Comparison of 4x10G vs Serial 40G

IEEE 802.3ba

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List of Supporters

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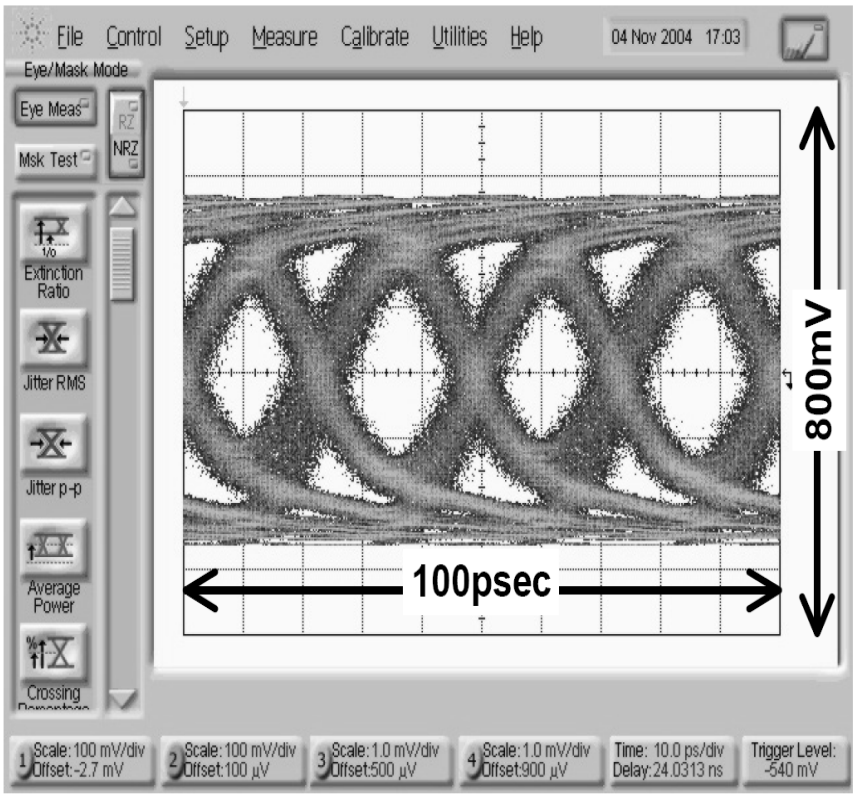
- Kieth Conroy – AMCC
- Alessandro Barbieri - Cisco
- Chris Cole – Finisar
- Ryan Latchman – Gennum
- Siddharth Sheth – NetLogic Micro

