HPC ADVISORY COUNCIL 2012
Michael Schmid, AMD
Product Marketing Manager CPU/APU EMEA
AMD SERVER PLATFORM STRATEGY

AMD Opteron™ 6000 Series Platform
- 2/4 socket; 4 memory channels
- For high core density

AMD Opteron™ 4000 Series Platform
- 1/2 socket; 2 memory channels
- For low power per core

AMD Opteron™ 6100 Series processor
8 and 12 cores

AMD Opteron™ 6200 Series processor
4, 8, 12 and 16 cores

AMD Opteron™ 4100 Series processor
4 and 6 cores

AMD Opteron™ 4200 Series processor
6 and 8 cores

SR5600 Series Chipsets

“Hydra” “Bulldozer” Future Core

Future Product

4P/8P Platforms
~5% of Market*

2P Platforms
~75% of Market*

1P Platforms
~20% of Market*

Performance-per-watt and Expandability

Highly Energy Efficient and Cost Optimized

Low cost, dedicated web hosting and small business

* Based on AMD estimates.

*AMD internal estimates of total server market as of Q3 2011.
WORKLOAD-FOCUSED PRODUCT STRATEGY

HPC

- Linux OS
- Open64
- GCC
- PGI Compilers

AMD Opteron 6000 Series

Performance HPC clusters

AMD Opteron 4000 Series

Small departmental HPC clusters
**Computing Without Compromises**

**Same Features Across Power Bands**

- No artificially limited features

<table>
<thead>
<tr>
<th>Feature</th>
<th>AMD</th>
<th>Intel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full memory speed on all models</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>Full I/O speed on all models</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>Same chipset on all platforms</td>
<td>✔️</td>
<td>✗</td>
</tr>
</tbody>
</table>

**Consistent Images and Software**

- Same Die, Chipset and Memory enable:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Consistency</th>
<th>Code</th>
<th>Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same API</td>
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<tr>
<td>Same BIOS Code</td>
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<tr>
<td>Same Drivers</td>
<td>✔️</td>
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</tbody>
</table>

**Easier To Buy**

- No tradeoffs of performance & core functionality

**Easier To Qualify**

- Full consistency across the entire processor stack

**Easier To Manage**

- Seamlessly move virtual machines, easily migrate software between systems
INTRODUCING THE AMD OPTERON™ 6200 SERIES PROCESSOR

New architecture designed to deliver business agility for the cloud era.

World’s first truly modular x86 processor core design.

Greater Performance
For up to 71% more throughput*

- World’s first 16-core x86 processor
- First processor with up to 1GHz boost over base frequency
- First processor with multi-threaded floating point unit
- First processor to support FMA and XOP instructions

Greater Efficiency
As low as 5.3 W/core**, reduced processor power at idle by up to 46%**

- First processor with modular core architecture
- First processor with 1.25V ULV-DDR3 Support
- First processor with TDP Power Capping

TPC-C and Price/TpmC are trademarks of the Transaction Processing Performance Council. The results stated above reflect results published on http://www.tpc.org as of November 28, 2011. The comparison presented above is based on the best performing two-socket servers using AMD Opteron™ processor Models 6282 SE and 6176 SE, operating at each processor’s default frequency. For the latest TPC-C results, visit http://www.tpc.orgPerformance (tpmc) = 1,267,982, 2 x AMD Opteron™ processors Model 6282 SE: http://www.tpc.org/tpcc/results/tpcc_result_detail.asp?id=111111501.


**See processor power savings slide in substantiation section

Numbered claims listed on substantiation slide in substantiation section
FLEX FP: MORE FLEXIBLE TECHNICAL PROCESSING

More performance and new instruction support

- No processing penalty for simultaneous execution
- Wider range of FP processing capabilities than competition
- Executes more instructions in fewer cycles than competition
- No waiting on integer scheduler to run instructions
- Designed to be always available to schedule floating point operations

- Runs SSE and AVX simultaneously
- Executes two SSE or AVX (128-bit) instructions simultaneously or one AVX (256-bit) instruction per Bulldozer module
- Processes calculations in a single cycle using FMA4* and XOP instructions
- Uses dedicated floating point scheduler

*FMA4 can execute an FMA4 execution \((a-b+cd)\) in one cycle vs. 2 cycles that would be required for FMA3 or standard SSE floating point calculation.
**DIRECT CONNECT ARCHITECTURE 2.0 (INTRODUCED IN 2010)**

Balanced and scalable design to support up to 16 Cores per CPU

- 1-hop between processors
- Four memory channels

33% greater memory throughput\(^1\) and 71% more processing throughput\(^2\) than AMD Opteron™ 6100 Series processors.

\(^1\) Based on measurements by AMD labs as of 8/9/11. Comparison is AMD Opteron 6200 Series with DDR3-1600 vs. AMD Opteron 6100 Series with DDR3-1333. See backup slide #39 for config info.

**AMD Opteron™ 6200 Series Processor**

- Full-speed memory
- 16 threads with 16 dedicated cores

**Intel Xeon 5600 Series Processor**

- Supported I/O speed varies by processor
- 16 threads with 6 shared cores

*AMD Opteron™ 6200 Series processors all offer the same I/O speed support @ 6.4 GT/s and max memory speed support of DDR3-1600 MHz. Intel Xeon 5600 Series max memory speed support varies by processor from DDR-1066 MHz to 1333 MHz and I/O speed support varies from 4.8 GT/s to 6.4 GT/s. Specs as of 11/30/11 can be found at [http://www.intel.com/content/www/us/enprocessors/xeon/xeon-processor-5000-sequence/Xeon5000Specifications.html](http://www.intel.com/content/www/us/enprocessors/xeon/xeon-processor-5000-sequence/Xeon5000Specifications.html).*
**AMD TURBO CORE TECHNOLOGY**

**Base frequency with TDP headroom**

- Mhz potential

**All core boost activated (up to 500MHz)**

- 300 - 500Mhz

**Max turbo activated (up to 1GHz+, half cores)**

- Up to 1 Gzh +

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**All Core Boost**

When there is TDP headroom in a given workload, AMD Turbo CORE technology is automatically activated and can increase clock speeds by 300-500 MHz* across all cores.

