



A Quantum Leap in Business Agility, Data Center Efficiency and IT Value

Microsoft® Windows Server® 2008 R2 and Intel® Xeon® Processors

SOLUTION BRIEF

Refresh existing infrastructure and accelerate data center ROI, saving on power and cooling, space, and labor costs

With many data centers now stretched to capacity in terms of power, cooling, and floor space, IT infrastructure is actually limiting IT from investing in innovation. Operating in today's challenging economic climate and in a competitive business environment, organizations need to reduce the cost of operations, increase productivity, and expand their capacity for innovation all at the same time. IDC estimates that for every dollar IT spends on hardware to support new users and applications, they spend another 50 cents on power and cooling for existing hardware.¹ And as much as 70 percent of IT budget is being spent on maintenance of existing systems, leaving only 30 percent for innovation.²

Microsoft® Windows Server® 2008 R2, Windows Server® 2008 R2 Hyper-V,[™] and SQL Server® 2008 R2, together with intelligent server platforms based on the latest Intel® Xeon® processors with Next-Generation Intel® Microarchitecture (Nehalem) offer an antidote to these challenges – an unprecedented opportunity to refresh existing infrastructure and accelerate data center ROI, improve security and save on power and cooling, space, and labor costs, while delivering more computing capacity in the same footprint. Compared to single-core servers, servers based on the Intel® Xeon® processor 5600 series deliver to 15x³ performance per server over 2-socket single-core servers, enabling up to 15:1 server consolidation⁴ ratios, up to 95 percent⁵ lower energy costs, and an estimated return on investment in as little as 5 months.⁶ For business-critical applications, the Intel® Xeon® processor 7500 series delivers up to 8x the memory bandwidth of previous-generation processors,⁷ and up to 20x⁸ the performance of 4-socket single-core servers, enabling up to 20:1 server consolidation, up to 90 percent lower operating costs, and an estimated return on investment in as little as 1 year.⁹

Windows Server 2008 R2 takes advantage of Next-Generation Intel Microarchitecture to adapt processor performance to workload requirements, to deliver the highest system-level performance/watt, and to provide flexible virtualization with outstanding energy efficiency and near-native performance. Because of their exceptional performance and efficiency, an investment in servers based on the latest Intel Xeon processors and running Windows Server 2008 R2 can pay for itself with exceptional data center efficiency and business agility.



Microsoft®

Boost Business Agility and Insight with Better Cost/Performance

Windows Server 2008 R2 and SQL Server 2008 R2 harness new intelligent performance features of Next-Generation Intel Microarchitecture, for greater application responsiveness and throughput. Together, Windows Server 2008 R2 and the Intel Xeon processor 5600 series deliver up to 40 percent higher performance per watt,¹⁰ so you can deliver greater business agility and insight in the same data center footprint and at a lower cost. On the TPC*-E benchmark, SQL Server 2008 on an Intel Xeon processor 7500 series processor-based server demonstrated up to 9.2x the performance of single-core processors.¹¹

Intel® Turbo Boost Technology^s delivers performance on demand, letting processors operate above the rated frequency under certain conditions to speed workloads.

Intel® Hyper-Threading Technology[†] delivers greater throughput and responsiveness for multi-threaded Windows®-based applications. Many Windows-based and SQL Server applications lend themselves to parallel, multi-threaded execution. Intel Hyper-Threading Technology enables multiple threads to be executed within each processor core, up to two threads per core – as many as sixteen threads per eight-core processor. Hyper-threading reduces computational latency, making optimal use of power. For example, while one thread is waiting for a result or event, another thread is executing in that core, to maximize the work from each clock cycle.

Intel® QuickPath Technology and an integrated memory controller speed traffic between processors and other components to reduce latency and optimize the use of system bandwidth, delivering better application responsiveness and

