The Explosion of Petascale in the Race to Exascale

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Relative performance is calculated by assigning a baseline value of 1.0 to one benchmark result, and then dividing the actual benchmark result for the baseline platform into each of the specific benchmark results of each of the other platforms, and assigning them a relative performance number that correlates with the performance improvements reported.


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HPC: Driving Data Center Growth

Doubling Volume and Revenue

Network
Ent. Storage
Workstation
HPC
Public Cloud
SMB & Enterprise

2X Volume Growth

* Forecast, CAGR

Cloud Growth >25%
HPC Growth >20%
Network Growth >30%

Source: Intel
Race for HPC Competency

- Industrial challenges
  - Renewable energy
  - Genomics/ Biosciences
  - Design and Simulation
  - Media and Entertainment
- National security challenges
  - Threat monitoring and cyber security
  - Nuclear safety

Performance of Countries

To Compete, You Must Compute
# The Road to Petascale Everywhere

<table>
<thead>
<tr>
<th>Top Machine</th>
<th>1997 Teraflop Ecosystem</th>
<th>2012 Petaflop Ecosystem</th>
<th>2018 Exaflop Ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCI-RED</td>
<td>.5 GF</td>
<td>5TF</td>
<td>0.5-1.0 PF</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td># of Workgroup Machines</td>
<td>140,000</td>
<td>160,000</td>
<td>170,000</td>
</tr>
<tr>
<td>70 TFLOPs</td>
<td>800 PFLOPs</td>
<td>170 ExaFLOPs</td>
<td></td>
</tr>
</tbody>
</table>

*Compute Capacity - All PC, Embedded and Server Combined*
Helping to Drive the Petascale Explosion

1 → 10 Petaflop Systems: 4 Years

10 → 20 Petaflop Systems: <1 Year

Source: Top500.org
Top500: Rapid Expansion in Total FLOPs

Largest all Intel® Xeon® Processor Cluster Ever

Top500 FLOPs Growth


Source: Top500.org

2.9 PetaFLOPs

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What’s Intel Doing in 2012 in HPC...

Intel® Xeon® Processor: E5-2600/4600 Product Families

Fabric Technology:
Cray’s Aries Interconnect
Qlogic’s TrueScale Product Family

Intel® Many Integrated Core Architecture
Intel® Xeon® Processor E5 Family: Foundation of HPC

- Intel® Xeon® processor remains #1 architecture
  - 78% of new Top500 systems
- Rapid Adoption of Intel® Xeon® Processor E5 Family
  - 45 systems just 3 months post-launch

Source: Top500.org

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Intel® Xeon® Processor E5 Family: Architecture for Discovery
Example: Cellular Imaging

- Drug discovery is one of the most CPU intensive workloads
- Processing of image data to support discovery of new drugs
- Real-time cell segmentation and classification at 2X speed

Cellular Imaging Execution Time
(Lower is Better)

<table>
<thead>
<tr>
<th>Processor</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xeon 5660</td>
<td>467</td>
</tr>
<tr>
<td>Xeon 5680</td>
<td>447</td>
</tr>
<tr>
<td>Xeon E5-2680</td>
<td>239</td>
</tr>
</tbody>
</table>

“The new Intel® Xeon® processor E5 family-based platform(s) doubles the speed of cellular image analysis.”

See the Live Demo at Booth #540

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Next Front of System Innovation: Fabrics

- **HPC Expertise**
  - Intellectual Property
  - World-class Interconnects

- **HPC Expertise**
  - Fabric Management & Software
  - Highest Performance, Scalable IB Products

- **Low-latency Ethernet Switching**
  - Data Center Ethernet Expertise
  - High Radix & Low Radix Switch Products

- **Market Leading Compute & Ethernet Products**
  - Platform Expertise

**Unprecedented Rate of Innovation in HPC Fabric**

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Driving from Petascale to Exascale

Workhorse for Petascale Systems: Flexible, Powerful for a Broad Range of Workloads

Path to Exascale: Efficient for Highly Parallel Applications
Transformational Performance From Workstations to Supercomputers
Example: Next Generation Manufacturing

- RADIOSS*: complete finite element solver
- Programming continuity a major advantage
- SGI UV2 system will support Intel® MIC Architecture

“...we were able to take advantage of the many core architecture to drastically reduce time to solution.”