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**Max Turbo Boost**

When a lightly threaded workload sends half the “Bulldozer” modules into C6 sleep state but also requests max performance, AMD Turbo CORE technology can increase clock speeds by up to 1 GHz+* across half the cores.

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*Based on AMD Opteron 6200 Series processors with up to 500 MHz in P1 frequency increase and 1.3 GHz P0 frequency increase as well as AMD Opteron 4200 Series processors with up to 300 MHz in P1 frequency increase and 1.2 GHz P0 frequency increase.
**“BULLDOZER” TECHNOLOGY SOFTWARE VISIBLE FEATURES**

### Optimizations for “Bulldozer” Module Architecture:
- Identifies “Bulldozer” architecture to OS or hypervisor

### New “Bulldozer” Instructions:
- For data level parallelism and hardware assist for encryption and fused multiple-add operations

### Performance Monitoring and Profiling:
- Provides info that can be used to improve system and application performance

### C6:
- “Bulldozer” module goes into a very low power sleep state when both core pairs are idle

### New Virtualization Functions:
- For use by hypervisors to help reduce overhead and achieve near-native application performance

**AMD Opteron™ 4200 and 6200 Series processors are built on “Bulldozer” technology**
## THE NEW “BULLDOZER” INSTRUCTIONS | A CLOSER LOOK

<table>
<thead>
<tr>
<th>Instructions</th>
<th>Applications/Use Cases</th>
</tr>
</thead>
</table>
| SSSE3, SSE4.1, SSE4.2 (AMD and Intel) | • Video encoding and transcoding  
• Biometrics algorithms  
• Text-intensive applications |
| AESNI PCLMULQDQ (AMD and Intel) | • Application using AES encryption  
• Secure network transactions  
• Disk encryption (MSFT BitLocker)  
• Database encryption  
• Cloud security |
| AVX (AMD and Intel) | Floating point intensive applications:  
• Signal processing / Seismic  
• Multimedia  
• Scientific simulations  
• Financial analytics  
• 3D modeling |
| FMA4 (AMD Unique)* | • Vector and matrix multiplications  
• Polynomial evaluations  
• Chemistry, physics, quantum mechanics and digital signal processing |
| XOP (AMD Unique)* | • Numeric applications  
• Multimedia applications  
• Algorithms used for audio/radio |

XOP and FMA4 instruction set extensions are AMD unique 128-bit and 256-bit instructions designed to:  
• Improve performance by increasing the work per instruction  
• Reduce the need to copy and move around register operands  
• Allow for some new cases of automatic vectorization by compilers

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HPC COMPUTING

HPC

- Linux OS
- Open64
- GCC
- PGI Compilers

Customer Requirements:
- Scalable performance
- Strong floating point performance
- High memory throughput
- More cores for highly threaded apps
- Wide range of technical instructions

73GB/s memory throughput

73% more memory bandwidth than Intel

Maximum cores per rack

More FLOPs per sq. foot

33% lower cost per core

Superior Performance

- 24-84% better performance at significantly lower price

Greatest FLOPs per Sq. Foot

With almost twice the FLOPs per sq. ft. with AMD Opteron™ 6276 Series processors, it would take 2 racks of Intel Xeon 5670 racks to match AMD in density and performance.

¹² See complete benchmark data on backup slides 35-37.
THANK YOU!

michael.schmid@amd.com
BACKUP AND CONFIGURATION INFORMATION
**Workload:**
Server-side java business operations
Balanced Profile Enabled

**Power Measurement:**
Yokogawa Electric International Pte. Ltd. Model WT210
Power data captured every 1 second over duration of workload

**Thermal Environment:**
Digi International Inc. Model Watchport/H temperature sensor
Power data captured at an ambient temperature of 20C
**AMD Opteron™ processor Model 4162 EE based platform**

**Processor:** 2x AMD Opteron™ processor Model 4162 EE (pre-production EVT)

**System:** Tyan 8228 (R02)

**Memory:** 4x 4GB 1.5v LV RDDR3 1066 DIMMs

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**Workload & Power:**
Server-side java
20% load point= 87.7W

Calculation assumes servers were operating at a constant 20% load point throughout the duration of the day.

KWh rate used was $0.11 (US)
Number of Servers: 42
KWh: $0.11

Percentage of time @20% Load Point: 100%

Server Power @ 20% Load Point: 87.7W

Estimated Annual Total Server Power Cost @ 20% load per server $84.51
Estimate Daily Total Server Power Cost @ 20% load per server $0.23

Estimated Annual Total Server Power Cost @ 20% load point based on 42 servers: $3,549.32
Estimated Daily Total Server Power Cost @ 20% load point based on 42 servers $9.72

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**Workload:**
Server-side java business operations (20% load point)
Microsoft® Windows Server® 2008 R2 Enterprise Edition (64-bit)
Balanced Profile Enabled

**Power Measurement:**
Yokogawa Electric International Pte. Ltd. Model WT210
Power data captured every 1 second over duration of workload

**Thermal Environment:**
Digi International Inc. Model Watchport/H temperature sensor
Power data captured at an ambient temperature of ~20C
2P AMD Opteron™ 6000 Series platform leadership over Intel Xeon 5600:

- **SPECint®_rate2006**
  - 543 using 2 x AMD Opteron™ processors Model 6282 SE
  - 421 using 2 x Intel Xeon processors Model X5690 (6-core 3.46GHz)

- **SPECint®_rate_base2006**
  - 474 using 2 x AMD Opteron™ processors Model 6282 SE
  - 393 using 2 x Intel Xeon processors Model X5690 (6-core 3.46GHz)

- **SPECfp®_rate2006**
  - 403 using 2 x AMD Opteron™ processors Model 6282 SE
  - 274 using 2 x Intel Xeon processors Model X5690 (6-core 3.46GHz)
    [Link](http://www.spec.org/cpu2006/results/res2011q1/cpu2006-20110131-14172.html)

- **SPECjbb®2005**
  - 1253827 bops (16 JVMs and 78364 BOPs/JVM) using 2 x AMD Opteron™ processors Model 6282 SE
  - 975257 bops (2 JVMs and 487629 BOPs/JVM) using 2 x Intel Xeon processors Model X5690 (6-core 3.46GHz)
2P AMD Opteron™ 6000 Series platform leadership over Intel Xeon 5600:

- **TPC-C Performance (tpmC)**
  - 1207982 tpmC using 2 x AMD Opteron™ processors Model 6282 SE in HP ProLiant DL385 G7 server, 512GB memory, Microsoft® Windows Server® 2008 x64 Enterprise Edition R2, Microsoft® SQL Server® 2005 Enterprise x64 Edition SP3
  - 1024380 tpmC using 2 x Intel Xeon X5690 (6-core 3.46GHz)

- **TPC-C Value (Price/tpmC)**
  - $0.60 / tpmC using 2 x AMD Opteron™ processors Model 6176 SE (12-core 2.3GHz)
  - $0.65 / tpmC using 2 x Intel Xeon processors Model X5690 (6-core 3.46GHz)

- **TPC-H Value (Price/QphH) using Microsoft® SQL Server® 2008**
  - $0.51 / QphH using 2 x AMD Opteron™ processors Model 6176 SE (12-core 2.3GHz)
  - $0.58 / QphH using 2 x Intel Xeon processors Model X5680
  - [http://www.tpc.org/results/individual_results/HP/HP_DL380G7_100702_ES.pdf](http://www.tpc.org/results/individual_results/HP/HP_DL380G7_100702_ES.pdf)

- **STREAM Memory Bandwidth (based on measurements in AMD labs as of November 14, 2011)**
  - 73GB/s using 2 x AMD Opteron™ processors Model 6276 (16-core 2.3GHz)
  - 42GB/s using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz)

- **High Performance Linpack FLOPs (based on measurements in AMD labs as of November 14, 2011)**
  - 239GFlops using 2 x AMD Opteron™ processors Model 6276 (16-core 2.3GHz)
  - 130GFlops using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz)
2P AMD Opteron™ 6000 Series platform leadership over Intel Xeon 5600:

- **High Performance Computing (HPC) Applications**
  - **BLAST**
    - 145s using 2 x Intel Xeon processors Model X5670 in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1
    - 106s using 2 x AMD Opteron™ processors Model 6276 in Supermicro H8DGT server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1
  - **GROMACS**
    - 100s using 2 x Intel Xeon processor Model X5670 in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1, Intel Professional Compiler v11.1, OpenMPI 1.5.1
    - 84s using 2 x AMD Opteron™ processor Model 6276 in Supermicro H8DGT server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1, gfortran compiler v4.6, OpenMPI 1.5.3
  - **LAMMPS**
    - 333 seconds using 2 x AMD Opteron™ processors Model 6276 (16-core 2.3GHz)
    - 471 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz)
  - **NAMD**
    - 0.37 days/ns using 2 x AMD Opteron™ processors Model 6276 (16-core 2.3GHz)
    - 0.64 days/ns using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz)
  - **MILC-QCD**
    - 131 seconds using 2 x AMD Opteron™ processors Model 6276 (16-core 2.3GHz)
    - 200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz)
  - **ROMS**
    - 142 seconds using 2 x AMD Opteron™ processors Model 6276 (16-core 2.3GHz)
    - 225 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz)
  - **WRF**
    - 180 seconds using 2 x AMD Opteron™ processors Model 6276 (16-core 2.3GHz)
    - 224 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz)
2P AMD Opteron™ 4000 Series platform leadership:

- SPECpower_ssj™2008 power consumption
  - 126W and 409496 ssj_ops at 100% of target load and 2106 overall ssj_ops/watt using 2 x AMD Opteron™ processors Model 4164 EE (6-core 1.8GHz)
  - 138W and 452043 ssj_ops at 100% of target load and 2118 overall ssj_ops/watt using 2 x Intel Xeon processors Model L5630 (4-core 2.13GHz)
SPEC Int Rate:

2 x AMD Opteron™ processors Model 6176 SE in HP ProLiant DL385 G7 server, 64GB (16 x 4GB DDR3-1333) memory, Red Hat Enterprise Linux® Server release 5 Update 4 64-bit


2 x Intel Xeon processors Model X5680 (130W TDP) in Fujitsu PRIMERGY RX300 S6 server, 48GB (12 x 4GB DDR3-1333) memory, SUSE Linux® Enterprise Server 11 64-bit


2X Intel Xeon processors Model X6550 in Dell PowerEdge R810 server, 128GB (32 X 4GB DDR-3 1066) memory, Red Hat Enterprise Linux 5 (x86_64) Update


SPECfp Rate:

2 x AMD Opteron™ processors Model 6176 SE in HP ProLiant DL385 G7 server, 64GB (16 x 4GB DDR3-1333) memory, Red Hat Enterprise Linux® Server release 5 Update 4 64-bit


2 x Intel Xeon processors Model X5680 (130W TDP) in Fujitsu PRIMERGY RX300 S6 server, 48GB (12 x 4GB DDR3-1333) memory, SUSE Linux® Enterprise Server 11 64-bit


2X Intel Xeon processors Model X6550 in Dell PowerEdge R810 server, 128GB (32 X 4GB DDR-3 1066) memory, Red Hat Enterprise Linux 5 (x86_64) Update

**Six-Core AMD Opteron™ processor Model 2425 HE based platform**

**Processor:**
2x AMD Opteron™ processor Model 2425 HE

**Motherboard:** Tyan 2927

**Memory:** 4x 4GB RDDR2 667 DIMMs

**Storage:** 500GB SATA WD50000ABPS

**Chassis:** Enermax Chakra ECA5001-B

**Power Supply:** Thermaltake Toughpower 1200

**Workload:**
Server-side java & active idle (2 minutes resting, idle measurement taken after two minutes of system idle)
Performance based on number of business operations
Microsoft® Windows Server® 2008 R2 Enterprise Edition (64-bit)
Balanced Profile Enabled

**Power Measurement:**
Yokogawa Electric International Pte. Ltd. Model WT210
Power data captured every 1 second over duration of workload