Intel® Xeon® Processors for Each Business Need

Enterprise Computing	Business-Critical Applications	
Intel® Xeon® Processor 5600 Series	Intel® Xeon® Processor 7500 Series	Intel® Xeon® Processor 6500 Series
The Intel® Xeon® processor 5600 series – the next generation of intelligent server processors – automatically regulates power consumption, combining industry-leading energy efficiency with intelligent performance that adapts to your workload.	The Intel® Xeon® processor 7500 series combines intelligent performance that automatically adapts to the diverse needs of a virtualized environment with advanced reliability and scalability never before seen in an industry-standard server.	The Intel® Xeon® processor 6500 series offers the mission-critical security features of the Intel Xeon processor 7500 series in a 2-socket processor designed for highly threaded, memory-intensive database applications and virtualization workloads.
Key Features		
<ul style="list-style-type: none"> • Intel® QuickPath Technology • Intel® Hyper-Threading Technology[†] • Intel® Turbo Boost Technology^s • Intel® Intelligent Power Technology^d • Integrated Memory Controller • Intel® Virtualization Technology^o 		
<ul style="list-style-type: none"> • Up to 6 cores/12 threads per socket • 12 MB shared L3 cache • 18 Memory DIMM slots 	<ul style="list-style-type: none"> • 8 cores/16 threads per socket • Up to 8 sockets and 64 cores in standard configurations • Supports expandable servers with up to 16 sockets and 128 cores • 24 MB shared L3 cache • 128 Memory DIMM slots⁷ (Up to 2 terabytes of memory in 8-socket configurations) 	<ul style="list-style-type: none"> • 8 cores/16 threads per socket • 18 MB shared L3 cache • 32 Memory DIMM slots
New Intel® AES-NI encryption instructions	More than 20 new mission-critical RAS features including Demand and Patrol Scrubbing, Intel® MCA-recovery capability, partitioning via virtualization, and Mirrored Memory Board Hot Add/Remove, and PCI-E Hot Plug	

greater throughput/processor for bandwidth-intensive SQL Server 2008 data warehousing, business intelligence (BI) and other Windows-based applications.

Intel Xeon processors also help lower power consumption and TCO for demanding applications by optimizing the ratio of throughput to total power consumed. Using 60-watt low-voltage versions, you can build high-density database systems, saving on space, power and cooling costs. The Intel Xeon processor 5600 series pairs with new, lower power DDR3 memory, and you can use special 40-watt and 60-watt low-voltage versions of the processor to build high-density database systems, saving on space, power and cooling costs. The Intel Xeon processor 6500 series, with more cores and threads per socket, is ideal for highly threaded, data-intensive database applications, and the Intel Xeon processor 7500 provides dramatically increased performance and massive scalability for the most business-critical applications.

These new platforms continue Intel and Microsoft platform leadership, with higher performance/processor that allows IT to support more applications and users per server, so the business can grow more without outgrowing the data center.

Power management tasks allow the operating system, in conjunction with “hardware available,” to strike an equilibrium between performance and the resources consumed. Windows Server 2008 R2 allows customers to take advantage of such enhancements as Core Parking and new Group Policy settings. Core Parking is an exciting development that allows Windows Server 2008 R2 to constantly track the relative workloads of every logical core in a server relative to all the others. Cores that aren't being fully utilized can be put into sleep mode until their silicon muscle is required. This capability means a 16-way server with a light workload can turn itself into a 4-way server until workloads suddenly increase and then spin up reserve CPU power in milliseconds.

Automated Energy Efficiency for Lower TCO

Energy efficiency is becoming a critical issue in the data center. 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.¹² With data center construction costs exceeding \$1,000 per square foot, IT refresh with more energy-efficient servers can offer a cost-effective way to help extend the lives of existing data centers.

Intel and Microsoft have worked closely to make sure that Windows Server 2008 R2 takes advantage of the new energy-efficiency features introduced in the Nehalem processor line. Windows Server 2008 R2 running on Intel Xeon processors is the first platform to deliver automated power management that scales energy usage in real time to fit workload performance needs and system and data center power and thermal policies. Windows Server 2008 R2 uses the advantages of the Next-Generation Intel Microarchitecture to help deliver increased performance and new levels of energy-efficiency.

The Next-Generation Intel Microarchitecture delivers a 5x improvement in power management capabilities from the first Intel® quad-core server processors: 5x as many operating states, a 5x reduction in idle power, and 5x faster transitions to and from low-power states.¹³ Automated Low-Power States allow the operating system to automatically put processor and memory into the lowest available power states that will meet the current workload while not impacting performance, and Integrated Power Gates allow individual idle cores to be reduced to near-zero power independent of other operating cores. Windows Server 2008 R2 takes advantage of these new features to adapt system power to workload and data center requirements, conserving across all operating points, so IT can dramatically lower energy costs and deliver more business results from every watt, every clock cycle, and every inch of data center space.

