HP and NVIDIA in HPC
NVIDIA GPU Technology Conference

Ed Turkel
Group Manager, HPC Segment Product Management
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High-Performance Computing is everywhere

To accelerate innovation and discovery and deliver better products and services first

- Computer-Aided Engineering
- Electronic Design Automation
- Research & Development
- Life Sciences
- Pharmaceutical
- Geophysical Sciences
- Energy Research & Production
- Meteorological Sciences
- Entertainment
- Media Production
- Visualization & Rendering
- Government
- Academia
- Finance
Tectonic shifts expose limits to HPC growth

Increasing demand for performance challenged by limits of power, space and complexity

- Growth in performance limited by application scalability
- Datacenter facilities unable to keep up with power and space requirements
- Solution complexity overwhelming operational resources
- No end in sight for budget pressures

Improving Price/Performance
HP delivers breakthrough innovation and scale

A new style of HPC:  Optimized HPC solutions from the leader in HPC

Overcoming the barriers of energy, space and complexity

Scalable Performance
Speed innovation with the broadest choice of purpose-built HPC solutions, optimized for performance and scalability

Maximum Efficiency
Optimize your high performance footprint with the most energy and density-efficient system and datacenter solutions.

Operational agility
Deploy easily, adapt quickly to change, and reduce operational costs for high performance solutions at any scale
HP #1 on the TOP500 list

Multiple system with integrated NVIDIA Tesla GPUs

Tokyo Institute of Technology – “Tsubame 2.5”
- 1408 HP ProLiant SL390s G7 servers, each with three NVIDIA Tesla K20x GPUs, recently upgraded from NVIDIA Tesla M2050 GPUs.
- #11 on the Nov’13 TOP500 list and #6 on the Nov’13 Green500 list, with 5.6PF peak performance and 2.8PF Linpack Rmax, over double the performance of the prior system

University of Southern California – “HPCC”
- 264 HP ProLiant SL250s Gen8 servers, each with two NVIDIA Tesla K20 GPUs
- #60 on the Nov’13 TOP500 list, with 690GF peak performance and 532GF Linpack Rmax

Clemson University – “Palmetto 2”
- 195 HP ProLiant SL250s Gen8 servers, each with two NVIDIA Tesla K20 GPUs
- #82 on the Nov’13 TOP500 list, with 518GF peak performance and 397GF Linpack Rmax
Delivering a complete HPC solution

HP Cluster Platforms

- Cloud
- Servers
- Storage
- Accelerators
- Network
- Power & Cooling
- Services
- Management
HP Servers with Integrated NVIDIA GPUS
HP provides broadest x86 choice for HPC solutions

The right servers for the right workload for every HPC environment

**ProLiant BL Family**
Blades Converged Infrastructure ideal for mission-critical industrial HPC environments

**ProLiant DL Family**
Versatile rack-optimized servers ideal for flexible HPC configurations

**ProLiant SL Family**
Density optimized shared infrastructure servers ideal for maximum HPC scale, efficiency and density
For your most demanding, data-intensive workloads

Unleash the power of your business data

NEW HP ProLiant DL580 Gen8 Server

Key Workloads
- Business Processing
- Business Intelligence
- Data Warehousing
- Databases
- Consolidation and virtualization

Performance
30X faster transaction processing

Reliability
30% greater memory and processor reliability

Efficiency
45% lower total cost of ownership
Breakthrough performance for blazing fast results

NEW HP ProLiant DL580 Gen8 Server

**4S Processor**
- Intel® Xeon® E7-4800/8800 v2
  - 2X

**Memory**
- 3TB* max memory (6TB later)
  - 1.5X

**I/O Expansion**
- 9 PCI-e Gen3
  - 2.7X

**Smart Array**
- 12Gbps SAS
  - 2X

**Internal Storage**
- 10 SFF Drives
  - 1.2X

* Up to 6TB post-launch with 64GB DIMMs

**Optimized for acceleration (K6000, K40c)**

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HP Ultimate Converged Infrastructure

Accelerating cloud computing, innovation and client ROI

#1 in blades
market share and revenue¹

3+ million
blades shipped – more than Dell, IBM, and Cisco combined! (since Q2CY2005)²

8+ million
virtual connect ports delivered³

7+ million
insight management licences⁴

900+
customer clouds⁵

¹, ² Based on IDC quarterly worldwide server tracker Q4CY2012
³, ⁴ Based on HP internal calculations
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The ProLiant BL Server Portfolio

ProLiant blades deliver the best value across workloads

**BL420c Gen8**
Breakthrough server blade economics for essential enterprise workloads

**BL460c Gen8**
Ideal balance of performance, scalability, and expandability

**BL465c Gen8**
The first server blade to deliver over 2,000 cores per rack

**BL685c G7**
Cost-effective, dense 4S computing

**WS460c Gen8**
First blade server Multi-Graphics Processing Unit for Client Virtualization

**BL620c G7**
World’s most scalable 2S server

**BL660c Gen8**
Redefining density-optimized 4S blade technology

**BL680c G7**
World’s first multi terabyte blade for the most demanding 4S applications
HP ProLiant WS460c Gen8 Graphics Server Blade

Built from the world's leading server blade BL460c Gen8, and enhanced with high-performance professional graphics accelerators, HP ProLiant WS460c Gen8 Graphics Server Blade offers the ideal balance of performance, scalability, and graphics functionality, to make it the gold standard for Client Virtualization platform.