**12-Core AMD Opteron™ processor Model 6164 HE based platform**

**Processor:**
2x AMD Opteron™ processor Model 6164 HE

**Motherboard:** “Dinar “ AMD Internal Validation platform

**Memory:** 4x 4GB RDDR3 1.5v 1333MHz DIMMs

**Storage:** 500GB SATA WD50000ABPS

**Chassis:** Enermax Chakra ECA5001-B

**Power Supply:** Thermaltake Toughpower 1200

**Thermal Environment:**
Digi International Inc. Model Watchport/H temperature sensor
Power data captured at an ambient temperature of 21.2C
Workload:
Server-side java business operations
Microsoft® Windows Server® 2008 R2 Enterprise E (100% load point) Edition (64-bit) / IBM J9 VM (build 2.4, J2RE 1.6.0 IBM J9 2.4 Windows Server 2008 amd64-64 jvmsa6460sr5fjx-20090612_37149 (JIT enabled, AOT enabled)
Balanced Profile Enabled

Power Measurement:
Yokogawa Electric International Pte. Ltd. Model WT210
Power data captured every 1 second over duration of workload

Thermal Environment:
Digi International Inc. Model Watchport/H temperature sensor
Power data captured at an ambient temperature of 20°C

Six-Core AMD Opteron™ processor Model 2419 EE-based platform

Processor: 2x AMD Opteron™ processor Model 2419 EE
System: Tyan 8228,
128GB MMCRE28G5MXP-0VB SATA SSD
Memory: 4x 4GB 1.5v RDDR3 1066 DIMMs
Power Supply: 3Y Power Technology YM-2415C

AMD Opteron™ processor Model 4164 EE-based platform

Processor: 2x AMD Opteron™ processor Model 4164 EE
System: Tyan 8228,
128GB MMCRE28G5MXP-0VB SATA SSD
Memory: 4x 4GB 1.5v RDDR3 1066 DIMMs
Power Supply: 3Y Power Technology YM-2415C
AMD (126W @ 100%):
SPECpower_ssj2008 – Lowest power 2P server (ZT Systems 1253Ra Datacenter Server)

Intel (172W @ 100%):
SPECpower_ssj2008 – Lowest power 2P server (HP ProLiant DL380)
SPECint® rate2006

381 using 2 x Intel Xeon processors Model X5680 (130W TDP) in Fujitsu PRIMERGY RX300 S6 server, 48GB (12 x 4GB DDR3-1333) memory, SUSE Linux® Enterprise Server 11 64-bit


588 using 4 x AMD Opteron™ processors Model 6136 in Dell PowerEdge R815, 128GB (32 x 4GB DDR3-1333) memory, SUSE Linux® Enterprise Server 11 64-bit

STREAM (Memory Bandwidth)

- 2 x Six-Core AMD Opteron™ processors (“Istanbul”) Model 2435 in Supermicro A+ Server 1021M-UR+B server, 16GB (8x2GB DDR2-800) memory, SuSE Linux® Enterprise Server 10 SP2 64-bit
- 4 x Six-Core AMD Opteron™ processors (“Istanbul”) Model 8435 in Tyan Transport TX46 server, 32GB (16x2GB DDR2-800) memory, SuSE Linux® Enterprise Server 10 SP2 64-bit
- 8 x Six-Core AMD Opteron™ processors (“Istanbul”) Model 8435, AMD 5690 Chipset reference design platform, 64GB (32x2GB DDR2-800) memory, SuSE Linux® Enterprise Server 10 SP2 64-bit
- 2 x AMD Opteron™ processors (“Magny-Cours”) Model 61xx, AMD 5690 Chipset reference design platform, 32GB memory, SuSE Linux® Enterprise Server 10 SP2 64-bit.
- 4 x AMD Opteron™ processors (“Magny-Cours”) Model 61xx, AMD 5690 Chipset reference design platform, 64GB memory, SuSE Linux® Enterprise Server 10 SP2 64-bit.
- 2x Intel Xeon processors (“Gainestown”) Model X5570 in Supermicro SuperServer 6026T-NTR+ server, 24GB memory (6x4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 10 SP2 64-bit
- 2x Intel Xeon processors (“Gainestown”) Model E5540 in Supermicro SuperServer 6026T-NTR+ server, 24GB memory (6x4GB DDR3-1066) memory, SuSE Linux® Enterprise Server 10 SP2 64-bit
- 2x Intel Xeon processors (“Gainestown”) Model L5520 in Supermicro SuperServer 6026T-NTR+ server, 24GB memory (6x4GB DDR3-1066) memory, SuSE Linux® Enterprise Server 10 SP2 64-bit
- 4x Intel Xeon processors (“Dunnington”) Model X7460 in Supermicro X7QC3+ motherboard, 32GB (16x2GB FBDIMM) memory, SuSE Linux® Enterprise Server 10 SP1 64-bit
## TRANSFORMING 4P SERVER ECONOMICS SUBSTANTIATION

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<thead>
<tr>
<th></th>
<th>Dell R815</th>
<th>Dell R710</th>
<th>HP DL585</th>
<th>HP DL580</th>
<th>IBM X3755 M3</th>
<th>IBM X3650 M3</th>
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<tr>
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</table>
BACKUP SLIDE #29

DELL POWEREDGE R815: DOUBLING

DATA CENTER DENSITY AND PERFORMANCE-PER-WATT

509W and 1840454 ssj_ops at 100% target load and 2596 overall ssj_ops/watt using 4 x AMD Opteron™ processors Model 6174 in Dell PowerEdge R815 server, 32GB (16 x 2GB DDR3-1333) memory, 50GB SATA SSD disk drive, Dell 9PG9X power supply, Microsoft® Windows Server® 2008 Enterprise x64 Edition R2


913W and 1862600 ssj_ops at 100% target load and 1314 overall ssj_ops/watt using 4 x Intel Xeon processors Model X7560 in NEC Express5800/R140b-4 server, 128GB (16 x 8GB DDR3-1333) memory, 50GB SATA SSD disk drive, Delta DPS-850FB power supply, Microsoft® Windows Server® 2008 Enterprise x64 Edition SP2

http://www.spec.org/power_ssj2008/results/res2011q1/power_ssj2008-20101213-00323.html
DELL POWEREDGE C6145:
WORLD’S HIGHEST PERFORMANCE 2U SERVER

1310 using 8 x AMD Opteron™ processors Model 6180 SE in Dell PowerEdge C6145 server, 128GB (32 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 64-bit, x86 Open64 4.2.4 Compiler Suite