Refreshing Value for Your Data Center Needs

Whatever your data center model, platforms based on Windows Server® 2008 R2 and Intel® Xeon® processor-based servers offer greater efficiency and fast ROI:

Small and medium business: Windows Server 2008 R2 and servers based on the Intel Xeon processor 5600 series are ideal for the small to medium-sized business looking for great performance, low TCO and energy efficiency, and plenty of room to grow and virtualize in the future.

Standard enterprise computing: For standard business computing and enterprise applications, intelligent servers based on the Intel Xeon processor 5600 series boost performance, energy efficiency, and virtualization flexibility, making it easier to deliver more business services within existing data center facilities.

Business-critical computing: For business-critical applications, the Intel Xeon processor 7500 series delivers unprecedented performance in an industry-standard server, plus massive scalability and mission-critical RAS features. The Intel Xeon processor 6500 series offers the same advanced RAS features in a 2-socket server with an expanded memory footprint.

Cloud computing: Flexibility and performance are paramount in the cloud data center, to maximize agility and uptime. The Intel Xeon processor 5600 series helps IT meet performance requirements while lowering costs, with high performance density and industry-leading energy efficiency. For mission-critical and demanding applications, the higher performance and memory bandwidth of the Intel Xeon processor 7500 series plus its advanced power management, RAS, and virtualization features all help to enhance efficiency and dramatically reduce operating costs in the cloud data center.

Windows Server 2008 R2 and Intel Xeon processors based on Next-Generation Intel Microarchitecture deliver performance on demand and conserve power overall through the judicious use of available resources. Windows Server 2008 R2 takes advantage of Intel® Intelligent Power Technology² to improve power efficiency with automated energy savings. It automatically and transparently determines the minimum number of cores needed to service the current workload, “parks” unneeded cores in a deep power down state, and scales the power of active processors to fit workload performance needs.

Windows Server 2008 R2 also takes advantage of the new power management technologies to improve power efficiency through features such as Intelligent Tick Distribution and Timer Coalescing. Intelligent Tick Distribution checks CPU state before sending the “tick” that the operating system uses to update the time of day. If a core is in a sleep state, Windows Server 2008 R2 doesn’t send the tick, allowing the core to save power by remaining asleep. Timer Coalescing saves power by identifying drivers that are only slightly offset in their timing and aligning their periods so they can be serviced with one tick.

Deploying Intel Xeon processor-based servers in an environment with Microsoft® System Center Configuration Manager software further extends the ability of IT professionals to proactively manage the energy consumption and environmental footprint of their physical and virtual IT environments. With its seamless integration with Microsoft’s operating systems and robust support for underlying Intel Xeon processor-based servers, System Center Configuration Manager helps system managers optimize resources and reduce energy consumption. For example, all power management settings in Windows Server 2008 R2 support Group Policy, which allows administrators to define and deploy specific configurations for groups of users and computers. System Center ships with more than 35 power management settings that administrators can use to create the power management strategy that best suits their needs. Centralized reporting and control help IT to optimize energy usage across the data center.

Windows Server 2008 R2 takes 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. With IPMI and out-of-band management, power monitoring, metering, and capping can be done from the system management console. Power consumption and budgeting information are reported via the Windows Management Interface (WMI), and system managers can configure the system power budget from within Windows.

Flexible, Efficient Virtualization to Tame Data Center Sprawl and Improve Agility

Virtualization is a critical IT tool for responding to data center 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. Windows Server 2008 R2 Hyper-V and the Intel Xeon processor-based on Next-Generation Intel Microarchitecture deliver exceptional performance, energy efficiency and reliability in a virtualized environment, plus flexibility to support a wide variety of virtualization models and they can help companies achieve the highest payoff from these virtualization initiatives.

Under-utilization of servers is a major cause of energy waste: typical servers today consume 60 percent of their maximum power levels when completely idle.¹⁴ Windows Server 2008 R2 and servers based on Intel Xeon processors help IT achieve maximum savings from consolidation in two ways: superior performance for higher consolidation ratios, and extending the energy-efficiency features from the physical to the virtualized environment.

