HP/NVIDIA Solutions for HPC Compute and Visualization Performance

Ed Turkel
Group Manager, HPC Business Development
Apollo, HPC and Big Data Business, HP Servers
The most exciting shifts of our time are underway.

Time to revenue is critical

Making IT critical to business success

Decisions must be rapid

Business needs happen anywhere

Change is constant

- 30 billion devices
- 40 trillion GB data
- By 2020
- 10 million mobile apps
- ...for 8 billion people
HP’s compute portfolio for better IT service delivery

**Software-defined and cloud-ready**

- **HP OneView**
- **HP Helion**
- **OpenStack**
- **RESTful APIs**

**Workload-optimized**

- **Mission-critical environments**
  - HP ProLiant scale-up
  - HP Integrity blades & Superdome
  - HP Integrity NonStop
  - **Availability for continuous business**

- **Virtualized & cloud workloads**
  - HP BladeSystem

- **Core business applications**
  - HP MicroServer
  - HP ProLiant ML
  - HP ProLiant DL
  - **Intelligence to increase productivity**

**Converged**

- **Converged network**
  - HP Networking

- **Converged management**
  - HP OneView

- **Converged storage**
  - HP StoreVirtual VSA

- **Common modular architecture**

**Global support and services** | **Best-in-class partnerships** | **ConvergedSystem**

**Big Data, HPC, & web scalability**

- HP ProLiant SL
- HP Moonshot
- HP Apollo Family
- **Density and efficiency to scale rapidly**

**SP Workloads**

- **Lowest Cost built to Scale**
- HP Cloudline
Hyperscale compute grows 10X faster than the total market

HPC is a strategic growth market for HP

Source: IDC and HP analysis
HP is the HPC market leader

HP in the TOP500 list

Nov'14 TOP500

- HP: 36.2%
- IBM: 30.6%
- Cray: 12.4%
- SGI: 4.6%
- Bull: 3.6%
- Dell: 1.8%
- Fujitsu: 1.6%
- Other: 9.2%

Top100 Systems

15. Tokyo Tech Tsubame 2.5
89. Clemson Palmetto2
94. USC HPCC

Source: www.top500.org
Solving global problems requires greater...

- Genetics
- Digital Content
- Medical research
- Weather modeling
- Manufacturing/Engineering
- Finance
- Government, Academia, Enterprises
- Performance
- Efficiency
- Accessibility
Delivering a complete HPC solution

Servers
HP Apollo Systems, HP BladeSystem, HP ProLiant Gen9 and HP Integrity Superdome X Servers

Storage
HP SL4500 System with Object-Storage and HPC Storage Solutions, 3rd party Lustre Solutions

Accelerators
NVIDIA Grid and Tesla GPUs, HP Accelerator-enabled Servers

Remote Desktops
NVIDIA Grid GPUs, HP GPU-enabled Servers, HP Workstation Blade Servers, HP Remote Graphics and 3rd party S/W

Network
Intel and Mellanox InfiniBand, Low-Latency Ethernet

Power & Cooling
HP Modular Cooling System, HP Performance Optimized DataCenter, HP Apollo 8000 System

Management
HP Insight CMU, Insight CMU Connector Partners, HP OpenView

Cloud
HP Helion Self-Service HPC Solution, OpenStack

Services
HP Services for HPC
HP ProLiant Gen9 Servers with Integrated NVIDIA GPUS
Accelerating Performance
New NVIDIA accelerators designed for HPC

Customer Benefits
• Fully integrated accelerators, installed, tested and supported in HP Apollo solutions
• Accelerate application performance, choosing the right accelerator for each application
• Enable maximum performance/ft\(^2\) and performance/watt in HP Apollo solutions

Key features
• Support for NVIDIA Grid K1/K2 GPUs
• Support for NVIDIA Tesla K40 and New K80 GPUs
• Unique to HP: Support for NEW NVIDIA Tesla K40d GPUs