Key workloads include:

- Graphics accelerated Virtual Desktop Infrastructure (VDI) hosting
- Graphics accelerated shared application session hosting
- Dedicated remote workstation for 3D graphics design & analysis
- Natural resource exploration and analysis
- Multi-display remote desktop server for financial services
## Broad GPU performance range and density

Best matching of graphics for different user needs and cost requirements

<table>
<thead>
<tr>
<th>Performance</th>
<th>Card/GPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra High-end</td>
<td>NVIDIA GRID K2 (2 GPU), Quadro K6000, K5000</td>
</tr>
<tr>
<td>High-end</td>
<td>NVIDIA K4000, 6 x Quadro K3100M (HP MultiGPU)</td>
</tr>
<tr>
<td>Mid/Entry</td>
<td>8 x Quadro 1000M (HP MultiGPU)</td>
</tr>
<tr>
<td></td>
<td>NVIDIA GRID K1 (4 GPU)</td>
</tr>
</tbody>
</table>

**Note:** NVIDIA GRID GPU and HP MultiGPU graphics available only with Intel Xeon E5-2600 v2 (Ivybridge) processors
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HP ProLiant SL Gen8 systems
The most comprehensive scalable systems portfolio

**SL2500**
Built for modularity, density & flexibility

**SL4500**
Densest storage, efficiency and serviceability purpose-built for big data

**SL6500**
Built for high performance, power efficiency and packaged for cost-effective, space-saving deployment at scale
Engineered to accelerate innovation
Introducing the HP ProLiant SL6500 Scalable System

**Scalable performance**
- Engineered for massive scale

**Maximum efficiency**
- Efficient to power, operate and maintain

**Operational agility**
- Fast adoption, faster time to results

*Designed for power and space efficiency to reduce both capital expense and operational expense when deploying systems at scale*

**Over 225 Tflops performance in 1 rack**

**provision 1,000 nodes less than 30 min.**

**Cluster arrival to production in DAYS not months**
Simple and efficient for highly scalable systems

- More performance per watt and per square foot
- Shared, efficient hot-plug fans
- Shared high-efficiency power supplies
- Optional redundant fans/power supplies
- Less sheet metal and mechanical components

**SL230s**
- CPU Compute optimized
  - up to 160 CPUs per rack

**SL250s**
- Balanced CPU/GPU performance
  - up to 3 accelerators per server
  - up to 80 CPUs plus 120 GPUs per rack

**SL270s**
- GPU computing optimized
  - up to 8 GPUs per server
  - up to 40 CPUs plus 160 GPUs per rack
Scalable performance with HP ProLiant SL6500 Gen8
Low-latency clustering with new levels of performance and scalability

High scalable performance
• Architecture designed for the high performance server components

Integrated GPUs
• Up to 8 of the highest performance NVIDIA® Tesla® GPUs integrated per server: K2, K10, K20/20x, K40

High performance interconnects
• High bandwidth interconnects, fast low-latency clustering

Over 225 teraflops per rack with up to 100 Gb/s cluster bandwidth per server

1 Peak double precision floating point performance. Based on SL270s with 8 integrated NVIDIA Tesla K40 GPUs -- Dual-port FDR 56Gb/s InfiniBand FlexibleLOM
Ultimate performance density for scale-out workloads

HP ProLiant SL2500 Scalable System

**Performance density**
Make better use of limited space with up to four powerful hot-pluggable servers and graphics accelerators in 2U

**Simple administration**
Reduce operational costs and drive higher levels of efficiency from servers to large Linux clusters

**Flexible configurations**
Adapt quickly to changing needs with a choice of server nodes, storage and expansion slots

35% more performance  50% less space  20% less power
**HP ProLiant SL2500 Scalable System**

Two server node configurations

- **Four 1U independent hot-swappable in 2U**
  - HP ProLiant SL210t Gen8 1U Node

- **Two 2U servers with increased expandability and GPU support (K4000, K5000, K6000)**
  - HP ProLiant SL210t Gen8 2U Node

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Datacenter Facilities
### HP Modular Data Center Solutions Portfolio