For mainstream enterprise computing, Windows Server 2008 R2 Hyper-V and the Intel Xeon processor 5600 series offer flexible virtualization with best-in-class performance and manageability. For higher-density virtualization and virtualization of business-critical applications, the Intel Xeon processor 7500 series offers the industry's highest virtualization performance in a standard server. Customer benchmarks show more than 2x performance increase when running a Hyper-V virtualization environment on Intel Xeon processor 7500 series-based servers.¹⁵ Benchmarks running a customer workload with leading ERP software showed that Hyper-V running on servers with the Intel Xeon processor 7500 series could support up to 2.67x more virtual machines than the previous-generation processor while providing equal or better performance.¹⁶ The Intel Xeon processor 7500 series is an ideal platform for large-scale application consolidation

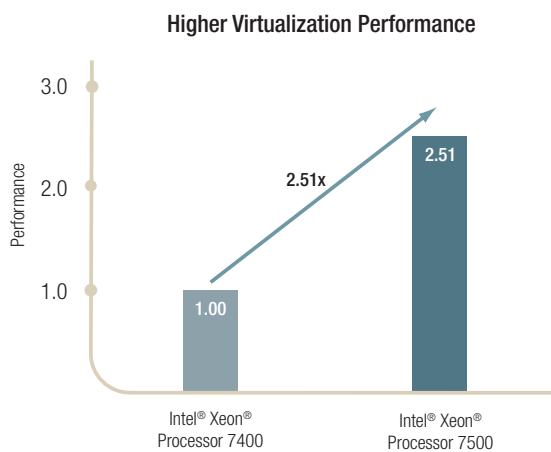


Figure 1. Intel® Xeon® processor 7500 series-based servers improved performance for Kingsoft JX Online* III by 2.51x versus previous-generation Intel® Xeon® processor 7400 series-based servers.

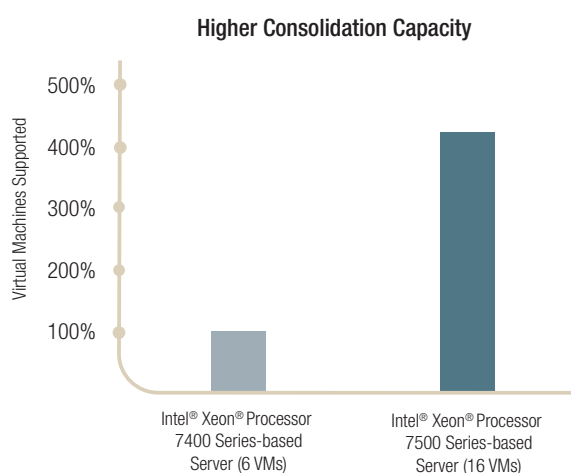


Figure 2. Intel® Xeon® processor 7500 series-based servers running Microsoft Windows Server® 2008 R2 with Hyper-V™ were able to support 2.67x more virtual machines than previous-generation servers and software, while delivering equal or better performance per virtual machine.

“Our benchmarks show that running our online gaming system in a Hyper-V™ virtualization environment on Intel® Xeon® processor 7500 series-based servers more than doubles performance. With their higher performance, consolidation headroom, and energy efficiency, these new Intel® Xeon® processors and 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

projects. Completed workload testing of virtualized Microsoft Dynamics CRM 4.0 on servers equipped with Intel Xeon processors 7500 series showed that with 20 virtual machines (VMs) on two 4-socket servers, the CRM workload was able to sustain 100,000 users.¹⁷

Windows Server 2008 R2 supports Intel® Extended Page Tables (EPT), which improve performance and reduce load on the Windows Hypervisor. Microsoft Virtual Machine Queue (VMQ) technology takes advantage of Intel Virtual Machine Device Queues (VMDq), a feature of Intel® Ethernet Server Adapters, to improve virtualized server I/O by offloading data packet sorting overhead from the hypervisor virtual switch to the Ethernet controller. Data packet sorting in the Ethernet controller, individual queues for each VM, and DMA of data packets directly to the VM's local memory, make more CPU cycles available for application processing, improving server throughput.

Windows Server 2008 R2 Hyper-V with Next-Generation Intel Microarchitecture provides the same power management capabilities to virtualized workloads that Windows Server 2008 R2 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 the virtualized workload performance requirements and processor utilization levels.

Windows Server 2008 R2 Hyper-V takes flexible virtualization to a new level with Live Migration. Live Migration is the ability to migrate running virtual machines from one server to another without any service disruption or perceived downtime. Data centers with multiple Hyper-V physical hosts will be able to move running VMs to the best physical computer for performance, scaling, or optimal consolidation without impacting users. Hyper-V reduces costs and increases productivity by enabling IT to service datacenters in a more controlled fashion by scheduling maintenance during regular business hours. Live Migration makes it possible to keep VMs online, even during maintenance, increasing productivity for both users and server administrators. With Intel® Virtualization Technology[®] (Intel® VT), Live Migration and Windows Server R2 Clustering can switch workloads in real-time to available systems in the same data center or across the country. This allows data centers to avoid system downtime caused by failures due to hardware, power, or natural disasters. Data centers will be also able to reduce power consumption by dynamically increasing consolidation ratios and powering off unused physical hosts during times of lower demand. One of the keys to Live Migration is Intel® VT-x technology, which provides the hypervisor with insight into servers that are available targets for migration.

