Ethernet Alliance Technology Exploration Forum 2014 “The Rate Debate”

Session 1: Data Center Speeds
Ethernet Alliance Roadmap Introduction
Scott Kipp, Brocade
Roadmap Subcommittee Vice-Chair
President of Ethernet Alliance
October 16, 2013
This presentation has been developed within the Ethernet Alliance, and is intended to educate and promote the exchange of information. Opinions expressed during this presentation are the views of the presenters, and should not be considered the views or positions of the Ethernet Alliance.
## Ethernet Alliance Roadmap

Find more at: [www.ethernetalliance.org/subcommittees/roadmapping-subcommittee/](http://www.ethernetalliance.org/subcommittees/roadmapping-subcommittee/)

<table>
<thead>
<tr>
<th>Name</th>
<th>Speed</th>
<th>Date Initial Standard Ratified</th>
</tr>
</thead>
<tbody>
<tr>
<td>10Mb/s Ethernet</td>
<td>10 Mb/s</td>
<td>1983</td>
</tr>
<tr>
<td>100Mb/s Ethernet</td>
<td>100Mb/s</td>
<td>1995</td>
</tr>
<tr>
<td>Gigabit Ethernet</td>
<td>1 Gb/s</td>
<td>1998</td>
</tr>
<tr>
<td>10 Gigabit Ethernet</td>
<td>10 Gb/s</td>
<td>2002</td>
</tr>
<tr>
<td>25 Gigabit Ethernet</td>
<td>25Gb/s</td>
<td>2016 (est)*</td>
</tr>
<tr>
<td>40 Gigabit Ethernet</td>
<td>40 Gb/s</td>
<td>2010</td>
</tr>
<tr>
<td>100 Gigabit Ethernet</td>
<td>100 Gb/s</td>
<td>2010</td>
</tr>
<tr>
<td>400 Gigabit Ethernet</td>
<td>400 Gb/s</td>
<td>2017 (est.)**</td>
</tr>
</tbody>
</table>

*Estimated on a 2-year standardization process that started with the CFI in July 2014

**Estimated on a 4-year standardization process that started with the CFI in March 2013
Ethernet Speeds - Log

Key:
- **Ethernet Speed**
- **Speed in Development**

### Speed (b/s)
- 1T
- 400G
- 100G
- 40G
- 10G
- 1G
- 100M

### Initial Standard Completed
- 1990
- 2000
- 2010
- 2020
Switch Ports Shipped

Low cost connectivity more important than speed for most applications (PCs, Voice over IP phones, cameras)

Source: Dell’Oro Ethernet Switch Layer 2+3 Report, July 2014
>1B Ports Shipped in 2014!
Over 7 Billion Ethernet ports shipped in last decade!

<table>
<thead>
<tr>
<th></th>
<th>Ethernet Switch Ports¹</th>
<th>Router Ports²</th>
<th>Controllers and Adapters³</th>
<th>PoE Devices⁴</th>
<th>Access Ports⁵</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2004</strong></td>
<td>195M</td>
<td>1.2M</td>
<td>110M*</td>
<td>8.9M</td>
<td>62M</td>
<td>377M</td>
</tr>
<tr>
<td><strong>2014</strong></td>
<td>452M</td>
<td>1.8M</td>
<td>294M</td>
<td>98M</td>
<td>129M</td>
<td>974M</td>
</tr>
</tbody>
</table>

Probably another 100M ports on widgets, TVs and other equipment in 2014.

With Internet of things and vehicular applications expected to ship 100s of Millions of ports by the end of the decade, Ethernet will surpass **1.5B Ports/year** by 2020.

1. Dell’Oro Ethernet Switch Layer 2+3 Report, July 2014
2. Dell’Oro Routers Report, July 2014
3. Dell’Oro Controller and Adapter Report, January 2012
4. Based on PoE switch ports from Dell’Oro Ethernet Switch Layer 2+3 Report, July 2014
5. Dell’Oro Access Five Year Forecast, July 2014

* 2006 values since 2004 values weren’t available
Why Lower Speeds?

• Installed base of CAT5E cabling in campus driving 2.5/5GBASE-T with new applications
  ▫ 10GBASE-T doesn’t support 100m of CAT5E
• Low cost/bit of SFP+ compared to QSFP+
  ▫ Serial lanes lower cost than parallel lanes
  ▫ 1X40GbE SFP+ should deliver good bandwidth/$ compared with 40GbE QSFP+ (4X10G)
• 40GBASE-T looks very challenging, but 25GBASE-T looks easier
• 100GbE still prohibitively expensive for many users
Electrical Interface Speeds

When will the next speeds arrive?