<table>
<thead>
<tr>
<th>Rack</th>
<th>Row</th>
<th>Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modular Cooling System</td>
<td>Performance Optimized Datacenters</td>
<td>Next Gen. DC &amp; Flexible DC</td>
</tr>
<tr>
<td>- Fully Contained Racks with High Density Cooling</td>
<td>- Enterprise Class Data Center Modules 100kW - 1.3MW</td>
<td>- Traditional DC design with modular components</td>
</tr>
<tr>
<td>- 25 to 50kW, Single/Dual Rack</td>
<td>- Energy Efficient PUE from 1.05-1.25</td>
<td>- Optimized costing through standardized design</td>
</tr>
<tr>
<td>- 30kW with 64°F EWT</td>
<td>- Standardized design, modular components</td>
<td>- Energy efficient through power and cooling choices</td>
</tr>
<tr>
<td>- In Stock, Factory Integrated &amp; Tested</td>
<td>- Factory Integrated &amp; Tested with IT</td>
<td>- Designed for lower density, legacy IT</td>
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</table>
HP Modular Cooling System G3

- Is a self-contained, self-cooled rack(s)
  - Can support an expansion rack (seen at right)

- Is able to cool up to 50kW of servers
  - Smaller models can cool up to 30kW

- Evenly distributes air over 42U of servers
  - HP Bi-Directional Cooling ensures front to back airflow

- Can be managed via Touchscreen
  - At the unit, or remotely
Compute Rack Building Block for Tsubame2.5

HP Modular Cooling System Rack enables maximum power density

42U HP Modular Cooling System rack Containing:

- 30 SL390s G7 2u servers per rack
  - 60 CPUs and 90 GPGPUs
- 8 chassis with Advanced Power Management
- 1 HP Network Switch for shared console and admin local area network
- 4 Voltaire QDR IB 4036 36-port Leaf Switch
- Power distribution units

Power per rack approximately 35 KW
HP Performance Optimized Data Center Portfolio

Full spectrum of leading modular data center alternatives

**Custom HP PODs**
- Custom Designed by HP
- Air/Water Cooled
- Variety of capacity/footprint

**Military Specification (SCIF, Ruggedized)**
- In-Field Design
- High Shock/Vibration Resistant
- Utilities Module

**HP POD 20t**
- Optimized Efficiency
- 2,200U, 30kW/Rack avg.
- POD Benefits/Data Center Feel

**HP POD 20c & 40c**
- Balanced Efficiency & Modularity
- Efficient Power and Cooling
- Water cooled
- Up to 1,100U, 29kW/Rack

**HP POD 240a**
- Maximum Efficiency & Density
- Military Specification
- (SCIF, Ruggedized)
Airbus HPC data center transformation with HP POD

Deploying the world’s largest industrial supercomputer,* in a modular data center

Performance, efficiency, and agility
via a Converged Infrastructure for HPC

Scalable performance
- Doubling usable supercomputing power for advanced research and engineering
- HP Cluster Platform 3000BL with 2,016 HP ProLiant BL280c G6 servers, and QDR InfiniBand

Maximum efficiency
- 40% less power than traditional data centers, with a PUE of only 1.25
- Nearly 1,000 m² of data center space in two 40 ft. (12 m) modular data centers

Instant-On Agility
- Fully deployed in 4 months
- Unique HPC-as-a-service usage model

* At the time it was deployed, per the TOP500 list of June’11, www.top500.org
Peregrine: Next generation ultra-efficient HPC system

Deployed at the DoE National Renewable Energy Laboratory (NREL)

The first HPC data center dedicated solely to advancing energy systems integration, renewable energy research, and energy efficiency technologies

New ultra-energy-efficient, petascale HPC system

- Hyper-efficient warm-water cooled system
- Datacenter showcase with PUE of only 1.06
- High performance to support NREL’s mission

Designed in collaboration with HP and Intel

- Dedicated Sept. 11, 2013

Designed to support NREL’s mission, address research challenges, reduce risks and accelerate the transformation of our energy system.
Agile Management
Reduce server administration time and tasks
Integrated Lifecycle Automation using HP Integrated Lights-Out (iLO4)

Set-up: Intelligent Provisioning

Monitor: Agentless Management

3X faster system deployment with 45% less startup steps

Increased security and stability

Support: Embedded Remote Support

Diagnostics: Active Health

Reduce time, cost and complexity

5x faster problem analysis without impacting performance*
Easy to deploy, manage and scale the cluster

HP Insight Cluster Management Utility (CMU)

**Provision**
Fast discovery and cloning, Tree Propagation, Scalable

**Monitor**
At-a-glance and zoom in views, Light-weight and customizable

**Control**
GUI and CLI options, easily find incorrect settings
Monitor cluster as an entity; zoom for more detail

Cluster Mgmt Panel displays all nodes in selected groupings: by switch location; by image; or by custom grouping

