



# Maximizing the Benefits of Virtualization

## Windows Server® 2008 Hyper-V™ and the Intel® Xeon® Processor 5500 Series

### SOLUTION BRIEF

Discover virtualization platforms that provide optimal performance and headroom, energy efficiency, flexible virtualization and manageability.

Enterprise computing demands continue to increase, but after decades of IT buildout, server sprawl is escalating system management costs and outstripping available data center space, power and cooling capabilities. In a recent survey, 42 percent of data center owners said they would exceed power capacity within the next 12-24 months, and 39 percent said they would exceed cooling capacity in the same timeframe.<sup>1</sup> IDC estimates that for every dollar IT spends today on hardware to support new users and applications, they spend another 50 cents on power and cooling for existing hardware.<sup>2</sup>

Virtualization is a critical IT tool for responding to these challenges: through consolidation that gets more computing done in a smaller space and power footprint, load balancing to increase business agility and utilization of server resources, and workload migration for business continuity. To achieve the highest payoff from these virtualization initiatives, IT needs virtualization platforms that provide optimal performance and headroom, energy efficiency, flexible virtualization and manageability to support a wide variety of virtualization models.

Windows Server® 2008 Hyper-V™ and the Intel® Xeon® processor 5500<sup>^</sup> series with Intel® Intelligent Power Technology<sup>9</sup> deliver exceptional virtualization efficiency and flexibility, enabling IT organizations to achieve maximum benefits from virtualization:

**Greater consolidation** potential and lower data center costs with up to 1.9x<sup>3</sup> the virtualization performance, leading energy efficiency and an integrated, robust set of tools for managing virtual and physical servers.

**Unprecedented flexibility** and control through multi-platform support and live virtual machine migration.

**Rock-solid business continuity** through complementary software and hardware capabilities that support high availability, disaster recovery, and on-line maintenance.



## Solution Overview

Together, Windows Server 2008 Hyper-V and servers based on the Intel Xeon processor 5500 series provide a highly efficient foundation for virtualization with improved performance and energy efficiency, increased flexibility, higher reliability and lower TCO.

## Virtualization Performance and Flexibility from the Intel® Xeon® Processor 5500 Series

The Intel Xeon processor 5500 series, built on new Intel® Microarchitecture, codenamed Nehalem, expands the benefits of virtualization with innovations that boost performance, enhance I/O, and enable servers of different generations to be combined in the same virtualized server pool. Whether your goal is to deploy more virtual machines than ever before, or to deliver agile, high-availability solutions for disaster recovery and real-time workload balancing, the Intel Xeon processor 5500 series provides a more efficient physical platform for your virtualized environment.

The new Intel Microarchitecture Nehalem, with next-generation Intel® Virtualization Technology<sup>◊</sup> (Intel® VT), enhances virtualization performance in several ways:

- **Intel® Virtualization Technology (Intel® VT-x)** continues to offer investment protection and infrastructure flexibility with hardware assistance to increase virtualization performance, and Intel® FlexPriority helps achieve major performance improvements, especially for 32-bit guest OSs such as Windows Server 2000 running legacy applications.
- **Intel® Virtualization Technology for Directed I/O (Intel® VT-d)** speeds data movement and reduces performance overhead by giving designated VMs their own dedicated I/O devices. Windows Server 2008 R2, now available in beta, will support this via Hyper-V configuration.

- **Intelligent performance features** in the new Intel Microarchitecture Nehalem dynamically adapt performance to workload needs in real time. The combination of Intel® Turbo Boost Technology<sup>§</sup> and Intel® Hyper-Threading Technology<sup>†</sup> delivers optimal performance for each workload in a virtualized environment application, and Intel® QuickPath Technology dramatically increases throughput for consolidated applications. In addition, servers based on the Intel Xeon processor 5500 series support up to 144 GB of memory and feature 8 MB of shared L3 cache featuring Enhanced Smart Cache. These innovations deliver the performance and headroom to achieve new levels of data center consolidation.