4x teraflops per square foot
Industry’s most complete portfolio for HPC
Workload optimized, engineered for any demand

**ProLiant BL family**
Cloud-ready Converged Infrastructure

**ProLiant DL family**
Versatile, rack-optimized servers

**ProLiant SL family**
Purpose-built density-optimized servers

**HP Moonshot**
The world’s first software defined server

**HP Apollo**
Optimized rack-scale computing for HPC
HP ProLiant WS460c Gen9 Server Blade

Broadest range of high performance, high density professional graphics

- Proven and qualified Gen8 graphics cards support with new additions post-launch
- Up to 70% performance increase with the new Intel® Xeon® E5-2600 v3 processors
- New flexible embedded storage controller options for the ideal balance of performance and price

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HP ProLiant WS460c Gen9 Graphics Server Blade

Two form factors with MXM & fullsize PCIe graphics

NVIDIA Quadro K3100M Graphics

WS460c Gen9 Graphics Server Blade
16 per 10U enclosure

NVIDIA Quadro K6000/K5000/K4000, GRID K2/K1 GPU

HP MultiGPU Carrier with 6X K3100M

WS460c Gen9 Graphics Server Blade with Expansion
8 per 10U enclosure

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HP ProLiant Gen9 Operating & Virtualization Support

**Microsoft Windows**
- Windows Server 2012 R2
- Windows 7 Pro (64-bit), Enterprise (64-bit)
- Windows 8.1 Pro (64-bit)

**Linux**
- Red Hat Enterprise Linux Desktop 6.5 or later

**Virtualization**
- VMware Horizon View 6, vSphere 5.5 or later
- Citrix XenServer 6.5 or later, XenDesktop 7

*Content Subject to change* – please check the OS Support Matrix for the latest [www.hp.com/go/ossupport](http://www.hp.com/go/ossupport)
HP ProLiant WS460c Graphics Server Blade
Business efficient and high-performance end-user computing delivered from the datacenter for superior user experience

![HP MultiGPU Carrier]

<table>
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<th>GPU accelerated end-user computing</th>
<th>Right sizing GPU performance per user type</th>
<th>Operational efficiency</th>
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<td>NVIDIA professional graphics</td>
<td>NVIDIA GRID vGPU HW virtualization</td>
<td>High host &amp; GPU density per rack</td>
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<td>MXM and fullsize PCIe graphics</td>
<td>Entry to Ultra-high GPU class</td>
<td>Simplified via Convergence</td>
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<td>Client OS on bare-metal</td>
<td>Software configurable performance</td>
<td>Power, Cooling and Cost efficiency</td>
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HP innovation for a new style of IT

Extending modularity and workload optimized product developments

Apollo 2000
New!

Apollo 6000
Rack-scale Efficiency

SL4500
Storage Density

SL6500
Compute Intensive

Apollo 8000
Performance Density

Delivering breakthrough efficiency at scale
New!

HP Apollo 2000 Servers
Density optimized for traditional datacenters
- Up to 4 powerful servers in 2U chassis – 2X the density of 1U servers
- Traditional racks and cabling for existing datacenters
- Cost effective in any configuration

Configuration flexibility for a variety of workloads
- Mix and Match servers for workload optimization
- HPC performance with accelerators, top bin CPUs, fast HPC clustering
- Storage flexibility and a broad range of I/O options for workload optimization

Simple at scale – it’s ProLiant Gen9
- ProLiant enterprise-class management and operational tools
- HP iLO Management saves administration time and cost
- HP Advanced Power Manager (APM) enables more efficient capacity per rack
- HP Insight CMU to monitor, manage and optimize compute clusters of any size

2X Density  7.9 TeraFLOPS in 2U  Flexible Familiar Fast
Apollo 2000 System offerings

Up to 4 servers in 2U, traditional rear cabling and front hot plug storage

Apollo r2200
Apollo r2600
Apollo r2800
ProLiant XL170r
ProLiant XL190r
Four powerful hot-pluggable servers in 2U