Windows Server 2008 R2 Hyper-V uses Intel VT to give IT unprecedented flexibility and control through multi-platform support and live virtual machine migration. Intel VT provides additional flexibility with the ability to seamlessly migrate VMs among current and future Intel processor-based servers, even though newer systems may include enhanced instruction sets. With this technology, Hyper-V can establish a consistent set of instructions across all servers in the migration pool. The result is a more flexible and unified pool of server resources that functions seamlessly across multiple hardware generations.¹⁸

With Hyper-V as a 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 R2. To further extend the value of running Intel Xeon processor-based servers with Hyper-V, policy-based management with Microsoft System Center Manager allows IT to manage both virtual and physical assets from a central location — enabling full realization of end-to-end virtualization. Giving IT the ability to handle enterprise-wide provisioning and change management from a central location vastly reduces the resources and time needed to administer the infrastructure, and enables you to be much more agile and responsive to business needs. With the combination of enhanced virtualization performance, higher energy efficiency, and the flexibility of live migration, Microsoft and Intel deliver a highly scalable, high availability and low-cost solution for the data center.

Advanced Security to Protect Business, Networks and Data

Intel Xeon processors offer the security benefits of the Trusted Platform Module (TPM), which is used by Windows Server 2008 R2 to create a more protected space for key operations and critical tasks, as well as the hardware-based Execute Disable Bit to help reduce exposure to malware attacks and help prevent malicious code from executing on the server or the network. The Intel Xeon processor 7500 series and Windows Server 2008 R2 or newer platforms provide all the security benefits of Microsoft's trustworthy computing initiatives, with security features such as:

- Policy-based access controls, which provide flexibility in protecting data
- Security auditing, which helps you track and log specific security-related events
- Kerberos authentication, which provides a flexible and efficient means of authenticating the identities of client and server computers
- User Account Control (UAC), which increases security by limiting applications to running with standard user privileges by default

- The Encrypting File System (EFS), which enables transparent encryption and decryption of data at the file system level, using public key cryptography
- IPSec, which helps protect data as it travels across an IP network by encrypting and authenticating each packet
- BitLocker,[®] which allows you to encrypt stored operating system files and data at the volume level, and BitLocker to Go™ (new in Windows Server 2008 R2), which allows you to encrypt the contents of removable drives such as USB sticks
- Active Directory[®] Rights Management Services (RMS), with which you can help protect information through persistent usage policies that remain with the information wherever it goes
- The Server Core installation option, which reduces the attack surface and makes the server less vulnerable to attack by installing only the most basic elements of the operating system

In addition, Windows Server 2008 R2 supports network security technologies such as:

- Network Access Protection (NAP), which monitors and determines client computers' compliance with your health policies (updates, firewall, antivirus) before it allows them to access the network
- Data Protection Manager (DPM), the disk-based backup and recovery component of Microsoft System Center
- Microsoft Forefront[®] security technologies, a group of enterprise-level products that provide identity management, threat management at the gateway, client security, and more

Windows Server 2008 R2 also adds the following security features:

- AppLocker,[™] with which you can control what software is allowed to run through centrally managed group policies
- Better support for biometric authentication, which gives you more options for increasing security via multifactor authentication
- Improvements to service accounts, smart cards, UAC, and auditing

In recent years, Internet security threats have increased at an alarming rate, yet only a small fraction of the traffic served by web servers is encrypted. In the past, data encryption entailed either the expense of custom hardware or the burden of reduced CPU performance. Now the Intel Xeon processor 5600 series offers AES-NI (Advanced Encryption Standard New Instructions), which is capable of performing robust data encryption without additional appliances or costly performance overhead. AES-NI not only accelerates the AES algorithms, it also guards against memory pattern attacks. By taking advantage of AES-NI, Windows Server 2008 R2 significantly reduces the computational overhead of serving encrypted data on web servers. On virtualized consolidated Web Banking Workload, Windows Server 2008 R2 delivered 21 percent performance improvement over Windows Server 2008 SP2.¹⁹ A significant portion of this improvement is directly attributable to the use of Intel Xeon processor 5600 series AES-NI for crypto operations.