- **Intel Intelligent Power Technology** delivers better performance with lower power consumption at all operating points, delivering as much as 2.25x more performance in a similar power envelope<sup>4</sup> and reducing idle power as much as 50 percent.<sup>5</sup> Windows Server 2008 takes advantage of these advances to improve power efficiency with automated energy savings. Windows Server 2008 automatically and transparently matches processor power to the needs of the workload, putting inactive cores into appropriate low-power states, and scaling the power of active processors to fit workload performance needs. Standard 95-watt and 80-watt, and low 60-watt versions of the Intel Xeon processor 5500 enable high-density deployments in both rack and blade form factors.

- **Enterprise-class RAS features** such as enhanced memory ECC, memory mirroring, DDR3 DIMM and support for Windows Hardware Error Architecture (WHEA), Intel-based servers have the highest record of uptime in Windows® environments.

By refreshing IT infrastructure with highly efficient servers based on the Intel Xeon processor 5500 series, you gain better virtualization performance for business responsiveness, greater flexibility in meeting all your virtualization goals, plus lower TCO through higher consolidation ratios and higher energy efficiency. In fact, the savings will pay for new servers in about eight months.<sup>6</sup>

## More Versatile Virtualization with Windows Server® 2008 Hyper-V™

Windows Server 2008 Hyper-V is a thin layer of software that sits between the hardware and the operating system. It allows multiple unmodified operating systems to run simultaneously on a host computer. It also enables simple partitioning, maintains strong isolation between partitions, and is inherently secure because it does not contain any third-party device drivers. Hyper-V is optimized to take advantage of Intel Virtualization Technology.

### Overcoming Challenges

Windows Server 2008 Hyper-V overcomes many of the challenges faced by previous, purely software-based virtualization technologies:

**Reduced complexity:** Hyper-V supports non-Microsoft and legacy operating systems as guest OSs, including Windows, RedHat and Suse Linux,\* and Xen\*-enabled Linux, without modifying the operating systems.

**Improved performance:** Virtual machines can use larger amounts of physical resources, including up to 64 GB of memory per virtual machine. Hyper-V also supports pass-through disk access and allows up to four processor cores to be assigned to each virtual machine. Further, Hyper-V optimizes memory use by maintaining a single copy of identical memory pages shared by multiple virtual machines, thus reducing resource utilization on the physical machine. With Windows Server 2008 R2, available in beta today, Microsoft plans to include support for Intel® Extended Page Tables (EPT), which will improve performance and reduce load on the Windows Hypervisor.

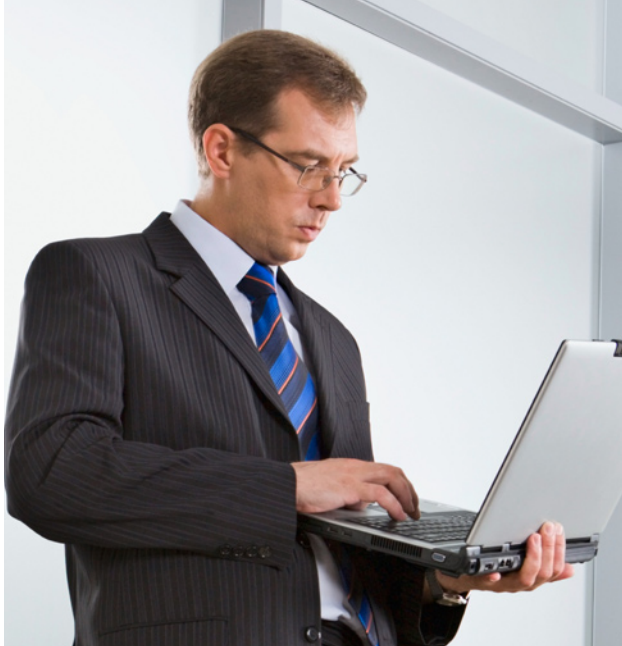
**Increased functionality:** With Hyper-V, a single physical machine can simultaneously run virtualized versions of 32-bit and 64-bit operating systems. Hyper-V also offers advanced networking capabilities for each virtual machine,

including VLAN, network address translation, firewall, the ability to quarantine individual virtual machines, and the option to add or remove virtual NICs without downtime.