Node States display current state of each node

CMU Main Display Panel

Alerts displayed along the bottom
Time View 3-D display of sensor histories

Circular x-section corresponds to real-time CMU flower, each spike is a petal on the flower, third-dimension represents time.
Extending HP Cluster Management to GPUs

**Extended to enable GPUs**
- Monitoring accelerator utilization, temperature, power, double bit errors, etc.
- Installation scripts for drivers and toolkits

**HP Cluster Test**
- Standard test used during factory integration of Cluster Platforms includes capability to check accelerators
Reduce desktop costs and risks
Remote visualization to desktop from central HPC cloud

• Users access resources remotely using access devices via a service catalog portal
• Moab with HP software managers/tools will help to orchestrates, dynamically provision and manage the various jobs, OS and infrastructure resources
HP + NVIDIA Center of Excellence
Grenoble, France

Objective:
• Provide a secure environment for customers and partners to enable HP + NVIDIA solution testing and development on GPU, Visualization, and VDI platforms

Goals:
• Provide access to production and pre-production level HW
• Provide on site access for testing and development
• Provide secure remote access for customer
• Knowledge capture, documentation and repository
• In coordination with the HP EMEA HPC Competency Center and NVIDIA
System definition

**GPU-based systems**
- HP SL250s/SL270s Gen8 with NVIDIA options: K10, K20, K20x, K40
- HP WS460c, ML350, DL380pGen8 with NVIDIA options: K20C, K4000, K5000, K1, K2, K40c, K3100M (WS460c)

**Support infrastructure**
- Infiniband interconnect
- Dedicated storage
- Access from inside or outside the HP network
- High end workplace
HP delivers breakthrough innovation and scale

**Scalable Performance**
Speed advancements with a converged infrastructure, purpose-built for the high performance at scale.

**Maximum Efficiency**
Optimize your high performance footprint with the most energy and density-efficient systems.

**Operational agility**
Deploy easily, adapt quickly to change, and reduce operational costs for high performance solutions at any scale.
Thank you
HP provides broadest choice for HPC solutions

The right servers for the right workload for every HPC environment

**HP Moonshot System**
Energy efficient servers for specific HPC workloads

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Clusters have become the dominant HPC architecture

As per the TOP500 list (www.top500.org)

- Proprietary mainframes and vector systems fall to near zero in the 90s.

- In the 90s, SMP systems/constellations and MPP systems dominate.

- But around 2000, clusters begin to dominate, with MPPs in the minority.
HP is the leader in HPC

Market share by Revenue, 2013 (IDC)

Total HPC 2013

- HP: 32.5%
- IBM: 27.7%
- Dell: 14.4%
- NEC: 3.0%
- Fujitsu: 4.2%
- Cray: 1.2%
- Bull: 0.8%
- SGI: 3.0%
- Dawning: 1.9%
- Other: 13.5%

IBM

HP

Dell

NEC

Fujitsu

Cray

Bull

SGI

Dawning

Other

Total HPC 2013
Insight CMU Extended Monitoring

Inject monitoring data from an arbitrary data source into the CMU monitoring system.

Extended metrics are used for

- Server hardware metrics (ILO 4 out-of-band & agentless monitoring)
  - Temperatures, fan speeds, power usage
  - Gathered out-of-band
  - OS-neutral
- Cluster peripherals
  - MCS temperatures, switch status
- Workload schedulers
HP is meeting those requirements today

- Fastest US University-owned supercomputer
- World’s largest supercomputer for commercial research
- Japan’s largest Single-Precision system

Purdue University

British Petroleum

Tokyo Institute of Technology

Examples – some HP customers on Top 500 Supercomputer list
Operational agility
Efficient to power, operate and maintain

Monitor and manage servers without compromising performance

Safely provision racks with the right amount of power

Simple, efficient, cluster management scaling to thousands of nodes
Key features and benefits:
Overview of 3 modes of HW graphics delivery

**Dedicated Blade per User**
- Client OS on bare metal
- High performance 3D Windows and Linux users
- High performance 2D quad display with dual Graphics
- Environments not to be virtualized
- **Target:** Engineers requiring best CPU & graphics performance

**Shared GPU**
- Client OS on hypervisor (virtualization)
- GPU is Shared among multiple users
- Lightweight 3D: Small VRAM, limited OGL support
- GREAT solution to virtualize media-rich desktops
- **Target:** PC Power Users

**Direct Mapped Graphics with Multi-GPU Pass-through**
- Client OS on hypervisor (virtualization)
- Each GPU is directly mapped to 1 user
- Up to eight dedicated graphics card users per blade
- Additional non-graphics accelerated VMs can also run on same blade
- **Target:** Engineering, Workstation-class users
Introducing HP ProLiant Gen8 servers
The world’s most intelligent servers

100K+
Customer Interactions

$300M
R&D Investment

900+
Patents Filed

150+
Design Innovations