284 using 2 x Intel Xeon processors Model X7560 in IBM System x3690 X5 server, 128GB (32 x 4GB DDR3-1066) memory, SuSE Linux Enterprise Server 11 64-bit, Intel Professional Compiler v11.1

 BACKUP SLIDE #31

- 84% higher performance: LINPACK (2P) AMD Opteron processor Model 6276 generates 84% more FLOPS than Intel Xeon processor Model X5670
  - 239.1 FLOPS, 2 x AMD Opteron™ processors Model 6276 in Supermicro H8DGT server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterpise Server 11 SP1 64-bit, gfortran compiler v4.6, OMPI 1.5.3, AMD Core Math Library 5.0.0.0
  - Compiler Flags: -fomit-frame-pointer -O3 -funroll-loops -W -Wall -mavx -mfma4 -fopenmp

- 130.1 FLOPS, 2 x Intel Xeon processors Model X5670 in Supermicro 6026TT-BIBQF server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OMPI 1.5.1, Intel Math Kernel Library 10.3, Hyper-Threading disabled, Turbo Boost Technology enabled
  - Compiler Flags: -O3 -w -ansi-alias -i-static -openmp -nocompchk

- 73% more memory bandwidth:
  - STREAM (2P) AMD Opteron processor Model 6276 has 73% higher memory bandwidth than Intel Xeon processor Model X5670
    - 73, 2 x AMD Opteron™ processors Model 6276 in Supermicro H8DGT, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5-1 Compiler Suite
    - 42, 2 x Intel Xeon processors Model X5670 in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Compiler v11.1.064
1/2 the power-per-core*
- As of Nov 1, 2011, AMD Opteron™ processor Models 4200 EE have the lowest known power per core of any x86 server processor, at 35W TDP (35W/8 = 4.375W/core). Intel’s lowest power per core server processor, L5630, is 40W TDP (40W/4 = 10W/core). See http://www.intel.com/Assets/PDF/prodbrief/323501.pdf. Previous record held by AMD Opteron processor Models 4100 EE at 35W TDP / 6 cores = 5.83 W/core.

Requires 2/3 less floor space*
- VMs/rack (2P and 4P) One rack of AMD Opteron 6200 Series-based servers can support 672 VMs (1 VM per core, 2U servers)
- This would take three racks of floor space and 56 2U Intel Xeon 5600 Series-based servers to do the same.
- Assumes 1 VM/core, AMD Opteron 6200 Series-based 2P 2U server has up to 32 cores, supports up to 32 VMs/server x 21 servers per rack, which equals 672 VMs per server. Intel Xeon 5600 Series-based 2P 2U server has up to 12 cores, supports up to 12 VMs/server x 21 servers per rack, which equals 252 VMs per rack, Intel specs as of 11/4/11 at www.intc.com/pricelist.cfm.
Intel Xeon processor Model L5609 is 10W/core (40W TDP/4 cores) as of 10/24/11, see http://www.intc.com/pricelist.cfm. AMD Opteron 6200 Series “HE” processors will be as low as 85W with 16 cores for 5.3 W/core. AMD Opteron 4200 Series “EE” processors will be as low as 35W TDP with 8 cores for 4.375W/core.


1 1ku pricing for AMD Opteron processor Model 6276 is $788 and $1,440 for Intel Xeon processor Model X5670

**SPECfp®_rate**

- SPEC and SPECfp are registered trademarks of the Standard Performance Evaluation Corporation. The results for AMD Opteron™ processor Model 6276 is based upon data submitted to Standard Performance Evaluation Corporation as of November 7, 2011. The other result stated above reflect results published on [http://www.spec.org/cpu2006/results.as](http://www.spec.org/cpu2006/results.as) in November 2011. The comparison presented above is based on the best performing two-socket servers using AMD Opteron™ processor Model 6276 and Intel Xeon processor Model X5670 operating at each processor’s default frequency. For the latest SPECfp_rate2006 results, visit [http://www.spec.org/cpu2006/results](http://www.spec.org/cpu2006/results). SPECfp®_rate score = 360, 2 x AMD Opteron™ processors Model 6276 in Supermicro A+ 1022-URFserver, 64GB (8 x 8GB DDR3-1600) memory, Red Hat Enterprise Linux 6.1 64-bit, x86 Open64 4.2.5.2 Compiler Suite.

- SPECfp®_rate score = 263, 2 x Intel Xeon processors Model X5670 in Cisco UCS B200 M2 server, 48GB (12 x 4GB DDR3-1333) memory, SUSE Linux® Enterprise Server 11 SP1 64-bit, Intel C++ Compiler XE v12.0.1.116

**STREAM**

- 73 GB/s, 2 x AMD Opteron™ processors Model 6276 in Supermicro H8DGT, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5-1 Compiler Suite

- 42 GB/s, 2 x Intel Xeon processors Model X5670 in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Compiler v11.1.064

**LINPACK**

- 239.1 FLOPS, 2 x AMD Opteron™ processors Model 6276 in Supermicro H8DGT server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, gfortran compiler v4.6, OMPI 1.5.3, AMD Core Math Library 5.0.0.0

- Compiler Flags: -fomit-frame-pointer -O3 -funroll-loops -W -Wall -mavx -mfma4 -fopenmp

- 130.1 FLOPS, 2 x Intel Xeon processors Model X5670 in Supermicro 6026TT-BIBQF server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OMPI 1.5.1, Intel Math Kernel Library 10.3, Hyper-Threading disabled, Turbo Boost Technology enabled

- Compiler Flags: -O3 -w -ansi-alias +i-static -openmp -nocompchk
The Regional Ocean Modeling Systems (ROMS) results are based on measurements in AMD labs as of October 26, 2011.

142 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, GCC 4.6.0 Compiler, OpenMPI 1.5.3+knem 0.9.6, Compiler Flags: -O3 -fast-math -funroll-loops -maxv -mprefr-avx128 -mfma4.

225 seconds using 2 x Intel Xeon processors Model X5670 (2.66GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1.064, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.

The Quantum Chromodynamics (MILC-QCD) results are based on measurements in AMD labs as of October 26, 2011.