See the Live Demo at Booth #540

Other brands and names are the property of their respective owners.
Announcing Brand for Intel® MIC Architecture Based Products

Intel® Xeon® Phi™ Product Family
Why Did We Create the Intel® Xeon® Phi™ Brand?

• Intel® Xeon® Brand
  - Industrial strength processing
  - Enterprise, cloud, mission critical, & technical compute

• Intel® Xeon® Phi™ Brand
  - Part of the Intel® Xeon® brand family
  - Parallel performance to power breakthrough innovation
  - Evokes many concepts in science & nature
Game Changer for HPC Performance & Programmability

"Unparalleled productivity... most of this software does not run on a GPU"

Dr. Robert Harrison, NICS, ORNL

"R. Harrison, "Opportunities and Challenges Posed by Exascale Computing - ORNL’s Plans and Perspectives", National Institute of Computational Sciences, Nov 2011"
Announcing Breakthrough Performance on Intel® Xeon® Phi™ Coprocessor (Codenamed Knights Corner)

>1 TFLOP Linpack (HPL) in a node

118 TFLOPs #150 on the Top500

In Production In 2012, Enabled by 22nm 3-D TriGate Transistors

Source: Intel Discovery Cluster Linpack benchmark run, June 2012
Barry Bolding
Vice President,
Corporate Marketing
Cray Inc.
Intel in High Performance Computing

Terascale Research

Manufacturing Process

Leading Performance, Performance/Watt

Platform Building Blocks

Defined HPC Application Platform

Broad SW Tools Portfolio

Interconnect Technology

Dedicated, Renowned Expertise

Large Scale Clusters for Test and Optimization

Strategic Commitment to High Performance Computing

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Summary

• **HPC market:**
  Growing and seen as a national + industrial imperative

• **Intel® Xeon® Processor E5 Family:**
  Rapid adoption, Leading the Industry

• **New Intel® Xeon® Phi™ Product Family:**
  Brand covers all Intel® MIC Architecture based products
  Provides additional boost for highly parallel applications
  Ecosystem aligned and supportive

• **Intel in HPC:**
  Building block alignment provides customers leading HPC technology
Risk Factors

The above statements and any others in this document that refer to plans and expectations for the second quarter, the year and the future are forward-looking statements that involve a number of risks and uncertainties. Words such as “anticipates,” “expects,” “intends,” “plans,” “believes,” “seeks,” “estimates,” “may,” “will,” “should,” and their variations identify forward-looking statements. Statements that refer to or are based on projections, uncertain events or assumptions also identify forward-looking statements. Many factors could affect Intel's actual results, and variances from Intel's current expectations regarding such factors could cause actual results to differ materially from those expressed in these forward-looking statements. Intel presently considers the following to be the important factors that could cause actual results to differ materially from the company's expectations. Demand could be different from Intel's expectations due to factors including changes in business and economic conditions, including supply constraints and other disruptions affecting customers; customer acceptance of Intel's and competitors' products; changes in customer order patterns including order cancellations; and changes in the level of inventory at customers. Potential disruptions in the high technology supply chain resulting from the recent disaster in Japan could cause customer demand to be different from Intel's expectations. Intel operates in intensely competitive industries that are characterized by a high percentage of costs that are fixed or difficult to reduce in the short term and product demand that is highly variable and difficult to forecast. Revenue and the gross margin percentage are affected by the timing of Intel product introductions and the demand for and market acceptance of Intel's products; actions taken by Intel's competitors, including product offerings and introductions, marketing programs and pricing pressures and Intel's response to such actions; and Intel's ability to respond quickly to technological developments and to incorporate new features into its products. The gross margin percentage could vary significantly from expectations based on capacity utilization; variations in inventory valuation, including variations related to the timing of qualifying products for sale; changes in revenue levels; product mix and pricing; the timing and execution of the manufacturing ramp and associated costs; start-up costs; excess or obsolete inventory; changes in unit costs; defects or disruptions in the supply of materials or resources; product manufacturing quality/yields; and impairments of long-lived assets, including manufacturing, assembly/test and intangible assets. Expenses, particularly certain marketing and compensation expenses, as well as restructuring and asset impairment charges, vary depending on the level of demand for Intel's products and the level of revenue and profits. The tax rate expectation is based on current tax law and current expected income. 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