**Greater energy efficiency:** Hyper-V is the most power-aware hypervisor solution on the market, providing the same power management capabilities to virtualized workloads that Windows Server 2008 provides natively. Hyper-V functions as an operating system role within Windows Server 2008, so it can dynamically manage processor performance and power states based on virtualized workload performance requirements and processor utilization levels. And Windows Server 2008 R2 will take advantage of the Intel® Intelligent Power Node Manager, allowing IT managers to set a power budget for a rack, a row of servers, or the entire data center, enabling denser deployments and even greater savings from virtualization.

**Improved reliability and protection:** Hyper-V leverages the clustering functionality in Windows Server 2008 to provide host and guest clustering for failover and load balancing across LANs and WANs. IT administrators can cluster multiple physical servers all running virtual machines to minimize the impact of one server failing, as well as migrate loads from one node to another in a cluster for easy maintenance and management.

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## Solutions for All Your Virtualization Needs

The flexibility and power of Windows Server 2008 Hyper-V coupled with the hardware assistance available in the Intel Xeon processor 5500 series offer unparalleled support for a variety of virtualization strategies.

### Server Consolidation and Business Agility

Consolidation seeks to lower TCO and improve IT flexibility by converting physical servers to virtual machines and running the virtual machines on fewer, highly scalable, and reliable enterprise-class servers. Intel Xeon processor 5500 series-based servers provide intelligent performance and greater virtualization capacity, and Hyper-V with System Center Virtual Machine Manager provides a robust set of features and tools for server consolidation.

**Increased native performance:** According to customer benchmarks, the Intel Xeon processor 5500 series with Intel VT increases native virtualization performance up to 1.72x<sup>7</sup>, providing more throughput in a virtualized environment and enabling higher levels of consolidation.

**Energy efficiency for denser deployments:** The energy efficiency of the Intel Xeon processor 5500 series combined with the power management features in Hyper-V enables denser deployments, reducing server footprint and TCO and multiplying the cost savings from virtualization.

“Our benchmarks show that running our on-line gaming system in a Windows Server 2008 Hyper-V virtualization environment on Intel Xeon 5500-based servers almost doubles performance. With their higher performance, consolidation headroom, and energy efficiency, these new Intel Xeon processors and Windows Server 2008 Hyper-V will help us reduce our carbon footprint, save on power costs, and let us grow our business a lot further with our existing data centers.”

- Chen FeiZhou, Vice President, Kingsoft

### Robust Tool-Set

Hyper-V is complemented by a robust set of tools for physical and virtual machine management. These tools are all components of Microsoft® System Center:

**Microsoft System Center Virtual Machine Manager 2008** enables centralized management of the virtual infrastructure, while providing support for both ESX\* and Hyper-V-based environments.

**Microsoft System Center Operations Manager 2007** allows advanced monitoring and service reporting for consolidation, configuration, utilization, and growth projections.

**Microsoft System Center Data Protection Manager 2007** provides live backup and virtual machine snapshots to support business continuity.

**Greater interoperability:** Intel Xeon processor 5500 series and Hyper-V both provide greater interoperability by supporting multiple virtual machines with different operating systems (Windows, Linux, Xen-based Linux) as well as 32-bit and 64-bit workloads on the same physical server.

**Historical data analysis:** Virtual Machine Manager helps identify consolidation candidates by analyzing historical performance data stored in the Microsoft System Center Operations Manager database, and Intelligent Placement helps administrators select appropriate virtual server hosts using historical data on workload requirements and physical host utilization.