131 seconds using 2 x AMD Opteron™ processors Model X6760 (6-core 2.93GHz) in Supermicro H8DTG server, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5.2 Compiler Suite, OpenMPI 1.5.3, Compiler Flags: -O3 -m64 -march=bdver1 -maxv -mfma4.

200 seconds using 2 x Intel Xeon processors Model X5670 (6-core 2.93GHz) in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Professional Compiler v11.1, OpenMPI 1.5.1, Compiler Flags: -O3 -axSSE4.2 -m64.
• Maximum cores per rack
  – 2P 1U AMD Opteron™ processor Model 6276-based server has up to 32 cores. Forty-two 1U servers can fit in a 42U rack, which equals 1344 cores per rack.
  – 2P 1U Intel Xeon processor Model 5670-based server has up to 12 cores. Forty-two 1U servers can fit in a 42U rack, which equals 504 cores per rack.

• STREAM (2P) AMD Opteron processor Model 6276 has 73% higher memory bandwidth than Intel Xeon processor Model X5670
  – 73 GB/s, 2 x AMD Opteron™ processors Model 6276 in Supermicro H8DGT, 64GB (8 x 8GB DDR3-1600) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, x86 Open64 4.2.5-1 Compiler Suite
  – 42 GB/s, 2 x Intel Xeon processors Model X5670 in Supermicro X8DTT server, 24GB (6 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 SP1 64-bit, Intel Compiler v11.1.064

• Comparison of 12-core AMD Opteron™ processor Model 6234 expected price of $377 at launch with 4-core Intel Xeon E5603 price of $188 according to [www.intel.com](http://www.intel.com) as of 11/4/11.
(46%) - Based on testing in AMD Performance Labs as of August, 2011, an AMD Opteron™ processor model 6174 (12-core 2.2GHz) consumes 11.7W in the active idle C1E power state while an AMD Opteron™ processor model 6276 (16-core 2.3GHz) consumes only 6.4W in the active idle C1E power state with new C6 power gating employed. System configuration: "Drachma" reference design kit, 32GB (8 x 4GB DDR3-1333) memory, 500GB SATA disk drive, Microsoft® Windows Server® 2008 x64 Enterprise Edition R2. SVR-60

5.3 W/core
AMD Opteron 6200 Series “HE” processors will be as low as 85W with 16 cores for 5.3 W/core.

2 Intel’s turbo boost is limited to 400MHz as of 6/3/11 on pg 147 at http://www.intel.com/Assets/PDF/datasheet/325119.pdf. AMD Turbo CORE technology claims based on internal AMD engineering projections of AMD Opteron 6200 Series processors with up to 500 MHz in P1 boost state and up to 1.4 GHz in P0 boost state over base P2 clock frequency.
3 Intel can only process one 128-bit instruction at a time. See page 13 of the Intel Hot Chips presentation. AMD Opteron™ 6200 Series has FMAC that can execute an FMA4 execution (a=b+c*d) in one cycle vs. 2 cycles that would be required for FMA3 or standard SSE floating point calculation.

4 Intel cannot multiply and add in one clock cycle (FMA4 and XOP instructions). See page 9 of the Intel Hot Chips presentation.
5 Intel’s floating point scheduler is not shared among two cores. See page 9 of the Intel Hot Chips presentation.
7 Not listed as a feature in Intel Xeon 5600 product brief
BACKUP SLIDE #39: 33% MEMORY THROUGHPUT INCREASE
CONFIG INFO

4P
- 146GB/s using 4 x AMD Opteron™ processors Model 6276 in “Drachma” reference design kit, 64GB (16 x 4GB DDR3-1600) memory, SuSE Linux® Enterprise Server 64-bit
- 110GB/s using 4 x AMD Opteron™ processors Model 6176 in “Drachma” reference design kit, 64GB (16 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 64-bit

2P
- 73GB/s using 2 x AMD Opteron™ processors Model 6276 in “Dinar” reference design kit, 32GB (8 x 4GB DDR3-1600) memory, SuSE Linux® Enterprise Server 64-bit
- 55GB/s using 2 x AMD Opteron™ processors Model 6176 in “Dinar” reference design kit, 32GB (8 x 4GB DDR3-1333) memory, SuSE Linux® Enterprise Server 11 64-bit
HP DL380 G7 with two top bin Intel Xeon processor Model X5690 is $7,630 and has 12 cores. This equates to $636/VM, assuming 1 VM / core. HP DL385 G7 with two top bin AMD Opteron processor Model 6282 SE is $5,169 and has 32 cores. This equates to $162/VM, assuming 1 VM / core. Servers were configured with 32GB RAM, 146GB 10K hdd, DVD drive, and 3yr base warranty and large enterprise pricing is from www.hp.com as of 11/15/11.

Dell R710 with two top bin Intel Xeon processor Model X5690 is $7,530 and has 12 cores. This equates to $628/VM, assuming 1 VM / core. Dell R715 with two top bin AMD Opteron processor Model 6282 SE is $6,065 and has 32 cores. This equates to $190/VM, assuming 1 VM / core. Servers were configured with 32GB RAM, 146GB 10K hdd, rack rails, DVD drive, and 3yr base warranty and large enterprise pricing is from www.dell.com as of 11/15/11.

HP DL580 G7 with four top bin Intel Xeon processor Model E7-4870 is $29,042 and has 40 cores. This equates to $726/VM, assuming 1 VM / core. HP DL585 G7 with four top bin AMD Opteron processor Model 6282 SE is $12,617 and has 64 cores. This equates to $197/VM, assuming 1 VM / core. Servers were configured with 64GB RAM, 146GB 10K hdd, DVD drive, and 3yr base warranty and large enterprise pricing is from www.hpe.com as of 11/15/11.

Dell R810 with four top bin Intel Xeon processor Model E7-4870 is $27,807 and has 40 cores. This equates to $695/VM, assuming 1 VM / core. Dell R815 with four highest available AMD Opteron processors Model 6276 is $9,352 and has 64 cores. This equates to $146/VM, assuming 1 VM / core. Servers were configured with 64GB RAM, 146GB 10K hdd, DVD drive, and 3yr base warranty and large enterprise pricing is from www.hpe.com as of 11/15/11.
TWO SOCKET SERVER SPECINT®_RATE2006

SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results/ as of 11/15/11. The comparison presented is based on the best performing two-socket servers using AMD Opteron™ processors and Intel Xeon processors, operating at each processor's default frequency.

