Performance & Technologies for Next Generation Data Centers

Boyd Davis
General Manager
Data Center Group Marketing
March 16, 2010
2009 - Intel® Xeon® Processor 5500 Series

Up to 9x Performance

- OR -

As low as 8 Month Payback

Transformed Computing
Refresh Opportunities in 2010

If you delayed refresh in 2009, you’re not alone

Approximately 1 million servers have had their replacement delayed by a year.

Source: Gartner press release

2010 will mark an important return to installed base refreshes driven by an uptick in enterprise budgets, new technological innovations, and a return to economic growth.

Source: IDC, February 2010

Aging Servers Limit Innovation & Growth

1 Estimated 34% single-core & 42% dual-core based on Q4’09 IDC Server Tracker. Source: IDC 2009 Q4 Server Tracker. Install base calculated by using this IDC data and a standard life-cycle distribution. Assumptions: 4 yr replacement cycle increases slightly when the recession hit.
Introducing -
Intel® Xeon® Processor 5600 Series

Energy Efficiency
Xeon® 5500 Perf @ 30% less power
Up to 15:1 consolidation

Performance
Up to 60% performance boost
5 month refresh ROI

Secure Virtualization
Encrypt today
Measure & Enforce tomorrow

Boost Performance, Lower IT Costs, Enhance Security

1 Source: Internal Intel estimates comparing Xeon® X5570 vs. L5640 SKUs using SPECint_rate_2006.
2 Source: Intel measurements as of Feb 2010. Performance comparison using server side java bops (business operations per second). Results have been estimated based on internal Intel analysis and are provided for informational purposes only.
3 Source: Internal Intel measurements for Xeon® X5680 vs. Xeon® X5570 on BlackScholes*. 
Huge Opportunity to Refresh old Servers

2005

- 15 Racks of Intel® Xeon® Single Core Servers

2010

- Efficiency Refresh 15:1
- 95% Annual Energy Cost Reduction (estimated)
- 5 Month Payback (estimated)
- 1 rack of Intel® Xeon® 5600 Based Servers

- OR -

- Performance Refresh 1:1
- Up to 15x Performance
- 8% Annual Energy Costs Reduction (estimated)
- 15 racks of Intel® Xeon® 5600 Based Servers

Source: Intel estimates as of Jan 2010. Performance comparison using SPECjbb2005 bops (business operations per second). Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance. For detailed calculations, configurations and assumptions refer to the legal information slide in backup.
# The Cost of Waiting to Refresh in 2010

## Monthly costs for **NOT** refreshing **50** Single-core Servers with **3** Intel® Xeon® 5600 Servers

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software support</td>
<td>$5,092</td>
</tr>
<tr>
<td>Utility costs</td>
<td>$1,838</td>
</tr>
<tr>
<td>Warranty costs</td>
<td>$3,125</td>
</tr>
</tbody>
</table>

**Total:** up to **$10,000** per month

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1 Monthly Savings in utility and SW support costs determined by comparing the incremental costs associated with not refreshing 50 older single-core servers purchased back in 2005 vs. refreshing on an approximate 15:1 ratio with a Xeon 5680-based servers in Year 1. Warranty cost assumes $750/year per server if purchased after the initial OEM 3-year warranty period has expired. Actual total cost is $10,075. Source: Consolidation ratio calculated using the Xeon Server Refresh Savings Estimator (www.intel.com/go/xeonestimator) and uses publicly available RHEL OS support costs, default utility settings, and SPECint_rate_base2006 performance and power data for the Xeon® X5680 as found in the backup. See the backup for system configurations. Source: Gartner http://www.gartner.com/it/page.jsp?id=1209913
Intel® Xeon® Processor 5600 Series

Performance Summary

Technical Computing

Up to 63% Performance

<table>
<thead>
<tr>
<th>Category</th>
<th>Xeon 5600-EP (6C, 3.33 GHz)</th>
<th>Intel Xeon X5570 (4C, 2.93 GHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Bandwidth</td>
<td>1.20</td>
<td>1.12</td>
</tr>
<tr>
<td>CAD</td>
<td>1.21</td>
<td>1.10</td>
</tr>
<tr>
<td>Floating Point</td>
<td>1.25</td>
<td>1.12</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>1.44</td>
<td>1.30</td>
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<tr>
<td>HPC</td>
<td>1.61</td>
<td>1.40</td>
</tr>
<tr>
<td>Financial</td>
<td>1.63</td>
<td>1.42</td>
</tr>
</tbody>
</table>

Mainstream Enterprise

Up to 46% Performance

<table>
<thead>
<tr>
<th>Category</th>
<th>Xeon 5600-EP (6C, 3.33 GHz)</th>
<th>Intel Xeon X5570 (4C, 2.93 GHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERP</td>
<td>1.27</td>
<td>1.00</td>
</tr>
<tr>
<td>Integer</td>
<td>1.40</td>
<td>1.00</td>
</tr>
<tr>
<td>Virtualization</td>
<td>1.42</td>
<td>1.00</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>1.42</td>
<td>1.00</td>
</tr>
<tr>
<td>Java</td>
<td>1.46</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Up to 63% performance boost over Xeon® 5500

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit http://www.intel.com/performance/resources/limits.htm

Source: Intel Internal measurements Jan 2010. See backup for additional details.