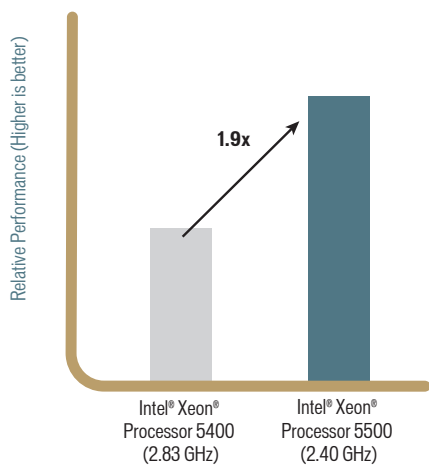
**Integrated system management tools:** System Center Virtual Machine Manager (SCVMM) provides integrated, time-saving tools for physical-to-virtual machine conversion. SCVMM can manage both VMware ESX\* and Hyper-V virtualized environments from a single console, and Volume Shadow Copy Service lets IT administrators create virtual machines without interrupting the source physical server.

**Extended Page Table support:** With Windows Server 2008 R2, available in beta today, Microsoft plans to include support for Intel EPT, which will improve performance and reduce load on the Windows Hypervisor.

**Live VM migration:** In Windows Server 2008 R2, now available in beta version, Hyper-V supports live migration of running VMs. The load-balancing tools and clustering capabilities of Hyper-V and Windows Server 2008, coupled with flexible migration support in Hyper-V and the Intel Xeon processor 5500 series, give IT administrators powerful capabilities for balancing virtual workloads across physical hosts to maximize application performance and business continuity.

**Policy-based management:** To further help extend the value of running Intel Xeon 5500 series servers with Hyper-V, policy-based management with Microsoft System Center provides a next level of cost savings via centralized management of both virtual and physical assets – enabling full realization of end-to-end virtualization. It lets IT handle enterprise-wide provisioning and change management from a central location. This vastly reduces the resources and time needed to administer the infrastructure, and enables you to be much more agile and responsive to business needs.

### Virtualization Performance with Hyper-V™ and Intel® Xeon® processor 5500 series<sup>8</sup>



Source: Intel internal measurements

### Customers See Dramatic Performance Gains

Intel and Microsoft have optimized Windows Server 2008 Hyper-V for Intel Virtualization Technology to deliver the best possible performance for our customers.

- In benchmarks with their online gaming system, Kingsoft, a leading software supplier in Asia and China, found that running virtual game sessions in Hyper-V on the Intel Xeon processor 5500-based servers improved performance by up to 1.72x.<sup>7</sup>
- Benchmarks by a leading ERP vendor running a customer workload showed up to 1.9x performance improvement when running in Hyper-V on servers with the Intel Xeon processor 5500 series.<sup>8</sup>

## Business Continuity

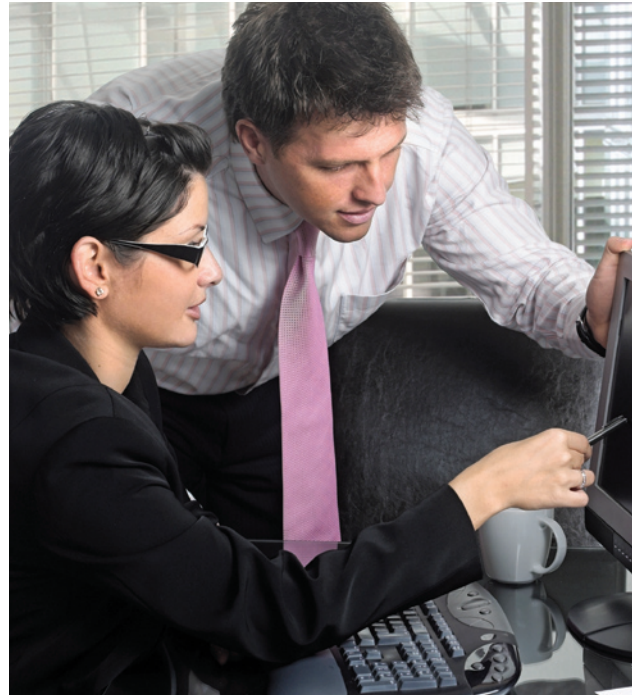
Business continuity is a comprehensive process that includes disaster and business recovery as well as planning to minimize downtime, both scheduled (maintenance and backup) and unscheduled (unanticipated outages). Intel Xeon processors with Intel VT and Windows Server 2008 Hyper-V include powerful business continuity features to support a variety of business continuity scenarios:

**High availability:** Virtual machines running on the same physical server are isolated from each other because they run in separate partitions. Administrators can create virtual machines that run a Windows Server 2008 Server Core installation and apply role-based security, further enhancing security and availability.

**Disaster recovery:** Businesses can architect warm standby solutions based on Windows Server 2008 clustering capabilities that allow virtual machines to automatically fail over to any remote server running Hyper-V. To guard against virtual machine failures, they can set up failover among duplicate virtual machines on a single server or among clustered physical servers, enabling increased business continuity on fewer platforms and for lower cost.

**Scheduled maintenance:** With Hyper-V virtual machine replication services and Quick Migration enabled by Intel® architecture, IT administrators can quickly move virtual workloads among physical machines, keeping applications running while physical hosts are down for scheduled maintenance.

Intel Xeon processors with Intel VT and Windows Server 2008 Hyper-V include powerful business continuity features to support a variety of business continuity scenarios.



## Summary

Virtualization technology plays an increasingly critical role in IT strategy for all kinds and sizes of organizations. Servers based on the Intel Xeon processor 5500 series, with Intel Microarchitecture Nehalem and Intel VT form a high-performance, high-availability and cost-effective hardware foundation for running and managing virtual servers by improving performance and efficiency, increasing flexibility, providing higher reliability, and lowering TCO. Windows Server 2008 Hyper-V and System Center Virtual Machine Manager offer an integrated set of robust virtualization and management tools for creating and maintaining virtual servers. And with Hyper-V as a server role, plus flexible licensing policies from Microsoft, it's now easier than ever to take advantage of the cost savings of virtualization through Windows Server 2008. Together, these technologies provide a powerful virtualization solution that enables businesses to be more agile in their IT deployments and realize significant time and cost-savings benefits.

## Benefits

Intel Xeon processors combined with Windows Server 2008 Hyper-V and System Center tools provide businesses with a powerful, complementary hardware and software solution for virtualization.