1 2 Socket Rack-based Servers: Pricing as of 11/15/11 on www.dell.com and based on configuration shown. In addition to configuration choices above, both systems configured with lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 11/15/11. The comparison presented above is based on the best performing two socket servers using AMD Opteron™ processor Model 6282 SE, and Intel Xeon processor Model X5690, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results.

SPECint®_rate2006 score of 421 using 2 x Intel Xeon X5690: NEC Express5800/R120b-1 (Intel Xeon X5690), 96 GB (12 x 8 GB 2Rx4 PC3-10600R-9, ECC), SUSE Linux Enterprise Server 11 SP1 (x86_64), Kernel 2.6.32-12-0.7-default, Intel C++ Compiler XE for applications running on IA32, Version 12.0.3.174 Build 20110309, http://www.spec.org/cpu2006/results/res2011q3/cpu2006-20110801-17813.html. SPECint®_rate2006 score of 543 using 2 x AMD Opteron 6282 SE: ASUSTeK Computer Inc. ASUS KGPE-D16 server motherboard (2.6 GHz AMD Opteron 6282 SE), 128 GB (16 x 8 GB 2Rx4 PC3-12800R-11, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.el6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20111024-18714.html

2 4 Socket Rack-based Servers: Pricing as of 11/15/2011 on http://www.dell.com and based on configuration shown. In addition to configuration choices above, both systems configured with lowest price options for all other components.

3 4 Socket Blade Servers: Pricing as of 12/19/11 on www.dell.com and based on configuration shown. In addition to configuration choices above, both systems configured with lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/19/11. The comparison presented above is based on the best performing four socket servers using AMD Opteron™ processor Model 6282 SE, and Intel Xeon processor Model E7-4830, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results.


BACKUP SLIDE #43 HP VS. HP

1 Socket Rack-based Servers: Pricing as of 12/5/11 on http://www.HP.com and based on configuration shown. In addition to configuration choices above, both systems were configured with the lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/5/11. The comparison presented above is based on the best performing two socket using AMD Opteron™ processor Model 6282 SE, and Intel Xeon processor Model X5690, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results. SPECint®_rate2006 score of 421 using 2 x Intel Xeon X5690; NEC Express5800/R120b-1 (Intel Xeon X5690), 96 GB (12 x 8 GB 2Rx4 PC3-10600R-9, ECC), SUSE Linux Enterprise Server 11 SP1 (x86_64), Kernel 2.6.32.12-0.7-default, Intel C++ Compiler XE for applications running on IA32, Version 12.0.3.174 Build 20110309, http://www.spec.org/cpu2006/results/res2011q3/cpu2006-20110801-17813.html, SPECint®_rate2006 score of 543 using 2 x AMD Opteron 6282 SE: ASUSTek Computer Inc. ASUS KGPE-D16 server motherboard (2.6 GHz AMD Opteron 6282 SE), 128 GB (16 x 8 GB 2Rx4 PC3-12800R-11, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.elf6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20111024-18714.html

2 Socket Blade Servers: Pricing as of 12/5/11 and 12/6/11 on http://www.HP.com and based on configuration shown. In addition to configuration choices above, both systems were configured with the lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/6/11. The comparison presented above is based on the best performing two socket using AMD Opteron™ processor Model 6276, and Intel Xeon processor Model X5675, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results. SPECint®_rate2006 score of 403 using 2 x Intel Xeon X5675: 403, NEC Express5800/R120b-1 (Intel Xeon X5675), 96 GB (12 x 8 GB 2Rx4 PC3-10600R-9, ECC), SUSE Linux Enterprise Server 11 SP1 (x86_64), Kernel 2.6.32.12-0.7-default, Intel C++ Compiler XE for applications running on IA32, Version 12.0.3.174 Build 20110309, http://www.spec.org/cpu2006/results/res2011q3/cpu2006-20110801-17800.html, SPECint®_rate2006 score of 488 using 2 x AMD Opteron 6276: Dell PowerEdge R715 (AMD Opteron 6276, 2.30 GHz), 128 GB (16 x 8 GB 2Rx4 PC3-12800R-11, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.elf6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20111121-19039.html

4 Socket Rack Servers: Pricing as of 12/5/11 and 12/6/11 on www.hp.com and based on configuration shown. In addition to configuration choices above, both systems configured with lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/6/11. The comparison presented above is based on the best performing four socket servers using AMD Opteron™ processor Model 6282 SE, and Intel Xeon processor Model E7-4870, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results. SPECint®_rate2006 score of 1110 using 4 x Intel Xeon E7-4870: Cisco UCS B440 M2 (Intel Xeon E7-4870, 2.40 GHz), 512 GB (64 x 8 GB 4Rx8 PC3-8500R-7, ECC), Red Hat Enterprise Linux 6.0, Kernel 2.6.32-71.elf6.x86_64, Intel C++ Compiler XE for applications running on IA32 Version 12.0.1.116 Build 20101116, http://www.spec.org/cpu2006/results/res2011q2/cpu2006-20110425-15930.html, SPECint®_rate2006 score of 1040 using 4 x AMD Opteron 6282 SE: HP ProLiant DL585 G7 (2.60 GHz AMD Opteron 6282 SE), 256 GB (32 x 8 GB 2Rx4 PC3-10600R-9, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.elf6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20111108-18785.html

2 Socket Rack-based Servers: Pricing as of 11/15 on www.dell.com and 12/5/11 on http://www.HP.com based on configuration shown. In addition to configuration choices above, both systems were configured with the lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/5/11. The comparison presented above is based on the best performing two socket using AMD Opteron™ processor Model 6282 SE, and Intel Xeon processor Model X5690, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results. SPECint®_rate2006 score of 421 using 2 x Intel Xeon X5690: NEC Express5800/R120b-1 (Intel Xeon X5690), 96 GB (12 x 8 GB 2Rx4 PC3-10600R-9, ECC), SUSE Linux Enterprise Server 11 SP1 (x86_64), Kernel 2.6.32.12-0.7-default, Intel C++ Compiler XE for applications running on IA32, Version 12.0.3.174 Build 20110309, http://www.spec.org/cpu2006/results/res2011q3/cpu2006-20110801-17813.html, SPECint®_rate2006 score of 543 using 2 x AMD Opteron 6282 SE: ASUSTeK Computer Inc. ASUS KGPE-D16 server motherboard (2.6 GHz AMD Opteron 6282 SE), 128 GB (16 x 8 GB 2Rx4 PC3-12800R-11, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.el6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20111024-18714.html.

