Future Architectural Directions
EE HPC WG Workshop

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System Scaling

• Power in fabric is mostly an issue when fabric is idle.
  – must be able to move idle-> active in nsecs to enable hardware management.

• There is no substitute for bisection bandwidth.
  – FFT, random access, all-to-all
  – “Big” nodes, “small” nodes…. Doesn’t matter.
  – Optics costs still dominate cost and are the limiting factor currently.

• Heavyweight fabrics have become the standard.
  – This will likely present a significant problem ala POSIX with NVM storage..
  – If optics costs plummet… we may have a hard time exploiting
Fabrics: Optics Remains The Challenge

Ideal Cost & Power (Requirements @ Exascale)

- 3 Exabits of total BW for ~3MW at $30M
- This translates to 3M 1Tbps links
  - 1W each (1mW/Gbps)
  - $10/link or $0.01/Gbps

20x improvement in power efficiency
50x improvement in cost per bit

Many/most high end applications are time step based

Power and performance trade off. Overlapping will drive up system maximum power or cause performance throttling
## Fabrics: Topology and optical bundle size may matter

<table>
<thead>
<tr>
<th>Topology</th>
<th>Number of unique Destinations from each rack (N= number of racks)</th>
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</thead>
<tbody>
<tr>
<td>Dragonfly</td>
<td>( \sim N^2 )</td>
</tr>
<tr>
<td>Fat Tree</td>
<td>( \sim N )</td>
</tr>
<tr>
<td>Torus</td>
<td>4 to 10</td>
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- Getting to exceptional cost will require very high BW per fiber to amortize fixed costs connectors, fiber etc.

- As BW/$ increases through WDM for example… if $ also raises as BW raises faster this can influence the choice of most cost effective topology.

- We are already approaching minimum size limits in dragonfly topologies for the largest machines.
Optical BW of Single Largest Supercomputer Swamps Total Worldwide Internet BW

As data center wakes up to BW needs, we will develop co-travelers in this.

Reference: wikipedia.org/internet_traffic
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