Results are based on internal Intel measurements as of March 16, 2010. Any difference in system hardware or software design or configuration may affect actual performance. See backup forls for system configuration.
**Intel® Xeon® 5600 Performance Publications**

**SPECjbb** *2005

- 928,393 BOPS (+46%)
- IBM J9* JVM

**VMmark***

- 35.83 @ 26 tiles (+42%)
- ESX 4

**SPECpower** *specpower*_ssj2008

- 2,927 ssj_ops/watt (+42%)
- IBM J9* JVM

**SPECint** *_rate_base2006

- Score: 355 (+40%)

**SPECpower** *specpower*_ssj2008

- 3,038 ssj_ops/watt (+31%)
- IBM J9* JVM

**SPECjAppServer** *2004

- Score: 355 (+40%)
- 3,038 ssj_ops/watt (+31%)
- IBM J9* JVM

**SAP-SD** 2-Tier

- 4,860 SD Users (+27%)
- SAP* ERP 6.0

**SPECfp** *_rate_base2006

- Score: 248 (+25%)

**SPECWeb** *2005

- 104,422 score (+25%)
- Rock Web* Server

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Over **NINE** New x86 2S Server & Workstation World Records!

Percentage gains shown are based on comparison to Xeon 5500 series; Performance results based on published/submitted results as of March 16, 2010. Platform configuration details are available at http://www.intel.com/performance/server/xeon/summary.htm. Other names and brands may be claimed as the property of others. Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any differences in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit Intel Performance Benchmark Limitations.
Intel® Xeon® Processor 5600 Series
Building on Xeon® 5500 Leadership Capabilities

Lower Power CPUs
Better performance/Watt
Lower power consumption
- 130W
- 95W
- 80W
- 60W (6C)
- 40W (4C)

Intelligent Power Technology
Automated Low Power States with Six Cores

CPU Power Management
More efficient Turbo Boost and memory power management

Lower Power DDR3 Memory
Up to 10% lower memory power

Greater Platform Energy Efficiency

New lower power CPU SKU options for Xeon® 5600

1 Based on voltage reduction from 1.50V to 1.35V, using Power (Watts) = Current x Voltage
Greater Data Center Energy Efficiency

Xeon® X5570 vs. Xeon® X5670
Power and Performance Comparison

- X5570 (4C) 2.93GHz 95W
- X5670 (6C) 2.93GHz 95W

- Relative Perf / Watt and CPU TDP Power
- Up to 40% More Perf/Watt
- Same CPU Power

Xeon® 5570 vs. Xeon® L5640
Power and Performance Comparison

- X5570 (4C) 2.93GHz 95W
- L5640 (6C) 6C, 2.26GHz 60W

- Peak power under load (W) and Performance
- Up to 30% Lower Power
- Same Performance

Maximize Performance or Energy Efficiency

1 Source: Internal Intel estimates comparing Xeon® X5670 vs. X5570 SKUs using SPECpower. See backup for system configurations.

2 Source: Internal Intel estimates comparing Xeon® X5570 vs. L5640 SKUs using SPECint_rate_2006. See backup for system configurations.

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by these tests. Any reference in these materials to an unqualified "Intel product," "product," "system," or "component" implies that it is an Intel product, system, or component manufactured or authorized by Intel. This reference may not imply recommendation or endorsement by Intel. For more information on performance tests and on the performance of Intel products, visit http://www.intel.com/performance/resources/limits.htm.
Foundation for a More Secure Infrastructure

New Security Features in the Intel® Xeon® processor 5600 series

Intel® Advanced Encryption Standard
New Instructions (Intel AES-NI)

- ORACLE
- Microsoft
- McAfee

- Increases Encryption Performance to Enable Broad Usage
- Ready for Today

Intel® Trusted Execution Technology (Intel TXT)

- VMware
- Parallels
- HyTrust

- Prevents the Insertion Of Malicious Software Prior To VMM Launch
- Ready for Tomorrow
Intel Xeon® Processor 5600 Series

- Support more users plus SSL transactions
- **Eliminate** crypto HW
- More **secure** datacenters and **cloud** environments

### Web Banking Workload

**Xeon® X5570 vs. Xeon® X5680 Comparison**

- **Turn on SSL** & MORE users
  - Xeon 5500: 10,500
  - Xeon 5600: 16,000
- **Turn on SSL** Fewer users
  - Xeon 5500 without SSL: 13,000
  - Xeon 5600 with SSL: 10,500