**BACKUP SLIDE #45 HP VS. DELL**

1. **2 Socket Rack-based Servers:** Pricing as of 12/5/11 on http://www.HP.com and 12/19/11 on www.dell.com based on configuration shown. In addition to configuration choices above, both systems were configured with the lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/5/11. The comparison presented above is based on the best performing two socket using AMD Opteron™ processor Model 6282 SE, and Intel Xeon processor Model X5675, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results. SPECint®_rate2006 score of 795 using 4 x Intel Xeon E7-4830: NEC Express5800/R120b-1 (Intel Xeon X5670), 96 GB (12 x 8 GB 2Rx4 PC3-10600R-9, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.el6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q3/cpu2006-20110108-17813.html, SPECint®_rate2006 score of 1040 using 4 x AMD Opteron 6282 SE: NEC Express5800/R120b-1 (Intel Xeon X5670), 96 GB (12 x 8 GB 2Rx4 PC3-10600R-9, ECC), SUSE Linux Enterprise Server 11 SP1 (x86_64), Kernel 2.6.32-12.0.7-default, Intel C++ Compiler XE for applications running on IA32, Version 12.0.3.174 Build 20110309, http://www.spec.org/cpu2006/results/res2011q3/cpu2006-20110108-17813.html, SPECint®_rate2006 score of 543 using 2 x AMD Opteron 6282 SE: ASUS KGPE-D16 server motherboard (2.6 GHz AMD Opteron 6282 SE), 128 GB (16 x 8 GB 2Rx4 PC3-12800R-11, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.el6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q4/cpu2006-201111024-18714.html.

2. **2 Socket Blade Servers:** Pricing as of 12/5/11 on http://www.HP.com and 12/19/11 on www.dell.com based on configuration shown. In addition to configuration choices above, both systems were configured with the lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/5/11. The comparison presented above is based on the best performing two socket using AMD Opteron™ processor Model 6276, and Intel Xeon processor Model X5675, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results. SPECint®_rate2006 score of 403 using 2 x Intel Xeon X5675: 403, NEC Express5800/R120b-1 (Intel Xeon X5675), 96 GB (12 x 8 GB 2Rx4 PC3-10600R-9, ECC), SUSE Linux Enterprise Server 11 SP1 (x86_64), Kernel 2.6.32.12.0.7-default, Intel C++ Compiler XE for applications running on IA32, Version 12.0.3.174 Build 20110309, http://www.spec.org/cpu2006/results/res2011q3/cpu2006-2011010801-17800.html, SPECint®_rate2006 score of 488 using 2 x AMD Opteron 6276: Dell PowerEdge R715 (AMD Opteron 6276, 2.30 GHz), 128 GB (16 x 8 GB 2Rx4 PC3-12800R-11, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.el6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), SPECint®_rate2006 score of 480 using 2 x AMD Opteron 6276: http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20111121-19039.html.

3. **4 Socket Rack Servers:** Pricing as of 12/5/11 on http://www.HP.com and 11/15/11 on www.dell.com based on configuration shown. In addition to configuration choices above, both systems configured with lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/5/11. The comparison presented above is based on the best performing four socket servers using AMD Opteron™ processor Model 6282 SE, and Intel Xeon processor Model E7-4870, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results. SPECint®_rate2006 score of 1110 using 4 x Intel Xeon E7-4870: Cisco UCS B440 M2 (Intel Xeon E7-4870, 2.40 GHz), 512 GB (64 x 8 GB 4Rx8 PC3-8500R-7, ECC), Redhat Enterprise Linux 6.0, Kernel 2.6.32-71.el6.x86_64, Intel C++ Compiler XE for applications running on IA-32 Version 12.0.1.116 Build 20110116, http://www.spec.org/cpu2006/results/res2011q2/cpu2006-20110425-15930.html, SPECint®_rate2006 score of 1040 using 4 x AMD Opteron 6282 SE: HP ProLiant DL585 G7 (2.60 GHz AMD Opteron 6282 SE), 256 GB (32 x 8 GB 2Rx4 PC3-10600R-9, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.el6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20111108-18785.html.

4. **4 Socket Blade Servers:** Pricing as of 12/5/11 on http://www.HP.com and 12/19/11 on www.dell.com based on configuration shown. In addition to configuration choices above, both systems configured with lowest price options for all other components. SPEC and SPECint are registered trademarks of the Standard Performance Evaluation Corporation. The results stated above reflect results published on http://www.spec.org/cpu2006/results as of 12/19/11. The comparison presented above is based on the best performing four socket servers using AMD Opteron™ processor Model 6276, and Intel Xeon processor Model E7-4830, operating at each processor’s default frequency. For the latest SPECint_rate2006 results, visit http://www.spec.org/cpu2006/results. SPECint®_rate2006 score of 795 using 4 x Intel Xeon E7-4830: ProLiant DL580 G7 (2.13 GHz, Intel Xeon E7-4830), 256 GB (64 x 4 GB 2Rx4 PC3-10600R-9, ECC, running at 1067 MHz), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.el6.x86_64, Intel C++ Compiler XE for applications running on IA-32 Version 12.0.1.116 Build 20110116, http://www.spec.org/cpu2006/results/res2011q3/cpu2006-20110718-17495.html, SPECint®_rate2006 score of 973 using 4 x Intel Xeon E7-4830: Dell PowerEdge R815 (AMD Opteron 6276, 2.30 GHz), 256 GB (32 x 8 GB 2Rx4 PC3-12800R-11, ECC), Red Hat Enterprise Linux Server release 6.1, Kernel 2.6.32-131.0.15.el6.x86_64, C/C++: Version 4.2.5.2 of x86 Open64 Compiler Suite (from AMD), http://www.spec.org/cpu2006/results/res2011q4/cpu2006-20111107-18767.html.
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