Proposal for a Limiting, Non-retimed PMD for 100 Gb/s and 40 Gb/s Ethernet and Related Specifications

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- Alessandro Barbieri – Cisco
- John Abbott – Corning
- David Cunningham – Avago Technologies
Outline

• Proposal of a limiting, non-retimed PMD to address 802.3ba objectives to reach 100m over OM3 at 100 Gb/s and 40 Gb/s
  – 10 lane parallel, short wavelength based PMD for 100 Gb/s
  – 4 lane parallel, short wavelength based PMD for 40 Gb/s

• Same per-lane specifications for both 100 Gb/s and 40 Gb/s PMD
Motivation for Non-retimed Limiting Parallel PMD Proposal

- 10 (4) parallel links operating at 10.3125 GBd utilize low cost, high performing 10 Gb/s optics and electronics used today in 10GBASE-S links
  - Limited, un-retimed interface is the highest density, lowest power, lowest cost 100m solution today
  - Uses existing, viable semiconductor technology
  - Uses known specification methods refined in SFP+ and 8GFC

- The 10 (4) optical lanes directly map the 10 (4) electrical lanes, without muxing or translation, retiming or deskewing
  - Works with all proposed striping methods

- This proposal is supported by multiple vendors and users and is economically feasible and competitive with other alternatives
802.3ba PMD Block Diagram

- TP1, TP2, TP3 and TP4 are traditional labels in 802.3 for interfaces of a fiber optics link.
- Two physical interfaces are introduced between the PMA and PMD (TP1 and TP4)
  - PMA may be in the host ASIC, PMD is the optical module
- The block diagram below shows relevant elements and interfaces for a link between two PMAs. The patch cord is included for the definition of TP2.
  - Intermediate fiber connectors are not shown
Proposal

- 10 parallel lanes @ 10.3125 GBd for 100 Gb/s over OM3 fiber
- 4 parallel lanes @ 10.3125 GBd for 40 Gb/s over OM3 fiber
- No glue chip required
  - See also last slide
Operating range

• 0.5-100m over OM3 fiber with TBD dB allocated for connector loss

• This is more than sufficient to cover
  – all distances in HPC environment,
  – almost 100% of Enterprise Data Center Client-to-Access Channels,
  – >90% of Enterprise Data Center Access-to-Distribution Links, and
  – almost 85% of Enterprise Data Center Distribution-to-Core Channels.

• See flatman_01_0108, Data Centre Link Survey
Transmitter specifications (each lane)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signaling speed (nominal)</td>
<td>10.3125</td>
<td>GBd</td>
</tr>
<tr>
<td>Signaling speed variation from nominal (max)</td>
<td>±100</td>
<td>ppm</td>
</tr>
<tr>
<td>Center wavelength (range)</td>
<td>840-860</td>
<td>nm</td>
</tr>
<tr>
<td>RMS spectral width (max)</td>
<td>0.65</td>
<td>nm</td>
</tr>
<tr>
<td>Average Launch Power (max)**</td>
<td>1*</td>
<td>dBm</td>
</tr>
<tr>
<td>Launch Power (min) in OMA</td>
<td>-3*</td>
<td>dBm</td>
</tr>
<tr>
<td>Average launch power of OFF transmitter (max)</td>
<td>-30</td>
<td>dBm</td>
</tr>
<tr>
<td>Extinction ratio (min)</td>
<td>3</td>
<td>dB</td>
</tr>
<tr>
<td>RIN$_{12}$ OMA (max)</td>
<td>-128*</td>
<td>dB/Hz</td>
</tr>
<tr>
<td>Optical return Loss Tolerance (max)</td>
<td>-12</td>
<td>dB</td>
</tr>
<tr>
<td>Encircled Flux</td>
<td>86% @ 19um, 30% at 4.5um *</td>
<td></td>
</tr>
<tr>
<td>Transmitter eye mask definition</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td>TP1 jitter allocation</td>
<td>TBD***</td>
<td>U.I.</td>
</tr>
</tbody>
</table>

* - subject to further study
** - See presentation on eye safety by J. Petrilla
*** - for further study, intermediate between 10G SFP+ and 8GFC
# Receiver characteristic (each lane)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value 1</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signaling speed (nominal)</td>
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<td>840-860</td>
<td>nm</td>
</tr>
<tr>
<td>Average receiver power (max)</td>
<td>1*</td>
<td>dBm</td>
</tr>
<tr>
<td>Average power at receiver input (min)</td>
<td>TBD*</td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver reflectance (max)</td>
<td>-12</td>
<td>dB</td>
</tr>
<tr>
<td>Stressed receiver sensitivity in OMA (max)</td>
<td>TBD</td>
<td>dBm</td>
</tr>
<tr>
<td>- Vertical eye closure penalty (target)</td>
<td>TBD</td>
<td>dB</td>
</tr>
<tr>
<td>- Stressed eye jitter (target)</td>
<td>TBD</td>
<td>UI pk-pk</td>
</tr>
<tr>
<td>TP4 jitter allocation</td>
<td>TBD</td>
<td>UI</td>
</tr>
</tbody>
</table>

* For further study, depends on connector loss
# Link and Cable Characteristic

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Effective Modal Bandwidth</td>
<td>2000*</td>
<td>MHz*km</td>
</tr>
<tr>
<td>Power Budget</td>
<td>&gt;8.3**</td>
<td>dB</td>
</tr>
<tr>
<td>Operating Range</td>
<td>0.5-100</td>
<td>m</td>
</tr>
<tr>
<td>Channel insertion loss</td>
<td>TBD***</td>
<td>dB</td>
</tr>
</tbody>
</table>

* - depends on launch conditions  
** - for further study  
*** - connector loss under study
Further Work

- Jitter
- Crosstalk
- Connector loss
- Fine tune parameters/eliminate TBDs
- Compliance/testing simplification
- Study impact of Encircled Flux specs on link performance
Conclusion

• We propose 10 (4) lane parallel short wavelength based PMD with limited non-retimed interface operating at 10.3125 GBd for 100 (40) Gb/s Ethernet
• This proposal is the highest density, lowest power consumption and lowest cost 100m solution today
• This proposal uses viable, proven semiconductor technology
• It plans using known specification methodologies refined in other standards
• It has broad support from multiple vendors and users
Compatible with in-box link extenders
Diagram for discussion

PMA is a CDR, possibly with simple EDC
* 10GBASE-KR PMA/PMD is different