HPE leads the HPC market today

143 systems
29% of the Top500 List

World’s most energy efficient supercomputer

Largest Market Share
36 percent

World’s most secure industry standard server for HPC

Fastest parallel processing performance

HPE Apollo 6000 Gen 10

HPE SGI 8600

TSUBAME 3.0 at Tokyo Institute of technology
– Direct liquid cooling
– Petaflop scale HPC and AI
– #1 on the Green 500

First Memory-Driven Computing Prototype
Several challenges designing High Performance @ Scale
Our Nemesis – the Active Optical Cable
(No offense intended to our AOC Partners)

Challenges
- Cost and Signaling
- Density and Egress
- Power and Thermals

Other opportunities
- “Wire Once” capabilities
- Affordable workload optimized topologies
- Reduce design dependencies on Radix
Optical Cable Sales continue to increase

High Speed Cable sales 1Q17-1Q18

- Projected Mix

50G 100G 200G

Optical Copper
Optical Costs driven by increased AOC complexity

The cost of the transport material
Copper = x
Glass = ~0.6x

The costs and complexity lie here!
Signaling challenges in PCB material

- **PCle Gen1 (2.5 GT/s)**
- **PCle Gen2 (5 GT/s)**
- **PCle Gen3 (8 GT/s)**
- **PCle Gen4 (16 GT/s)**
- **PCle Gen5 (32 GT/s)**

**Total Path Length in PCB (w/ 1 connector)**

- **20G**: 1 x 8
- **40G**: 1 x 8
- **56G**: 1 x 8
- **100G**: 1 x 16
- **200G**: 2 x 16
- **400G**: 1 x 16

**Useful Board Routing Lengths**

- Longer reaches require more expensive PCB materials.

**Commodity PCB Materials**

**More Expensive High Speed PCB Materials**

- Extend Reach
8 Diff Pair Copper Cable

9.5mm (19mm DIA)

5mm

Optic Fiber 0.25mm

12 Fiber Optic Cable

HPE Presented: HPC Users Group
72 Node Rack 1:1 Fat Tree – Single Side of Rack

Copper Bundle

~45mm

~100mm

Optic Equivalent

~30mm

~15mm
128 Node Rack 1:1 Fat Tree – Single Side of Rack

Copper Bundle
~90mm

Optic Equivalent
~30mm
~32mm

~100mm

Hewlett Packard Enterprise
256 Node Rack 1:1 Fat Tree – Single Side of Rack

Copper Bundle
~120mm

Optic Equivalent
~36mm

~120mm

HPE - Presented HPC Users group
Copper becomes a challenge at scale

- Copper Cables
- 1:1 Optical Cables
- Equivalent Bandwidth Optical Cables
Egress

When you put several of these in a rack…

Apollo 6000 OPA Switch

This is what you get…
Power and Thermals

– Optical Cable adoption is driving increased power in the switch

<table>
<thead>
<tr>
<th>Copper</th>
<th>50G</th>
<th>100G</th>
<th>200G</th>
<th>400G</th>
</tr>
</thead>
<tbody>
<tr>
<td>0W</td>
<td>1.5W</td>
<td>2.2W</td>
<td>5W</td>
<td>??W</td>
</tr>
</tbody>
</table>

– This drives a commensurate thermal issue in the switch

– In System Design,
  Cooling techniques prefer planar and localized
  
This is NEITHER
Other Degrees of Freedom if we moved to Passive Optical

- Optimize fabric topologies for workloads not cable costs

- Wire Once Capability

- Design relief to drive to more physical constraints
The time for affordable, reliable mid-board optics is NOW!!
Thank You!
9.5mm
(Penny is 19mm diameter)

3mm
Copper

Optic Fiber
0.25mm
We can stop optimizing our networks for cable costs

Fat Tree

- Designed for worst case traffic
- Highest diameter

Dragonfly

- Save cost, optimize for AOC expenses
- Increased routing complexity
- Reduced performance
- Medium diameter

HyperX

- Maximum performance
- Lowest cost
- Lowest diameter