**Making Data Encryption More Accessible**

Source: Internal Intel measurements with a web banking workload, comparing a Intel® Xeon® X5680 (3.33 GHz) with SSL ON compared with Intel Xeon® X5570 (2.93 GHz) with SSL OFF. See backup foil for details.
Summary

Boosts Performance
Lower IT Costs
Enhance Security

Up to 15:1 Consolidation w/ Estimated 5-month Payback\(^1\)
Up to 60% Higher Performance Over Xeon® 5500\(^2\)
More Secure Solutions with AES-NI and Intel® TXT

Intel® Xeon® processor 5600 series

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1. Source: Intel estimates as of Jan 2010. Performance comparison using SPECjbb2005 bops (business operations per second). Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance. For detailed calculations, configurations and assumptions refer to the legal information slide in backup.

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  - Intel Virtualization Technology requires a computer system with a processor, chipset, BIOS, virtual machine monitor (VMM) and applications enabled for virtualization technology. Functionality, performance or other virtualization technology benefits will vary depending on hardware and software configurations. Virtualization technology-enabled BIOS and VMM applications are currently in development.
  - 64-bit computing on Intel architecture requires a computer system with a processor, chipset, BIOS, operating system, device drivers and applications enabled for Intel® 64 architecture. Performance will vary depending on your hardware and software configurations. Consult with your system vendor for more information.
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Performance Claim Backup

- Up to 1.6x performance compared to Xeon 5500 series claim supported by a CPU intensive benchmark (Blackscholes). Intel internal measurement. (Feb 25, 2010)
  - Configuration details: Blackscholes*
    - Baseline Configuration and Score on Benchmark: Intel pre-production system with two Intel® Xeon® processor X5570 (2.93 GHz, 8 MB last level cache, 6.4 GT/sec QPI), 24GB memory (6x4GB DDR3-1333), 4 x 150GB 10K RPM SATA RAID0 for scratch, Red Hat* EL 5 Update 4 64-bit OS. Source: Intel internal testing as of February 2010. SunGard v3.0 source code compiled with Intel v11.0 compiler. Elapsed time to run benchmark: 18.74 seconds.
    - New Configuration and Score on Benchmark: Intel pre-production system with two Intel® Xeon® processor X5680 (3.33 GHz, 12 MB last level cache, 6.4 GT/sec QPI), 24GB memory (6x4GB DDR3-1333), 4 x 150GB 10K RPM SATA RAID0 for scratch, Red Hat* EL 5 Update 4 64-bit OS. Source: Intel internal testing as of February 2010. SunGard v3.0 source code compiled with Intel v11.0 compiler. Elapsed time to run benchmark: 11.51 seconds.

- Up to 40% higher performance/watt compared to Intel® Xeon® Processor 5500 Series claim supported by performance results on a server side java benchmark in conjunction with power consumption across a load line. Intel internal measurement (Jan 15, 2010)
  - Baseline platform: Intel preproduction server platform with two Quad-Core Intel® Xeon® processor X5570, 2.93 GHz, 8MB L3 cache, 6.4QPI, 8GB memory (4x2GB DDR3-1333), 1 PSU, Microsoft Windows Server 2008 Enterprise SP2. Intel internal measurement as of January 15, 2010.
    - New platform: Intel preproduction server platform with two six-Core Intel® Xeon® processor X5670, 2.93 GHz, 12MB L3 cache, 6.4QPI, 8GB memory (4x2GB DDR3-1333), 1 PSU, Microsoft Windows Server 2008 Enterprise SP2. Intel internal measurement as of January 15, 2010.

- Intel® Xeon® processor 5600 series with Intel microarchitecture Nehalem delivers similar performance as previous-generation servers but uses up to 30 percent less power
  - Baseline Configuration and Score on Benchmark: Fujitsu PRIMERGY RX300 S5 system with two Intel® Xeon® processor sX5570 (2.93 GHz, 8MB L3, 6.4 GT/s, Quad-core, 95W TDP), BIOS rev. R1.09, Turbo Enabled, HT Enabled, NUMA Enabled, 5 x Fans, 24 GB (6x4GB DDR3-1333 DR registered ECC), 1x Fujitsu MBD2147RC 147GB 10K RPM 2.5" SAS HDD, 1x800W PSU, SLES 11 (X86_64) Kernel 2.6.27.19-5-default. Source: Fujitsu Performance Lab testing as of Mar 2010. SPECint_rate_base2006 score: 250. http://docs.ts.fujitsu.com/dl.aspx?id=0140b19d-56e3-4b24-a01e-26b8a80cf53
    - New Configuration and Score on Benchmark: Fujitsu PRIMERGY RX300 S6 system with two Intel® Xeon® processors L5640 (2.26 GHz, 12MB L3, 5.86 GT/s, Hex-core, 60W TDP), BIOS rev R1.00A, Turbo Enabled, HT Enabled, NUMA Enabled, 5 x Fans, 24 GB (6x4GB DDR3-1333 LV DR registered ECC), 1x Fujitsu MBD2147RC 147GB 10K RPM 2.5" SAS HDD, 1x800W PSU, SLES 11 (X86_64) Kernel 2.6.27.19-5-default. Source: Fujitsu Performance Lab testing as of Mar 2010. SPECint_rate_base2006 score: 250 http://docs.ts.fujitsu.com/dl.aspx?id=4af74e10-24b1-4cf8-bb3b-9c4f5f177389
Performance Summary and World Record Benchmarks