HP ProLiant XL170r - Gen 9 1U Node

30-40% more performance from dual Intel® Xeon® E5-2600 v3 processors, Top Bin Support

High performance memory with HP SmartMemory at speeds of up to 2133 MHz and 512GB maximum

Individual node serviceability with 4 independent serviceable servers

Flexible I/O Two I/O expansion slots with flexibleLOM support
Expandable 2U Compute Trays

HP ProLiant Apollo XL190r - Gen 9 2U Node

Accelerated application performance
- Support for up to 2 NVIDIA Tesla K40 GPUs per 2U node

Increased I/O capacity
- Up to four PCIe 3.0 slots with FlexibleLOM support
- Multiple I/O options for workload customization
Endless Workload Possibilities

**HPC**
- Top bin processors
- **NVIDIA Tesla GPUs**
- I/O Expansion
- Storage Flexibility

**Service providers**
- Flexible configurations
- Low cost options
- Shared infrastructure efficiency
- Density
- Solutions Approach

**SMB / Enterprise / Remote Site**
- Flexible configurations
- Single node service domain
- Redundant power and fans
- Traditional rear cabling and front hot plug drives
HP Apollo 6000 System
HP Apollo 6000 System

Rackscale performance and efficiency for High Performance Computing

- **Leading performance**
  Get up to 4x more performance per $ per watt using 60% less rack space in 5U

- **Rack scale efficiency**
  External power shelf and HP Advance Power Manager helps maximize energy efficiency

- **Lower TCO for right workload**
  Various server trays and networking to fit workload needs while increasing cost savings

4x more performance/$/watt  60% less space  $3M TCO savings
The Apollo 6000 System

**Density**
HP Apollo 6000 Power Shelf

**Efficiency**
HP ProLiant XL220a 2x1P servers
HP ProLiant XL230a 2P server

**Serviceability**
HP Apollo a6000 Chassis

**Manageability**
HP APM

**Flexibility**
HP ProLiant XL250a 2P + 2 NVIDIA Tesla GPUs
HP Apollo a6000 Chassis

Standard 1m rack, rear cabled

Features
- 1 slot and 2 slot tray support
  - 10 single slot trays
  - 5 double slot trays
- Mix-n-match trays
- Shared cooling
- 12V DC power distribution
- 5U tall infrastructure
- Up to 5700W per chassis

Serviceability
- Front serviceable trays
- Standard rear cabling
- Front serviceable hot plug drives
- Redundant, hot plug fans

5U (H) x 44.81cm (W) x 86.23cm (D)
5U (H) x 17.64 in (W) x 33.95 in (D)
Max Airflow < 330 CFM per chassis
HP Apollo a6000 Chassis

Easy Serviceability Support

HP Innovation Zone

(5) Fans
- Hot pluggable
- 80mm Redundant
- Dual rotor fans

Management Module

Power Shelf
HP APM
Aggregated iLO

(2) DC Power Cable Cages per chassis
Supports up to 4 x 12V DC cables per chassis

Network I/O Modules

Two 1GbE 1-port module

OR

Two FlexibleLOM riser:
supports 1GbE, 10GbE or IB

OR

June ’15:
One standard LP PCIe (x16)
& one FlexibleLOM card (x8)
HP Apollo 6000 Power Shelf

Pooled Power Efficiency

Efficiency
- External pooled power shelf
- Fits up to 6 power supplies
- 2400W or 2650W power supplies
- Up to 15.9kW non-redundant
- Single or 3-phased AC input
- Up to twelve 12V DC cables

1.5U (H) x 44.81cm (W) x 78.44cm (D)
1.5U (H) x 17.64 in (W) x 30.88 in (D)
HP Apollo 6000 Infrastructure

