128 Gigabit Fibre Channel Introduction

- FCIA released the 128GFC MRD as 12-515v0

- 128 Gigabit Fibre Channel (128GFC) will enable high speed parallel links between two ports
  - 4 lanes of 32GFC form 128GFC

- This parallel solution will not match the capabilities of SFP+ and these limitations will be investigated in this presentation

- Single-lane SFP+ based Fibre Channel will remain the dominant type of Fibre Channel because of its flexibility and user base
## 3-4 Years Between 2X Fibre Channel Electrical Interfaces and Speeds

<table>
<thead>
<tr>
<th>Generation</th>
<th>Product Naming</th>
<th>Throughput (MBps)</th>
<th>Line Rate (GBaud)</th>
<th>T11 Spec Technically Completed (Year)‡</th>
<th>Market Availability (Year)‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1GFC</td>
<td>200</td>
<td>1.0625</td>
<td>1996</td>
<td>1997</td>
</tr>
<tr>
<td>2</td>
<td>2GFC</td>
<td>400</td>
<td>2.125</td>
<td>2000</td>
<td>2001</td>
</tr>
<tr>
<td>3</td>
<td>4GFC</td>
<td>800</td>
<td>4.25</td>
<td>2003</td>
<td>2005</td>
</tr>
<tr>
<td>4</td>
<td>8GFC</td>
<td>1600</td>
<td>8.5</td>
<td>2006</td>
<td>2008</td>
</tr>
<tr>
<td>5</td>
<td>16GFC</td>
<td>3200</td>
<td>14.025</td>
<td>2009</td>
<td>2011</td>
</tr>
<tr>
<td>6</td>
<td>32GFC</td>
<td>6400</td>
<td>28.05</td>
<td>2013</td>
<td>2014</td>
</tr>
<tr>
<td>7</td>
<td>64GFC</td>
<td>12800</td>
<td>TBD</td>
<td>2016</td>
<td>Market Demand</td>
</tr>
<tr>
<td>8</td>
<td>128GFC</td>
<td>25600</td>
<td>TBD</td>
<td>2019</td>
<td>Market Demand</td>
</tr>
<tr>
<td>9</td>
<td>256GFC</td>
<td>51200</td>
<td>TBD</td>
<td>2022</td>
<td>Market Demand</td>
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<tr>
<td>10</td>
<td>512GFC</td>
<td>102400</td>
<td>TBD</td>
<td>2025</td>
<td>Market Demand</td>
</tr>
</tbody>
</table>

Source: FCIA Roadmap v15
Electrical Interface Speeds 1995-2015

Key:
- FC Electrical Interfaces
- Ethernet Electrical Interfaces
- OIF Electrical Interfaces

Acronym List
- GFC = Gigabit Fibre Channel
- XSBI - 10G (X) Sixteen Bit Interface
- XAUI - 10G (X) Attachment Unit Interface
- XFI – 10G (X) High Speed Interface
- SFI – SFP+ High Speed Interface
- XLAUI – 40G(XL) Attachment Unit Interface
- XLPPI – 40G(XL)Parallel Physical Interface
- CAUI – 100G(C) Attachment Unit Interface
- CAUI-4 – 100G(C) Attachment Unit Interface -4 lanes
- CPPI – 100G(C) Parallel Physical Interface
Ethernet and Fibre Channel 2010-2025

Key:
- **Fibre Channel**
- **FC Electrical Interfaces**
- **Ethernet**
- **Ethernet Electrical Interfaces**

**Acronym List**
- XLAUI – 40G(XL) Attachment Unit Interface
- XLPPI – 40G(XL) Parallel Physiscal Interface
- CAUI – 100G(C) Attachment Unit Interface
- CAUI-4 – 100G(C) Attachment Unit Interface – 4 lanes
- CPPI – 100G(C) Parallel Physical Interface
- CDAUI-16 – 400G (CD) Attachment Unit Interface – 16 lanes
- CDAUI-8 – 400G (CD) Attachment Unit Interface – 8 lanes
- CDAUI-4 – 400G (CD) Attachment Unit Interface – 4 lanes
- CAUI-1 – 100G(C) Attachment Unit Interface – 1 lane
- TAUI – Terabit Attachment Unit Interface
## Generations of Fibre Channel