42% gain on Single Node server SPECpower* ssj2008 at similar power level over previous generation processors supported by the following:

- Baseline Configuration and Score: Referenced as published at 2053 overall ssj_ops/watt

- New Configuration and Score: IBM x3650 M3 was configured with the Intel Xeon Processor X5670 (2.93GHz, 256KB L2 cache per core, 12MB L3 cache per processor—12 cores/2 chips/6 cores per chip) and 12GB of PC3L-10600R(6 x 2GB) memory and ran IBM Java™6 Runtime Environment and Microsoft® Windows® Server 2008 R2 Enterprise x64 Edition. Score: 2,927 overall ssj_ops/watt. Submitted and in review at [www.spec.org](http://www.spec.org)

46% gain on SPECjbb2005 supported by the following:

- Baseline Configuration and Score: 632,425 bops, SPECjbb2005 bops/JVM = 158106

- New Configuration and Score: Fujitsu PRIMERGY RX300 S6 system with two Intel® Xeon® processors X5680 (3.33 GHz, 12MB L3, 6.4 GT/s, Hex-core, 130W TDP), Turbo Enabled, HT Enabled, NUMA Enabled, Data Reuse Optimization disabled, all prefetchers disabled, 48 GB (12x4GB DDR3-1333 DR registered ECC), 1 x Seagate 73GB 10K RPM 2.5” SAS HDD, Microsoft Windows Server 2008 R2 Enterprise, IBM J9 VM (build 2.4, JRE 1.6.0 IBM J9 2.4 Windows Server 2008 amd64-64 jvmmw646684AFD7D558B23A917F4C0D).

27% boost on SAP ERP 6.0 Unicode over previous generation supported by the following:

- Baseline Configuration and Score: 3800 Number of SAP SD benchmark users
  [http://download.sap.com/download.epd?context=40E2D9D5E00EEF7C259FFE6AB54898440C838DED66684AFD7D558B23A917F4C0D](http://download.sap.com/download.epd?context=40E2D9D5E00EEF7C259FFE6AB54898440C838DED66684AFD7D558B23A917F4C0D)


40% gain on SPECint_rate_2006 over previous generation supported by the following:

- Baseline Configuration and Score: Score: 253

- New Configuration and Score: Dell PowerEdge R710 system with two Intel® Xeon® processor X5680 (3.33 GHz, 12MB L3, 6.4 GT/s, six-core, 130W TDP), Maximum Performance Power Management mode, Data Reuse Disabled, C1E Enabled, Turbo Enabled, HT Enabled, 48 GB (12x4GB DDR3-1333 DR registered ECC), 1x1446GB 15K RPM SAS HDD, SUSE Linux Enterprise Server 11 (2.6.27.19-smp). Source: Submitted to [www.spec.org](http://www.spec.org) for publication as of March 15 2010. Geomean Score of 12 workloads: 355

42% gain on VMmark* over previous generation supported by the following:

- Baseline Configuration and Score: Cisco result referenced as published at 25.06 at 17 tiles. For more information see [www.vmware.com/files/pdf/vmmark/vmmark-Cisco-2010-01-12-8200M1.pdf](http://www.vmware.com/files/pdf/vmmark/vmmark-Cisco-2010-01-12-8200M1.pdf)

- New Configuration and Score on Benchmark:– Cisco UCS B250 M2 platform with two Intel® Xeon® processor X5680 (3.33 GHz, 12MB L3, 6.4 GT/s, 6-core, 130W TDP), Turbo Enabled, HT Enabled, 192GB memory (48x4GB DDR3-1333), EMC CLARiON CX4-240 storage system with 25x73GB SSD, 20 x 450GB 15K RPM, 5 x 300GB 15K RPM, VMware vSphere 4.0 U1 Source: [www.cisco.com](http://www.cisco.com). Score of 35.83@26 tiles. For more information see: [www.cisco.com/en/US/prod/ps10265/at_work_promo.html#~industry_benchmarks](http://www.cisco.com/en/US/prod/ps10265/at_work_promo.html#~industry_benchmarks)
Performance Summary Backup

World Record Benchmarks (continued)

31% gain on Multi-Node server SPECpower_ssj2008 over previous generation supported by the following:

- Baseline Configuration and Score: 2316 ssp_ops/watt
- New Configuration and Score: IBM dx360 M3 system with the Intel® Xeon® Processor X5670 (2.93GHz with 256KB L2 cache per core and 12MB L3 cache per processor—2 chips/12 cores/6 cores per chip), 12GB of memory, one 50GB solid state drive, and IBM J9 Java 6 (using a 1500MB heap), and Microsoft® Windows® Server 2008 R2 Datacenter Edition2. Source: IBM testing as of Mar 2010. SPECpower_ssj2008 score: 3038 overall ssp_ops/watt. Submitted and in review at [www.spec.org](http://www.spec.org)

25% boost on SPECweb2005 over previous generation supported by the following:

- Baseline Configuration and Score: SPECweb2005 Score 83198
- Fujitsu PRIMERGY TX300 S6 system with two Intel® Xeon® processors X5680 (3.33 GHz, 12MB L3, 6.4 GT/s, Hex-core, 130W TDP), Turbo Enabled, HT Enabled, NUMA Enabled, 96 GB (12x8GB DDR3-1333 DR registered ECC), 8 x Seagate 73GB 15K RPM SAS HDD (storage subsystem), Red Hat Enterprise Linux 5.3, 86_64, Accoria Networks Rock Web Server v1.4.8 (x86_64). Source: Fujitsu Performance Lab testing as of Mar 2010. SPECweb2005 score: 104422 (SPECweb2005_Banking = 162000, SPECweb2005_Ecommerce = 177000, SPECweb2005_Support = 88000)
- [http://docs.ts.fujitsu.com/dl.aspx?id=2ce10d43-bc0a-4479-bd2b-a67387d157959](http://docs.ts.fujitsu.com/dl.aspx?id=2ce10d43-bc0a-4479-bd2b-a67387d157959)

25% gain on SPECfp_rate_base2006 over previous generation supported by the following:

- New Configuration and Score: Dell PowerEdge R710 system with two Intel® Xeon® processor X5680 (3.33 GHz, 12MB L3, 6.4 GT/s, six-core, 130W TDP), Maximum Performance Power Management mode, Data Reuse Disabled, C1E Enabled, Turbo Enabled, HT Enabled, 48 GB (12x4GB DDR3-1333 registered ECC), 1x146GB 15K RPM SAS HDD, SUSE Linux Enterprise Server 11 (2.6.27.19-smp). Source: Submitted to [www.spec.org](http://www.spec.org) for publication as of March 15 2010. Geomean Score of 17 workloads: 248.

30% gain on SPECjAppServer2004 over previous generation supported by the following:

- New Configuration and Score: Cisco UCS C250 M2 platform with two Intel® Xeon® processor X5680 (3.33 GHz, 12MB L3, 6.4 GT/s, 6-core, 130W TDP), Turbo Enabled, HT Enabled, H/W Prefetcher Disabled, Adj. Cache Line Prefetcher Disabled, DCU Prefetcher Disabled, DCU IP Prefetcher Disabled. 96 GB (24x4GB DDR3-1333 registered ECC), 2x73GB 15K RPM SAS HDD, Oracle Enterprise Linux 5 Update 3 x86_64, Oracle WebLogic Server Standard Edition Release 10.3.3, Oracle JRockit(R) 6.0 JDK (R28.0.0-587) (Linux x86_64bit), EMC CLARION CX4-240 storage system with 60 x 450GB 15K RPM. Source: Result submitted to [www.spec.org](http://www.spec.org) as of Feb 24, 2010. s,185.45 SPECjAppServer2004 JOPS@Standard

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Performance Summary Backup

Technical Computing Benchmarks

- **STREAM**: Baseline Configuration and Score on Stream-MP Benchmark: - Intel pre-production system with two Intel® Xeon® processor X5570 (2.93 GHz, 12 MB L3, 6.4 GT/s, Quad-core, 130W TDP), C3 Disabled, C6 Enabled, Turbo Disabled, HT Disabled, NUMA Enabled, 24 GB (6x4GB DDR3-1333 DR registered ECC), 1x150GB 10K RPM SATA HDD, Red Hat ELS-U4 kernel 2.6.18-164.e15 experimental.8). Source: Intel internal testing TR1012. Score of workloads: 36588.0 MB/s.

- New Configuration and Score on Stream-MP Benchmark: - Intel pre-production system with two Intel® Xeon® processor X5680 (3.33 GHz, 12 MB L3, 6.4 GT/s, Hex-core, 130W TDP), C3 Disabled, C6 Enabled, Turbo Disabled, HT Disabled, NUMA Enabled, 24 GB (6x4GB DDR3-1333 DR registered ECC), 1x150GB 10K RPM SATA HDD, Red Hat ELS-U4 kernel 2.6.18-164.e15 experimental.8). Source: Intel internal testing as of Feb 2010. Score of workloads: MB/s.