Rack Level Power Efficiency

Serviceability meets Efficiency

- Each power shelf can support 3 to 6 chassis (depending on power and redundancy configuration)
- Supports N, N+1, and N+N Redundancy
- Rack level management with HP APM module
  Dedicated or aggregated iLO to manage at chassis, server or power level
### HP ProLiant XL250a Gen9 Server

**2P Compute with Accelerators**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rack</strong></td>
<td>Ideal fit for standard 1.0m rack depth</td>
</tr>
<tr>
<td><strong>Chassis</strong></td>
<td>HP Apollo a6000 Chassis (max 5 trays/servers per chassis)</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>HP Apollo 6000 Power Shelf</td>
</tr>
<tr>
<td><strong>Processor</strong></td>
<td>Intel Xeon E5-2600 v3 family</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>16 DDR4 DIMMs (Registered or Load Reduced) 2133 MHz, 512GB max (16 x 32GB)</td>
</tr>
</tbody>
</table>
| **Network**           | - Two 1GbE single-port module\(^1\)  
                        | - Two IO Slot module: InfiniBand, Ethernet (1GbE or 10GbE), FC               |
                        |   1 x16 PCIe Gen3 (HH LP PCIe Card or FlexibleLOM)                           |
                        |   1 x8 PCIe Gen3 FlexibleLOM                                                 |
| **IO Slots**          | 1 x8 PCIe Low Profile Gen3 for Smart Array or HBA                            |
                        | 2 x16 PCIe Gen3 for FH/FL Accelerators                                       |
| **Storage**           | Up to 6 SFF hot plug SAS/SATA/SSD - front accessible storage                 |
| **Accelerator**       | NVIDIA Tesla: K40, K80                                                        |
| **Management**        | HP iLO 4 *(Each server will have its own dedicated iLO)*                    |
                        | HP Advance Power Manager *(rack level mgmt)*                                 |
The New HP Apollo 8000 System
Advancing the science of supercomputing

**Leading teraflops per rack for accelerated results**
- 4X teraflops/sq. ft. than air-cooled systems
- > 250 teraflops/rack

**Efficient liquid cooling without the risk**
- 40% more FLOPS/watt and 28% less energy than air-cooled systems
- Dry-disconnect servers, intelligent Cooling Distribution Unit (iCDU) monitoring and isolation

**Redefining data center energy recycling**
- Save up to **3,800 tons** of CO2/year (790 cars)
- Recycle water to heat facility

4X teraflops/sq. ft.  40% more FLOPS/watt  3,800 tons of CO2
HP Apollo 8000 System

Leading performance density
HP Apollo f8000 Rack

Dry disconnect server trays
HP ProLiant XL730f 2x2P Servers
HP ProLiant XL750f 2P+2 NVIDIA Tesla GPUs

Efficient liquid cooling without the risk
HP Apollo 8000 iCDU Rack

HP InfiniBand Switch for Apollo 8000 System
HP Apollo 8000 Cooling Circuit
Apollo 8000 System Technologies
Advancing the science of supercomputing

**Dry disconnect servers**
- 100% water cooled components
- Designed for serviceability

**Intelligent Cooling Distribution Unit**
- 320 KW power capacity
- Integrated controls with active-active failover

**Management infrastructure**
- HP iLO4, IPMI 2.0 and DCMI 1.0
- HP Apollo 8000 System Manager

**Power infrastructure**
- Up to 80kW per rack
- Four 30A 3-phase 380-480VAC

**Warm water**
- Closed secondary loop in CDU
- Isolated and open facility loop

**Raised Floor**

4 f8000 + 2 iCDU + under-floor Plumbing Kit
Server Tray alternatives

Two Dual Socket Server Tray

- 2 Intel Xeon E5-2600v3 processors
- 1 SFF SSD per server
- 1 IB FDR/10GbE adaptor per server
- ~750 Watts power consumption