| Features                         | Benefits  |   |
|----------------------------------|---|---|
|                                  | Intel® Xeon® Processor 5500 Series  | Microsoft® Hyper-V™   |
| <b>“Near native” performance</b> | <ul style="list-style-type: none"> <li>Up to 1.9x better performance in a virtualized environment than previous-generation platforms.<sup>8</sup></li> <li>Intel® VT reduces need for compute-intensive translation between guest and host operating systems.</li> <li>Intel VT-d accelerates I/O in virtualized environments.</li> </ul>   | <ul style="list-style-type: none"> <li>Each virtual machine can use up to 4 processor cores and up to 64 GB of memory plus pass-through disk access.</li> <li>Uses page sharing to optimize memory access for virtual machines and reduce physical resource utilization.</li> <li>Windows Server 2008 R2 takes advantage of Intel® Extended Page Tables (Intel® EPT) to further enhance virtualization performance.</li> </ul>  |
| <b>Lower TCO</b>                 | <ul style="list-style-type: none"> <li>New intelligent performance features, up to 144 GB memory capacity, and higher-throughput Intel® QuickPath Architecture enable greater consolidation in the same footprint.</li> <li>Intel® Intelligent Power Technology delivers better performance with lower power consumption at all operating points, as much as 2.25x more performance in a similar power envelope.<sup>4</sup></li> <li>With as much as 9x higher consolidation capacity and higher energy efficiency, new servers pay for themselves in approximately eight months.<sup>6</sup></li> </ul> | <ul style="list-style-type: none"> <li>Unified management for virtual and physical servers streamlines operations and lowers data center costs.</li> <li>Virtual Machine Manager and Intelligent Placement tools plus Windows Server® 2008 clustering enable optimal server utilization.</li> <li>Hyper-V™ provides the same power management capabilities to virtualized workloads that Windows Server 2008 provides natively.</li> <li>Windows Server 2008 R2 takes advantage of the Intel® Intelligent Power Node Manager, allowing IT managers to set power budgets for a rack, a row of servers, or the entire data center.</li> </ul> |
| <b>Interoperability</b>          | <ul style="list-style-type: none"> <li>64-bit computing with support for 32-bit applications provides a smooth migration path.</li> <li>Intel VT provides high-performance support for legacy operating systems.</li> </ul>   | <ul style="list-style-type: none"> <li>Hyper-V supports Microsoft and legacy virtual machines, including Windows®, Linux* and Xen*-enabled Linux without OS modification.</li> <li>Hyper-V supports 64-bit and 32-bit applications.</li> </ul>  |
| <b>Flexibility</b>               | <ul style="list-style-type: none"> <li>More cores and higher per-core performance give IT administrators greater choice and flexibility in assigning virtualized workloads.</li> <li>Intel FlexMigration enables live VM migration across the full range of 32-bit and 64-bit configurations, enabling bigger VM pools.</li> </ul>  | <ul style="list-style-type: none"> <li>Virtual Machine Manager and Intelligent Placement tools plus Windows Server 2008 clustering enable analysis for optimal load balancing.</li> <li>Quick Migration lets administrators easily move virtual machines between physical servers.</li> </ul>   |
| <b>Security</b>                  | <ul style="list-style-type: none"> <li>Microsoft Windows® uses the Trusted Platform Module feature to provide a protected space for key operations and other security-critical tasks.</li> <li>The hardware-based Execute Disable Bit security feature helps reduce exposure to viruses and malicious-code attacks and prevents harmful software from executing and propagating on the server or network.</li> </ul>  | <ul style="list-style-type: none"> <li>Virtual machines are isolated because they run in separate partitions on the physical server.</li> <li>Virtual machines can use roles-based security on Windows Server 2008 Server Core installations.</li> </ul>  |
| <b>High Availability</b>         | <ul style="list-style-type: none"> <li>Unique RAS features, including support for Windows Hardware Error Architecture (WHEA) reduce the cost and complexity of high availability solutions in virtualized environments.</li> <li>Intel-based servers provide the highest levels of uptime in Windows environments.</li> </ul>   | <ul style="list-style-type: none"> <li>Leverages Windows Server 2008 clustering for failover and load balancing across LANs and WANs.</li> <li>Quick Migration helps with disaster recovery strategies.</li> </ul>  |

## For More Information

To read more about virtualization solutions from Intel and Microsoft, visit [www.intelalliance.com/microsoft/virtualization](http://www.intelalliance.com/microsoft/virtualization).

To learn more about the Intel Xeon processor 5500 series, visit [www.intel.com/xeon](http://www.intel.com/xeon).

To find out more about Windows Server 2008 Hyper-V, visit [www.microsoft.com/hyper-v](http://www.microsoft.com/hyper-v) and [www.microsoft.com/virtualization](http://www.microsoft.com/virtualization).

For more information about Intel Microarchitecture, codenamed Nehalem, visit [www.intel.com/technology/architecture-silicon/next-gen](http://www.intel.com/technology/architecture-silicon/next-gen).