- **CAE**: Baseline Configuration and Score on CAE Vertical: - Intel pre-production 2-socket server with Intel® Xeon® processor X5570 (2.93 GHz, 8 MB LLC, 6.4 GT/S QPI, 95W TDP), Turbo Enabled, HT Enabled or Disabled for best performance on each application, 24 GB memory (6x4GB DDR3-1333 registered ECC), 4x150GB 10K RPM SATA HDD RAID0 for scratch, Red Hat* EL 5.4 64-bit OS (2.6.18-164-e15). Source: Intel internal testing TR1012. Score of workloads: .

- New Configuration and Score on CAE Vertical: - Intel pre-production 2-socket server with Intel® Xeon® processor X5680 (3.33 GHz, 12 MB LLC, 6.4 GT/S QPI, 130W TDP), Turbo Enabled, HT Enabled or Disabled for best performance on each application, 24 GB memory (6x4GB DDR3-1333 registered ECC), 4x150GB 10K RPM SATA HDD RAID0 for scratch, Red Hat* EL 5.4 64-bit OS (2.6.18-164-e15). Source: Intel internal testing as of January 2010. Geometric mean score for nine applications.

- **SPECfp_rate**: Baseline Configuration and Score on Floating Point (SPECfp_rate_base2006) Benchmark: - ASUSTek** ZBPE-D18 server motherboard using 2x Intel Xeon processor X5570 (8M Cache, 2.93 GHz, 6.4 GT/S Intel® QPI), 72 GB (28x 4 GB PC3-10600R CL=9), SUSE* Linux Enterprise Server 10 (x86_64) SP2, Intel® C++ Compiler Professional for LINUX version 11.0 (build 20090131). Published: May-2009 Source: http://www.spec.org/cpu2006/results/res2009q2/cpu2006-2009011-07354.html.

- New Configuration and Score on Floating Point (SPECfp_rate_base2006) Benchmark: - Supermicro* pre-production system with two Intel® Xeon® processor X5670 (3.33 GHz, 12 MB L3, 6.4 GT/S, Quad-core, 130W TDP), BIOS rev 01/06/2010 , C3 Disabled, C6 Enabled, Turbo Enabled, HT Enabled, NUMA Enabled, 48 GB (12x4GB DDR3-1333 DR registered ECC), 1x150GB 10K RPM SATA HDD, Red Hat* EL 5.4 64-bit OS (2.6.18-164-e15). Source: Intel internal testing as of Jan 2010. Score of workloads: 146 GFlops.

- **LIFE SCIENCES**: Baseline Configuration and Score on Life Sciences Vertical: - Intel pre-production 2-socket server with Intel® Xeon® processor X5570 (2.93 GHz, 8 MB LLC, 6.4 GT/S, Quad-core, 95W TDP), Turbo Enabled, HT Enabled or Disabled for best performance on each application, 24 GB memory (6x4GB DDR3-1333 registered ECC), 1x150GB 10K RPM SATA RAID0 for scratch, Red Hat* EL 5.4 64-bit OS (2.6.18-164-e15). Source: Intel internal testing as of Jan 2010. Geometric mean score for ten applications.

- New Configuration and Score on Life Sciences Vertical: - Intel pre-production 2-socket server with Intel® Xeon® processor X5680 (3.33 GHz, 12 MB LLC, 6.4 GT/S QPI, 130W TDP), Turbo Enabled, HT Enabled or Disabled for best performance on each application, 24 GB memory (6x4GB DDR3-1333 registered ECC), 1x150GB 10K RPM SATA RAID0 for scratch, Red Hat* EL 5.4 64-bit OS (2.6.18-164-e15). Source: Intel internal testing as of Jan 2010. Geometric mean score for ten applications.

- **LINPACK**: Baseline Configuration and Score on Linpack Benchmark: - Supermicro* pre-production system with two Intel® Xeon® processor X5570 (2.93 GHz, 8 MB LLC, 6.4 GT/S, Quad-core, 95W TDP), BIOS rev 02/23/2009, C3 Disabled, C6 Enabled, Turbo Enabled, HT Enabled, NUMA Enabled, 24 GB (6x4GB DDR3-1333 DR registered ECC), 1x150GB 10K RPM SATA HDD, Red Hat ELS-U4 kernel 2.6.18-164.e15 experimental.8). Source: Intel internal testing as of Feb 2010. Score of workloads: 146 GFlops.

- New Configuration and Score on Linpack Benchmark: - Supermicro* pre-production system with two Intel® Xeon® processor X5680 (3.33 GHz, 12 MB L3, 6.4 GT/S, Hex-core, 130W TDP), BIOS rev 01/06/2010, C3 Disabled, C6 Enabled, Turbo Enabled, HT Disabled, NUMA Enabled, 24 GB (6x4GB DDR3-1333 DR registered ECC), 1x150GB 10K RPM SATA HDD, Red Hat ELS-U4 kernel 2.6.18-164.e15 experimental.8). Source: Intel internal testing as of Feb 2010. Score of workloads: 18.74 seconds.