Dual Socket Dual GPU Server Tray

- 2 Intel Xeon E5-2600v3 processors
- 2 NVIDIA Tesla K40 XL (K40d) GPUS
- 1 SFF SSD
- 1 IB FDR/10GbE adaptor
- ~1000 Watts power consumption
HP f8000 Power Block Diagram

High-Voltage AC to the Rack: Limiting conversion steps to improve efficiency
Energy Reuse

- Evaporative Cooling Tower
- Heat Buildings
- Energy Reuse Loop
- Digester and Biogas Handling
- Warm Water Cooled Servers
- Bio Gas Generator Output
- Melt Snow on sidewalks

Energy Reuse
HP Apollo Systems Management
Built-in intelligence that maximizes every hour, watt and dollar

**Rack Level Environmental**

**HP Advanced Power Manager**
- See and manage shared infrastructure.
- Flex to meet workload demands

*Simplify, and save >80%*

**Solution Level**

**HP Insight Cluster Management Utility (CMU)**
- Hyperscale lifecycle management software
- Fast and scalable cloning

*Easy, friction-less control of remote servers*

**On System**

**HP iLO Management Engine**
Intelligent management on every HP server enabling health and alerting, firmware maintenance and support automation

*5x faster problem analysis*
HP Services for HPC solutions

Consulting Services
- Data center planning and design services to achieve business outcomes
  - Data center facilities
  - Workload migration
  - Big data, mobility, virtualization design, planning and implementation

Implementation
- Services to speed startup and build capabilities with new technology
  - Factory Express
  - Onsite installation
  - HP Education

Support
- Ongoing support for business continuity
  - Datacenter Care supports your environment
  - Proactive Care helps prevent problems
  - Foundation Care helps solve problems faster

Financing
- Flexible payment plan and terms
  - Available globally where HP Financial Services conducts business\(^1\)
  - Technology refresh approach to allow for future scalability and upgrades

\(^1\)Financing and service offerings available through Hewlett-Packard Financial Services Company and its subsidiaries and affiliates (collectively HPFSC) in certain countries and is subject to credit approval and execution of standard HPFSC documentation. Rates and terms are based on customer’s credit rating, offering types, services and/or equipment type and options. Not all customers may qualify. Not all services or offers are available in all countries. Other restrictions may apply. HPFSC reserves the right to change or cancel this program at any time without notice.
Reinventing HPC today to accelerate the world of tomorrow

- **Accelerating performance** to speed up answers
  - 4x teraflops per square foot

- **Maximizing efficiency** for sustainability and savings
  - 4x density per rack per dollar

- **Unleashing HPC** to enterprises of any size
  - Years to days for new innovations

**HP Apollo family**
Optimizing rack-scale computing for HPC
Thank you
S5825 - HP/NVIDIA Solutions for HPC Compute and Visualization Performance (Presented by HP)

Ed Turkel Group Manager, HPC Business Development, HP Servers, HP

Ed manages the worldwide product marketing team for the High Performance Computing (HPC) business at Hewlett Packard. The HPC business delivers integrated solutions for HPC with maximum performance and efficiency, enabling innovative research, engineering and analytics. Ed’s team is responsible for developing HP’s solutions and go-to-market strategy for HPC, working closely with HP’s customers to develop the solutions that enable them to best achieve their business and research outcomes. Ed has almost 35 years experience in HPC, including 30 years with HP, in various technical, marketing and business roles.

High Performance Computing is characterized by user demand for increasing levels of computational performance, combined with exploding volumes of data, to accomplish their science, engineering, or analytics workloads. Demands for performance growth are becoming increasingly limited by the power, space and cost of deployment of new systems, while exploding data volumes challenge traditional client/server computing models. For years, HP has partnered with NVIDIA to develop HPC solutions that are purpose-built for compute and visualization performance and scalability, while delivering innovative energy and space efficiency, with a focus on customer ROI. This session will showcase HP and NVIDIA’s latest technologies and solutions in use today by leaders in the HPC community, plus trends for the future.