### Serial Fibre Channel

<table>
<thead>
<tr>
<th>Generation</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Gen</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Gen</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; Gen</th>
<th>4&lt;sup&gt;th&lt;/sup&gt; Gen</th>
<th>5&lt;sup&gt;th&lt;/sup&gt; Gen</th>
<th>6&lt;sup&gt;th&lt;/sup&gt; Gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical / Optical Module</td>
<td>1GFC / GBIC / SFP</td>
<td>2GFC / SFP</td>
<td>4GFC / SFP</td>
<td>8GFC / SFP+</td>
<td>16GFC / SFP+</td>
<td>32GFC / SFP+</td>
</tr>
<tr>
<td>Electrical Speeds (Gbps)</td>
<td>1 lane at 1.0625</td>
<td>1 lane at 2.125</td>
<td>1 lane at 4.25</td>
<td>1 lane at 8.5</td>
<td>1 lane at 14.025</td>
<td>1 lane at 28.05</td>
</tr>
<tr>
<td>Encoding</td>
<td>8b/10b</td>
<td>8b/10b</td>
<td>8b/10b</td>
<td>8b/10b</td>
<td>64b/66b</td>
<td>64b/66b</td>
</tr>
</tbody>
</table>
# Generations of Fibre Channel

## Serial and Parallel

<table>
<thead>
<tr>
<th>Generation</th>
<th>6th Gen</th>
<th>7th Gen</th>
<th>8th Gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical / Optical Module</td>
<td>32GFC and 128GFC /SFP+ and QSFP28</td>
<td>64GFC and 256GFC /SFP+ and QSFP56</td>
<td>128GFC and 512GFC /SFP+ and QSFP112</td>
</tr>
<tr>
<td>Electrical Speeds (Gbps)</td>
<td>1 lane of 28.05 4 lanes at 28.05</td>
<td>1 lanes of 56.1 4 lanes at 56.1</td>
<td>1 lane of 112.2 4 lanes at 112.2</td>
</tr>
</tbody>
</table>

![Image of QSFP28, SFP+, QSFP56, and QSFP112 modules]
High Level 128GFC Proposal

• 128GFC will be based on 4-lane modules
  • QSFP28 modules are preferred but larger modules like CFP2, CFP4 may be required for single-mode solutions

• For flexibility, the 4-lane port can use a breakout cable to adapt to 1 to 4 individual lanes in SFP+
  • Because of crosstalk and other challenges, parallel solutions will not be able to support the same optical requirements as SFP+ and will support less than 100 meters
  • 128GFC Optical parameters should be defined in a separate document than FC-PI-6
  • Individual lanes will only be backward compatible to one speed below the fastest speed due to module limitations
Block Spraying across 4 Lanes

- 128GFC will leverage the work of Ethernet as much as possible including:
  - 66-bit block striping across 4 lanes
  - Reed Solomon (528/514) Forward Error Correction at the 128GFC level instead of the 32GFC level

Source: IEEE 802.3-2012
128GFC Cabling with 4-lane Modules

• 128GFC will require two 4-lane ports and modules

• The ports can be either QSFP28, CFP2, CFP4 or some future 4 lane optical module

12 fiber ribbon with MPO connectors
4 Tx, 4 Rx and 4 dark fibers

Distance less than 100 meters and based on 32GFC SFP+
128GFC shall not have an impact on how 32GFC is defined and shall be compatible with 32GFC to a shorter distance of TBD
Breakout Cabling and Modules

• 40GbE QSFPs have been very successfully deployed because they can break out into 4 lanes of 10GbE

• 128GFC port can be broken out to individual 16GFC and 32GFC lanes with a breakout cable

MPO to LC Breakout Cable

QSFP28

MPO connector – 12 fibers
4 Tx, 4 Rx and 4 dark

4 unused fibers

16GFC SFP+ -2 fibers

32GFC SFP+ -2 fibers

32GFC SFP+ -2 fibers

16GFC SFP+ -2 fibers
Multiple Physical Ports Behind a Multiplexer

Management Aspects of 128GFC and 4X32GFC need to be defined

- From FC-FS-3

- From FC-SW-5

Breakout cable to individual 32GFC lanes
128GFC Conclusion

- With the ability to support 128GFC, Fibre Channel will be able to compete effectively with competing technologies

- 128GFC Multimode solutions will not be able to go 100 meters because of the limitations of crosstalk

- Speed Negotiation will need to be modified to support 128GFC – See 13-062v0

- 128GFC will need to be standardized in a separate document (suggest FC-PI-7) and be compatible with 32GFC SFP+ as defined in FC-PI-6
THANK YOU