- **BLACKSCHOLES**: Baseline Configuration and Score on Benchmark: - Intel pre-production system with two Intel® Xeon® processor X5570 (2.93 GHz, 8 MB last level cache, 6.4 GT/sec QPI), 24GB memory (6x4GB DDR3-1333), 4 x 150GB 10K RPM SATA RAID0 for scratch, Red Hat* EL 5 Update 4 64-bit OS. Source: Intel internal testing as of February 2010. SunGard v3.0 source code compiled with Intel x11.0 compiler. Elapsed time to run benchmark: 8.74 seconds.

- New Configuration and Score on Benchmark: - Intel pre-production system with two Intel® Xeon® processor X5680 (3.33 GHz, 12 MB last level cache, 6.4 GT/sec QPI), 24GB memory (6x4GB DDR3-1333), 4 x 150GB 10K RPM SATA RAID0 for scratch, Red Hat* EL 5 Update 4 64-bit OS. Source: Intel internal testing as of February 2010. SunGard v3.0 source code compiled with Intel x11.0 compiler. Elapsed time to run benchmark: 11.51 seconds.
5 Month Single Core Refresh ROI Claim

- 5 month ROI claim estimated based on comparison between 2S Single Core Intel® Xeon® 3.80 with 2M L2 Cache and 2S Intel® Xeon® X5680 based servers. Calculation includes analysis based on performance, power, cooling, electricity rates, operating system annual license costs and estimated server costs. This assumes 8kW racks, $0.10 per kWh, cooling costs are 2x the server power consumption costs, operating system license cost of $900/year per server, per server cost of $7200 based on estimated list prices and estimated server utilization rates. All dollar figures are approximate. Performance and power comparisons are based on measured server side java benchmark results (Intel Corporation Feb 2010). Platform power was measured during the steady state window of the benchmark run and at idle. Performance gain compared to baseline was 15x.
  - Baseline platform: Intel server platform with two 64-bit Intel Xeon Processor 3.80Ghz with 2M L2 Cache, 800 FSB, 8x1GB DDR2-400 memory, 1 hard drive, 1 power supply, Microsoft* Windows* Server 2003 Ent. SP1, Oracle* JRockit* build P27.4.0-windows-x86_64 run with 2 JVM instances
  - New platform: Intel server platform with two Intel® Xeon® Processor X5680 (12M Cache, 3.33 GHz, 6.40 GT/s Intel® QPI), 24 GB memory (6x4GB DDR3-1333), 1 SATA 10krpm 150GB hard drive, 1 800w power supply, Microsoft Windows Server 2008 64 bit SP2, Oracle* JRockit* build P28.0.0-29 run with 4 JVM instances

- Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit Intel Performance Benchmark Limitations.
<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>Delta / Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
<td>Intel® Xeon® 3.8GHz with 2M cache</td>
<td>Intel® Xeon® X5680 (3.33GHz)</td>
<td></td>
</tr>
<tr>
<td><strong>Performance per Server</strong></td>
<td>1</td>
<td><strong>Up to 15x increase</strong></td>
<td>Intel internal measurements on a server side java benchmark as of Feb 2010</td>
</tr>
<tr>
<td><strong>Server Power</strong></td>
<td>228W idle / 382W active</td>
<td>117W idle / 383W active</td>
<td>Server idle for 16 hours per day and active for 8 hours per day</td>
</tr>
<tr>
<td><strong>Idle / Active Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong># Servers needed</strong></td>
<td>315</td>
<td>21</td>
<td>~ 15:1 server consolidation</td>
</tr>
<tr>
<td><strong># Racks needed</strong></td>
<td>15 racks</td>
<td>1 rack</td>
<td>15:1 Rack Consolidation</td>
</tr>
<tr>
<td><strong>Annual Server kWh</strong></td>
<td>772,904</td>
<td>37,938</td>
<td><strong>Up to 95% lower energy costs</strong></td>
</tr>
<tr>
<td><strong>Total Annual Energy Costs</strong></td>
<td>$154,581</td>
<td>$7,588</td>
<td>$146,993 electricity cost reduction per year. Assumes $0.10/kWhr and 2x cooling factor</td>
</tr>
<tr>
<td><strong>Operating System Licensing Costs</strong></td>
<td>$283,500</td>
<td>$18,900</td>
<td>$264,600 less per year. Assumes a RHEL 1yr license at $900 Source <a href="http://www.dell.com">www.dell.com</a> as of 12/16/08</td>
</tr>
</tbody>
</table>

**Estimated Annual Cost Savings of $411,593**

| **Cost of new HW** | n/a                                       | $151,200                                  | Assume $7,200 per server                                                     |

