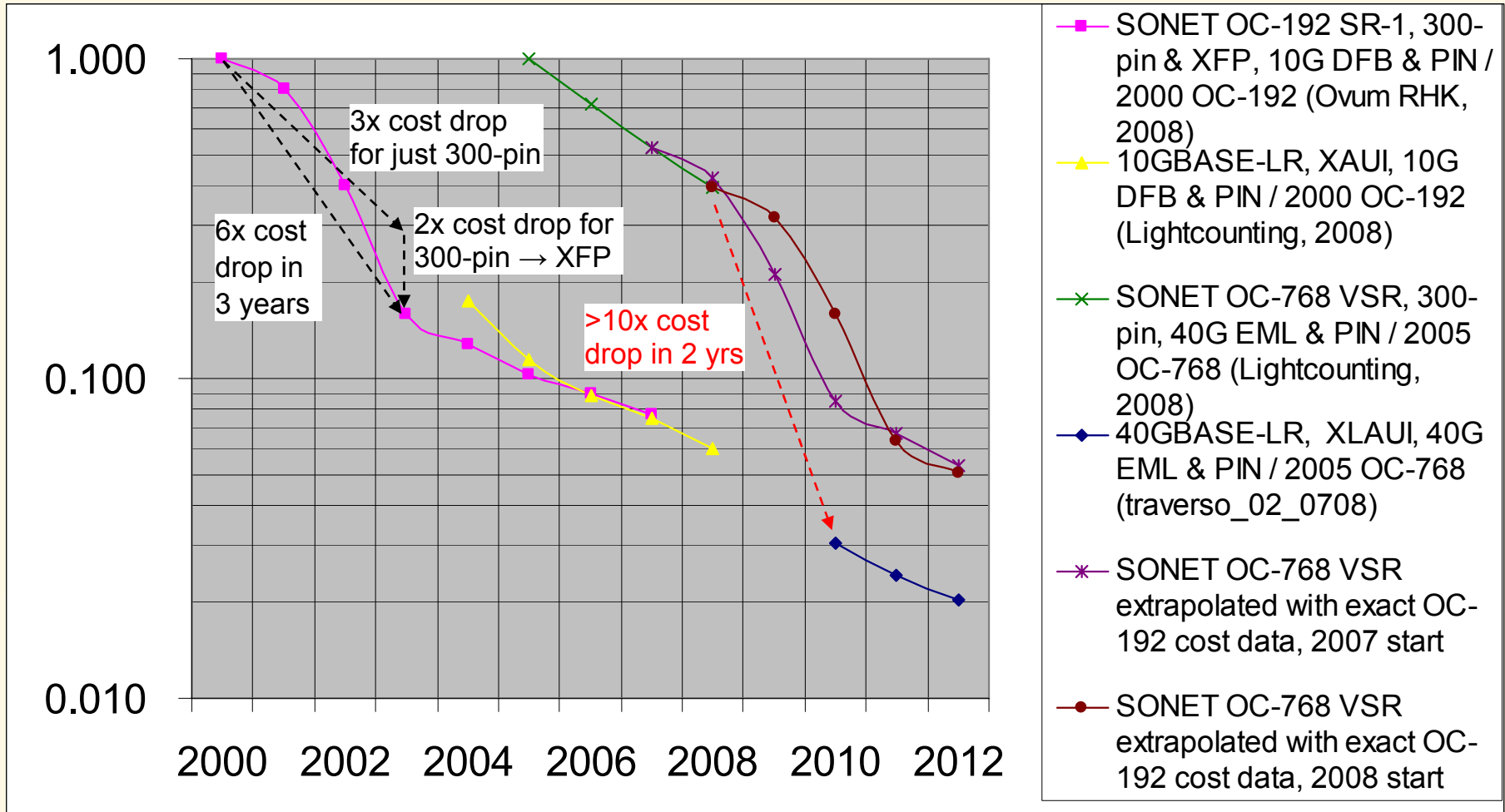


8x10G 1550nm DFB array (CyOptics)



CWDM Mux λ response (Kotura)

Appendix 3: OC-192 SR-1 & OC-768 VSR Cost Data



Same data as in 9/13/2008 cole 802-3-HSSG reflector email.

Appendix 3: OC-192 SR-1 Cost Data Conclusions

- The cost decline of OC-192 and OC-768 SerDes based 300-pin modules in the first three years of shipment are similar, >3x cost drop for OC-192 and 2.5x cost drop for OC-768. (See 9/8/2008 cole 802-3-HSSG reflector email for 300-pin only data.) This makes OC-192 a good historical analogy to use in 40GE discussion.
- A dramatic shift from SerDes and fiber pig-tailed OSA based 300-pin technology to CDR based receptacle OSA XFP technology gave OC-192 modules an additional factor of 2x cost drop in 2003. We should expect similar ~2x cost drop boosts from future dramatic technology shifts; NOT 10x.
- The cost projections by 40GE-Serial proponents are a factor of ~3x more aggressive than predicted by even the best case (i.e. transitioned to XFP) OC-192 SR-1 historical cost data. This makes these cost projections a poor basis for making standards decisions.

Same conclusions as in 9/13/2008 cole 802-3-HSSG reflector email.