Historical Perspective

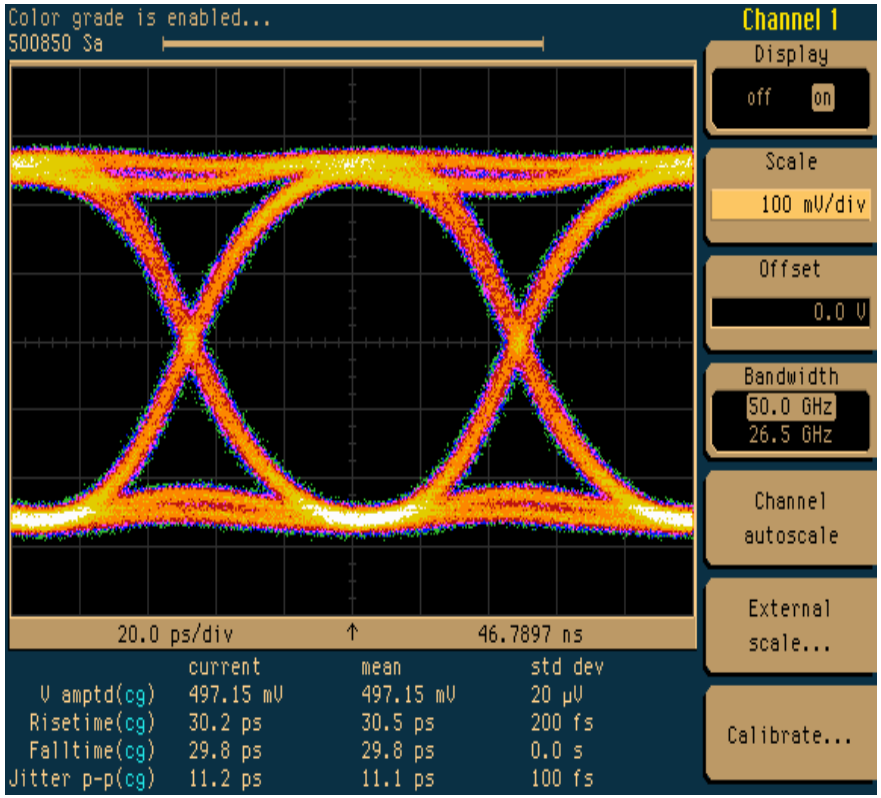
- 10GbE Call for interest March 1999
- 10GbE study group started on June 1999
- Newport Communication introduced 1st CMOS OC-192 production XCVR July 1999.
- IEEE 802.3ae had their 1st task force meeting March 2000.
- Newport Communication was acquired by Broadcom Aug 2000.
- Broadcom introduces 1st 10 GbE XAUI-serial XCVR May 2000 based on CMOS.
- In IEEE 802.3 our standards are designed for high volume, low cost, and based on nearly mature technology.
  - Production 10G CMOS was available when 802.3ae defined serial PMDs.

Comparisons of 40G Research Serdes vs 1st 10G Production Serdes

- 4x1 Mux, ISSCC 2005 8.2 K. Kanada
- 90 nm CMOS 20 GHz clock supplied externally, state of the art!



- Newport Com/Broadcom 0.18 um CMOS XAUI XCVR.
- Production grade XCVR!



10G XCVR Cost in 2000 vs 2008

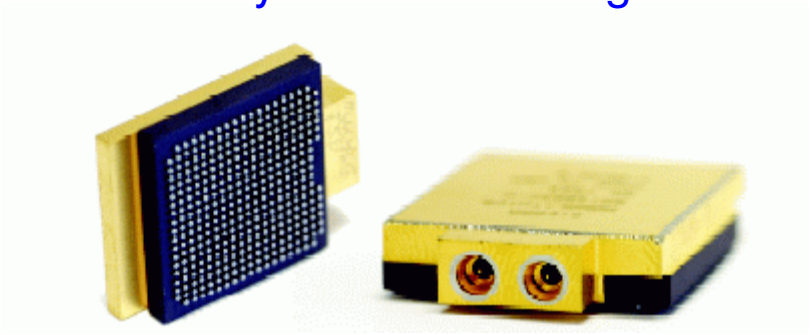
- **Primary driver for cost reduction**
  - Moving from very expensive bench top testing every part to ATE
  - Yield increase
- **Secondary driver for cost reduction**
  - Package cost
  - Wafer cost
- **Other factor contributing to cost reduction**
  - Availability of XCVR from 3-5 suppliers
  - Volume

Cost Breakdown	2000	2008
Testing	40.00%	20.00%
Yield	40.00%	10.00%
Package Cost	10.00%	20.00%
Wafer cost	10.00%	50.00%

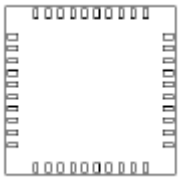
OC-768 Cost

- **Currently OC-768 cost more than 100x the cost of OC-192!**
- **Our estimate is that OC-768 cost are similar to to OC-192 cost in 2000, dominated by yield and testing.**
  - **It has been stated going from GPPO package to SMT will result in 87.5% cost reduction, only possible if test cost, yield, and etc is zero!**
- **Even if LGA/BGA package has adequate performance for serial 40G it will complicate at speed testing and may result in yield loss!**