Mission-Critical Reliability

Intel Xeon processors are backed by the proven track record of the world's most widely deployed servers.

- More than 20 years of server experience
- Nearly 40 million servers deployed worldwide
- Billions of hours of real application runtime

To continue this tradition of outstanding reliability and availability, Intel collaborated closely with Microsoft on the Windows Hardware Error Architecture (WHEA). In Windows Server 2008 R2, WHEA offers robust failure reporting, rich diagnostics and faster recovery times to further improve server availability. WHEA uses standard flows between the firmware and the OS to process errors and uses a standard data format to report errors. This makes errors easier and quicker to root cause and hence repair. Servers built on Intel Xeon processors and running the Windows Server 2008 R2 operating system enable high availability and increased uptime.

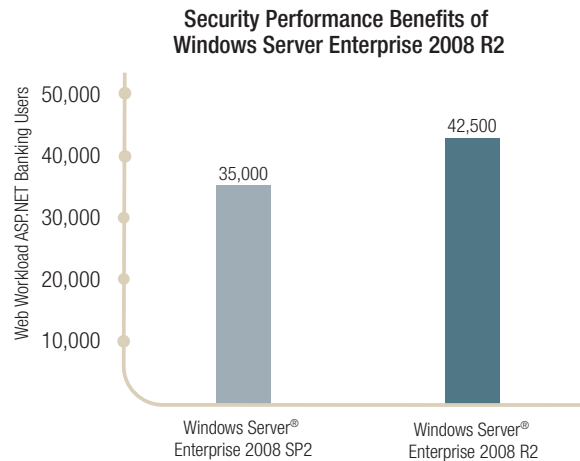


Figure 3. The Intel® Xeon® processor 5600 series offers AES-NI instructions that reduce the performance overhead of data encryption.

Intel Xeon processors built on the Next-Generation Intel Micro-architecture are designed for reliability, with features such as Enhanced Memory ECC, Memory Sparing, Memory Mirroring, and Memory CRC. Intel Xeon processor 7500 series delivers dramatically enhanced reliability for business-critical applications, with more than 20 new advanced RAS features, including Intel® Enhanced Machine Check Architecture Recovery – MCA technology usually found in high-end RISC and Itanium®-based systems. MCA recovery will enable these systems to detect and correct errors in the CPU, memory, and I/O, working in conjunction with the operating system, to enable the high levels of uptime that mission-critical systems are required to deliver. Hot-pluggable component support and simplified clustering in Windows Server 2008 R2, coupled with the advanced RAS features of the Intel Xeon processor, reduce the cost and complexity of high-availability solutions.

Breakthrough Performance and Massive Scalability for the Most Demanding Jobs

The new Intel Xeon processor 7500 series delivers the biggest performance boost ever achieved in successive Intel Xeon processor generations, doubling memory capacity, providing up to 8 times the memory bandwidth and delivering unprecedented support for high-availability in a mainstream server. The Intel Xeon processor 7500 series offers massive scalability for demanding business-critical applications with eight cores per processor on 4- or 8-socket servers,²⁰ up to 2 TB of memory in 8-socket configurations, and up to 24 megabytes of on-die L3 cache. It supports non-uniform memory access (NUMA) and provides breakthrough performance for demanding, memory-intensive applications.

Ideal for heavy workloads and large consolidation projects, the Intel Xeon processor 7500 series can reduce operating expenses by up to 90 percent⁹ with performance increases approaching 20x over single-core servers⁸ and more than double the virtualization performance of previous-generation processors.¹⁵ Four-socket and larger Intel Xeon processor-based servers can also provide enhanced reliability, availability and serviceability through redundant and hot-plug components. These large servers allow you to assign more processors, memory and I/O per virtual machine to provide better performance for business-critical applications running in virtualized machines.

Transforming the Economics of the Data Center

For over 20 years, Microsoft and Intel have collaborated to provide the best performance and value in enterprise platforms. Now Microsoft Windows Server 2008 R2 and Intel Xeon processors take data center efficiency to a new level, with intelligent performance to deliver more business agility in a smaller footprint and enhanced security, plus automated energy efficiency and flexible virtualization that help you dramatically lower TCO.