<sup>1</sup> Source: Infoworld, March 26, 2008.

<sup>2</sup> Source: IDC Document: Virtualization and Multicore Innovations Disrupt the Worldwide Server Market. Document number: 206035. Publish date: March 2007.

<sup>3</sup> Source: Intel Internal measurements, February 2009 Intel Xeon Processor X5500 series, 2.40GHz; 72GB (18x4GB) DDR3-1066MHz, vs. Intel Xeon Processor E5400 series, 2.83GHz; 32GB (8x4GB) DDR2-667MHz.

<sup>4</sup> Compared to Intel® Xeon® processor 5400 series. Claim supported by multiple performance results including an OLTP database benchmark on Windows Server 2008. Intel internal measurement. (Feb 2009).

<sup>5</sup> Intel internal measurements of 221W at idle with Supermicro 2xE5450 (3.0GHz 80W) processors, 8x2GB 667MHz FBDIMMs, 1x700W PSU, 1x320GB SATA hard drive vs. 111W at idle with Supermicro software development platform with 2xE5540 (2.53GHz Nehalem 80W) processors, 6x2GB DDR3-1066 RDIMMs, 1x800W PSU, 1x150GB 10k SATA hard drive. Both systems were running Windows 2008 with USB suspend select enabled and maximum power savings mode for PCIe link state power management. Measurements as of Feb 2009.

<sup>6</sup> 8-month ROI claim estimated based on comparison between 2S Single Core Intel® Xeon® 3.80 with 2M L2 Cache and 2S Intel® Xeon® X5570 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 \$6900 based on estimated list prices and estimated server utilization rates. All dollar figures are approximate. Performance and power comparisons are based on measured SPECjbb2005\* benchmark results (Intel Corporation Feb 2009). Platform power was measured during the steady state window of the benchmark run and at idle. Performance gain compared to baseline was 9x while the platform power was 0.8x.

<sup>7</sup> Source: Customer measurements, February 2009. Intel Xeon Processor X5560, 2.80GHz; 12 GB, 6x2GB DDR3-1333 vs. Intel Xeon Processor E5400 series, 2.83GHz; 12GB, 6x2GB DDR2-667 FB.

<sup>8</sup> Source: Intel Internal measurements, February 2009 Intel Xeon processor X5500 series, 2.40GHz; 72GB (18x4GB) DDR3-1066MHz, vs. Intel Xeon Processor E5400 series, 2.83GHz; 32GB (8x4GB) DDR2-667MHz.

<sup>9</sup> Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See [www.intel.com/products/processor\\_number](http://www.intel.com/products/processor_number) for details.

<sup>10</sup> Intel® Virtualization Technology requires a computer system with an enabled Intel® processor, BIOS, virtual machine monitor (VMM) and, for some uses, certain platform software enabled for it. Functionality, performance or other benefits will vary depending on hardware and software configurations and may require a BIOS update. Software applications may not be compatible with all operating systems. Please check with your application vendor.

<sup>11</sup> Intel® Intelligent Power Technology requires a computer system with an enabled Intel® processor, chipset, BIOS and for some features, an operating system enabled for it. Functionality or other benefits may vary depending on hardware implementation and may require a BIOS and/or operating system update. Please check with your system vendor for details.

<sup>12</sup> Intel® Turbo Boost Technology requires a Platform with a processor with Intel Turbo Boost Technology capability. Intel Turbo Boost Technology performance varies depending on hardware, software and overall system configuration. Check with your platform manufacturer on whether your system delivers Intel Turbo Boost Technology. For more information, see <http://www.intel.com/technology/turboboost>.

<sup>13</sup> Hyper-Threading Technology requires a computer system with a processor supporting Hyper-Threading Technology and an HT Technology enabled chipset, BIOS and operating system. Performance will vary depending on the specific hardware and software you use. See <http://www.intel.com/info/hyperthreading/> for more information including details on which processors support HT Technology.

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