Key:
- Ethernet Speed
- Future Speed

100G
10G
1G
100M

Electrical Lane Speed (b/s)

IEEE Standard Completed

1990 2000 2010 2020 2030

- Gigabit Ethernet (no electrical standard for 1 Gb/s) in 1998
- Fast Ethernet standardizes 100 Mb/s in 1995
- Fast Ethernet standardizes 100 Mb/s in 2005
- XFP MSA standardizes XFI 10Gb/s in 2005
- 802.3bj standardizing CR4 4X25Gb/s in 2014

- 10X/3 Years = 116%/year
- 10X/7 Years = 39%/year
- 10X/9 Years = 11%/year
- 2.5X/9 Years = 11%/year
- 8X50G
- nX100G

When will the next speeds arrive?
11% CAGR is Fairly Slow

100GBASE-CR4 in 2014
11% CAGR is Fairly Slow

XFP MSA standardizes XFI 10Gb/s in 2005

400GbE Task Force voted to do 8X50G electrical by 2017

Key:
- Ethernet Speed
- Future Speed

2.5X/9 Years = 11%/year

8X50G in 2020?
100G in 2027
2000 2010 2020 2030

Standard Completed
20% CAGR is Great!

**Key:**
- **Ethernet Speed**
- **Future Speed**

**Electrical Lane Speed (b/s)**

- 100G
- 50G
- 40G
- 25G
- 10G

**Standard Completed**

- 100GBASE-CR4 in 2014
- 100G in 2020
- 8X50G in 2017?
- 40G Serial in 2016?

- SFP+ MSA standardizes SFI 10Gb/s in 2009
- 2.5X/5 Years = 20%/year

2000 2010 2020 2030
How far will 40G and 50G Serial go?

- Bandwidth Length Product depends on Media

<table>
<thead>
<tr>
<th>Speed</th>
<th>Reach with PCB Loss =10dB</th>
<th>MMF Reach (OM3)</th>
<th>BASE-T Cable Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>20-36” on FR4</td>
<td>550m (OM2)</td>
<td>100m on CAT5</td>
</tr>
<tr>
<td>10G</td>
<td>10-15” on Nelco4000</td>
<td>300m</td>
<td>100m on CAT6A</td>
</tr>
<tr>
<td>25G</td>
<td>4-6” on MEGTRON6</td>
<td>70m</td>
<td>??</td>
</tr>
<tr>
<td>40G</td>
<td>?? 2”?</td>
<td>??</td>
<td>30m on CAT8</td>
</tr>
<tr>
<td>50G</td>
<td>??</td>
<td>??</td>
<td>??</td>
</tr>
</tbody>
</table>

One example of an Ethernet Link

PCB Loss 1  Media Loss  PCB Loss 2
Faster is Much Harder

- Higher speeds equal higher loss and power or shorter distances

CAUI-4 Chip to Module Insertion Loss

- 10dB @ 25Gb/s (12.89GHz)
- 19dB @ 50Gb/s (PAM-4 @12.89GHz)
- >20dB @ 40Gb/s (20GHz)

50Gb/s is off the chart unless advanced modulation is used (12.89GHz with PAM-4)

When will we get 100Gb/s signaling?
Why 25G Now?

- Best cost/Gbps soon
- Technology is ready
  - ASICs are port limited, so need more Gb/s/port

- 640Gb/s
  - 64 Ports of 10G in 2009

- 5X in 5 Years

- 3.2 Tb/s
  - 128 Ports of 25G in 2015

64 10GbE port ASIC enables 48 SFP+ and 4 QSFP+
640Gb/s of Throughput

128 25GbE port ASIC enables 32 QSFP+
3.2 Tb/s of Throughput
5X The Calories

McDonald’s Hamburger - 250 calories

Burger King’s Triple Whopper with Cheese - 1250 calories
1000X the Storage in 10 Years

2003
512MB

2014
512GB!
Where’s the Debate?

- When should we standardize 40GbE and/or 50GbE SFP+?
  - Will it be NRZ or PAM-4 or ?
- Should we standardize 2X50G 100GbE?
- When can we standardize 100GbE Serial in SFP+?
  - 4X100GbE QSFP112 should combine to 400GbE
- 400GbE has many options:
  - Should 8X50G Electrical Interface be NRZ or PAM-4
  - Should optics be 8X50G or 4X100G \( \lambda \) and what encoding (NRZ, PAM-4, DMT)?
- Many BASE-T questions to be discussed later...
# Session 1: Data Center Speeds

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:10am</td>
<td><strong>Ethernet Alliance Roadmap Introduction</strong></td>
<td>Scott Kipp, Ethernet Alliance President (Brocade)</td>
</tr>
<tr>
<td>9:30am</td>
<td><strong>Networking Data Rates inside the Data Centers</strong></td>
<td>Alan Weckel, Dell’Oro Group</td>
</tr>
<tr>
<td>9:50am</td>
<td><strong>Server Diversity: Why One Speed Is No Longer Enough</strong></td>
<td>Dave Chalupsky, Intel</td>
</tr>
<tr>
<td>10:10am</td>
<td><strong>Implications of the Next Signaling Rate on Ethernet Speeds</strong></td>
<td>Kapil Shrikhande, Dell</td>
</tr>
<tr>
<td>10:30am</td>
<td><strong>Switch Perspective</strong></td>
<td>Rob Stone, Broadcom</td>
</tr>
<tr>
<td>10:50am</td>
<td><strong>Break</strong></td>
<td></td>
</tr>
<tr>
<td>11:05am</td>
<td><strong>Discussion on Sessions</strong></td>
<td>Scott Kipp, Ethernet Alliance President (Brocade)</td>
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