Comparison of 4x10G vs Serial 40G

IEEE 802.3ba

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Historical Perspective

- 10GbE Call for interest March 1999
- 10GbE study group started on June 1999
- Newport Communication introduced 1\textsuperscript{st} CMOS OC-192 production XCVR July 1999.
- IEEE 802.3ae had their 1\textsuperscript{st} task force meeting March 2000.
- Newport Communication was acquired by Broadcom Aug 2000.
- Broadcom introduces 1\textsuperscript{st} 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

<table>
<thead>
<tr>
<th>Cost Breakdown</th>
<th>2000</th>
<th>2008</th>
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</thead>
<tbody>
<tr>
<td>Testing</td>
<td>40.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>Yield</td>
<td>40.00%</td>
<td>10.00%</td>
</tr>
<tr>
<td>Package Cost</td>
<td>10.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>Wafer cost</td>
<td>10.00%</td>
<td>50.00%</td>
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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!
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.