Today OC-768 Package

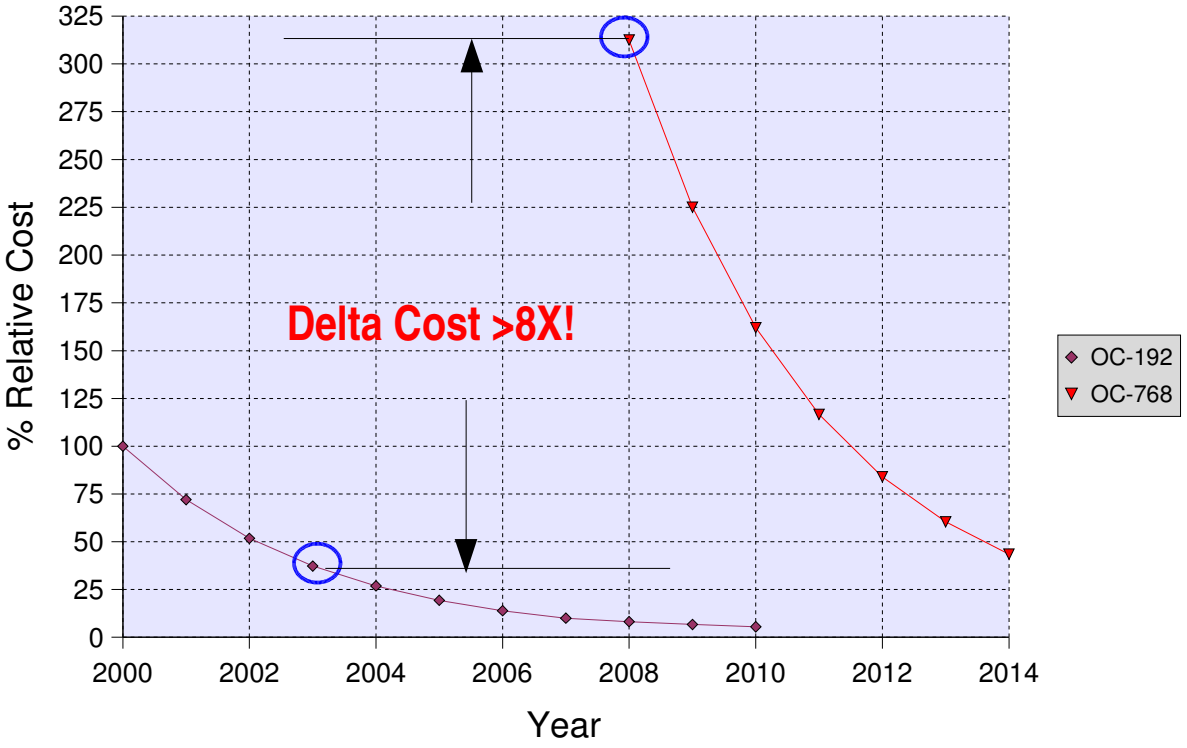


Tomorrow Serial 40 Package
Might be LGA/BGA



Cost Comparison of OC-192 vs OC-768 XCVR

- **OC-768 cost compare to OC-192 cost is >8X, 6 years from product introduction!**
  - **Product shipment for OC-192 started in ~1997**
  - **Product shipment for OC-768 started in ~2002**



* OC-768 cost was assumed to follow 28% YoY cost reduction

Summary

- **Even after 6 years after OC-768 product introduction it has not yet followed OC-192 volume curve or cost reduction.**
  - **As result of test equipment cost, yield, signal integrity, packaging, and requirement for esoteric processes.**
  - **ITU SG-15 is actually considering alternative modulation scheme with better spectral efficiency and lower Baudrate (2x20 or 4x10 Gigabud).**
- **Even if 87.5% cost reduction is possible by using LGA/BGA package for a 40G SerDes, the XCVR still will cost 6x the cost of quad CDR!**
- **IEEE 802.3ba should standardize 4x10G SMF PMD based on maturity, low cost, technology reuse, and synergy with 4x10G/10x10G MMF PMD.**