**Estimated Payback Period of 5 months**
15 Month Dual Core Refresh ROI Claim

- 15 month ROI claim estimated based on comparison between 2S Dual Core Intel® Xeon® 5160 (3.0GHz) and 2S Intel® Xeon® X5680 based servers. Calculation includes analysis based on performance, power, cooling, electricity rates, operating system annual license costs and estimated server costs. This assumes 8kW racks, $0.10 per kWh, cooling costs are 2x the server power consumption costs, operating system license cost of $900/year per server, per server cost of $7200 based on estimated list prices and estimated server utilization rates. All dollar figures are approximate. Performance and power comparisons are based on measured server side java benchmark results (Intel Corporation Feb 2010). Platform power was measured during the steady state window of the benchmark run and at idle. Performance gain compared to baseline was 5x.
  - Baseline platform: Intel server platform with two Dual-core Intel® Xeon® Processor 5160, 3.33GHz, 1333MHz FSB, 8x2GB FBDMIMM DDR2-667 memory, 1 hard drive, 1 power supply, Microsoft* Windows* Server 2003 Ent. SP1, Oracle* JRockit* build P27.4.0-windows-x86_64 run with 2 JVM instances
  - New platform: Intel server platform with two Intel® Xeon® Processor X5680 (12M Cache, 3.33 GHz, 6.40 GT/s Intel® QPI), 24 GB memory (6x4GB DDR3-1333), 1 SATA 10krpm 150GB hard drive, 1 800w power supply, Microsoft Windows Server 2008 64 bit SP2, Oracle* JRockit* build P28.0.0-29 run with 4 JVM instances

- Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit Intel Performance Benchmark Limitations.
## Dual Core Energy Efficient Refresh Calculation Details

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>Delta / Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
<td>Intel Xeon 5100 series (3.00GHz)</td>
<td>Intel® Xeon® X5680 (3.33GHz)</td>
<td></td>
</tr>
<tr>
<td><strong>Performance per Server</strong></td>
<td>1</td>
<td><strong>Up to 5x increase</strong></td>
<td>Intel internal measurements on a server side java benchmark as of Feb 2010</td>
</tr>
<tr>
<td><strong>Server Power Idle / Active Power</strong></td>
<td>252W idle / 354W active</td>
<td>117W idle / 383W active</td>
<td>Server idle for 16 hours per day and active for 8 hours per day</td>
</tr>
<tr>
<td><strong># Servers needed</strong></td>
<td>105</td>
<td>21</td>
<td>5:1 server consolidation</td>
</tr>
<tr>
<td><strong># Racks needed</strong></td>
<td>5 racks</td>
<td>1 rack</td>
<td><strong>5:1 Rack Consolidation</strong></td>
</tr>
<tr>
<td><strong>Annual kWhr</strong></td>
<td>281,883</td>
<td>37,938</td>
<td><strong>Estimated 85% lower energy costs</strong></td>
</tr>
<tr>
<td><strong>Annual Energy Costs</strong></td>
<td>$56,376</td>
<td>$7,588</td>
<td>$45,169 electricity cost reduction per year. Assumes $0.10/kWhr and 2x cooling factor</td>
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<tr>
<td><strong>OS Licensing Costs</strong></td>
<td>$94,500</td>
<td>$18,900</td>
<td>$75,600 less per year. Assumes a RHEL 1yr license at $900 Source <a href="http://www.dell.com">www.dell.com</a> as of 12/16/08</td>
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</table>

**Estimated Annual Cost Savings of $120,769**

<table>
<thead>
<tr>
<th>Cost of new HW</th>
<th>n/a</th>
<th>$151,200</th>
<th>Assume $7,200 per server</th>
</tr>
</thead>
</table>

**Estimated Payback Period of 15 months**
Intel® Xeon® 5600 Encryption Performance

**Web Banking Workload (MS IIS/PHP)**

- Higher is better
- Number of Users: 3500, 13000, 16000
- WDC w/o encryption, NHM w/o encryption, WSM

**Database Encryption/Decryption (Oracle 11g)**

- Lower is better
- Decryption Time (us): 158, 20
- NHM w/o Intel® IPP, WSM

**Full Disk Encryption (McAfee Endpoint Encryption)**

- Lower is better
- Provisioning time (seconds): 17, 12
- NHM, WSM

1 System configuration: Windows 2008 R2 x64 Ent. Server. PHP banking sessions/users measured with Intel® Xeon® X5680 (3.33 GHz) vs Intel Xeon® 5160 (3.00 GHz) and Intel Xeon® X5570 (2.93 GHz), 24 SSD RAID 0 arrays, TLS_RSA_with_AES_128_CBC_SHA cipher suite.

2 System configuration: Oracle 11g with TDE, time takes to decrypt a 5.1 million row encrypted table with AES-256 CBC mode on WSM 3.33 GHz optimized with Intel® Performance Primitives crypto library (IPP) vs NHM 2.8 GHz without IPP. Timing measured is per 4K of data.

3 System configuration: McAfee Endpoint Encryption for PCs (EEPC) 6.0 package with McAfee ePolicy Orchestrator (ePO) 4.5 encrypting a 32GB X25E SSD with WSM 3.33 GHz vs. NHM 2.93 GHz. 24GB of memory.