Building highly efficient and flexible data centers with Microsoft Windows Server 2008 R2 and the Intel Xeon processors enables IT departments to:

- Dramatically lower TCO and use the money saved to build new and innovative services
- Provide the highest service levels to customers
- Lead the business in overcoming economic hurdles
- Be more agile in responding to business needs
- Provide IT capacity on demand at an industry-leading TCO

By upgrading their IT infrastructure with these industry-leading technologies, organizations can reduce the cost of operations, increase productivity, and expand their capacity for innovation all at the same time.

For More Information

To learn more about the latest Intel Xeon processors, visit www.intel.com/xeon.

For more about Windows Server 2008 R2, visit www.microsoft.com/windowsserver2008.

To learn more about SQL Server 2008, visit www.microsoft.com/sqlserver.

To find out more about Windows Server 2008 Hyper-V, visit www.microsoft.com/hyper-v.

To find out more about Microsoft virtualization, visit www.microsoft.com/virtualization.

For more information about Next-Generation Intel Microarchitecture, visit www.intel.com/technology/architecture-silicon/next-gen.

¹ Source: IDC Document: Virtualization and Multicore Innovations Disrupt the Worldwide Server Market. Document number: 206035. Publish date: March 2007.

² Forrester Research - The Five Essential Metrics for Managing IT - by Craig Symons, with Alexander Peters, Alex Cullen, and Brandy Worthington, April 2008.

³ Intel performance comparison using SPECjbb2005* business operations per second between four-year-old single-core Intel® Xeon® processor 3.8 GHz with 2M cache based servers and one new Intel® Xeon® processor X5670 based server. 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, visit www.intel.com/performance/server.

Baseline platform: Intel server platform with two 64-bit Intel® Xeon® Processor 3.80 GHz with 2M L2 Cache, 800 FSB, 8x1 GB 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 six-core Intel® Xeon® processor X5670, 2.93 GHz, 12 MB L3 cache, 6.4 QPI, 12 GB memory (6x2 GB DDR3-1333), 1 hard drive, 1 power supply, Microsoft Windows Server* 2008 64 bit SP2, Oracle JRockit* build P28.0.0-29 run with 2 JVM instances.

⁴ Intel consolidation based on replacing 15 four-year-old single-core Intel® Xeon® processor 3.8 GHz with 2M cache based servers with one new Intel® Xeon® processor X5670 based server while maintaining performance as measured by SPECjbb2005* business operations per second. 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, visit www.intel.com/performance/server.

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⁵ Intel comparison replacing 15 four-year-old single-core Intel® Xeon® processor 3.8 GHz with 2M cache based servers with one new Intel® Xeon® processor X5670 based server. Costs have been estimated based on internal Intel analysis and are provided for informational purposes only.

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⁶ Claim: "As little as 5 month ROI claim estimated based on comparison between 2S Single Core Intel® Xeon® 3.80 with 2M L2 Cache and 2S Intel® Xeon® X5670 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 estimated server side java benchmark results (Intel Corporation Jan 2010). Platform power was estimated 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 3.80 GHz with 2M L2 Cache, 800 FSB, 8x1 GB 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 six-core Intel® Xeon® processor X5670, 2.93 GHz, 12 MB L3 cache, 6.4 QPI, 12 GB memory (6x2 GB DDR3-1333), 1 hard drive, 1 power supply, Microsoft Windows Server* 2008 64 bit SP2, Oracle JRockit* build P28.0.0-29 run with 2 JVM instances.

⁷ The higher Intel® Xeon® processor 7500 series memory capacity can be used to populate for highest capacity/performance or to enable use of lower-cost, lower-density DIMMs. 128 DIMM slots supported on 8-socket systems; 4-socket systems support 64 DIMMs.

⁸ Intel performance comparison using SPECjbb2005* business operations per second between 5-year-old single-core Intel® Xeon® processor 3.33 GHz based servers and one new Intel® Xeon® processor X7560 based server. 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, visit www.intel.com/performance/server.

⁹ Claim based on comparison between 4S Intel® Xeon® MP CPU 3.3 GHz (Single core w/ HT, 1 MB L2, 8MB L3, Potomac) and 4S Intel® Xeon® X7560 (8 core, 2.26 GHz) based servers. Calculation includes analysis based on performance, power, cooling, electricity rates, operating system annual license costs and estimated server costs. This assumes 42U 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 \$36,000 based on estimated list prices, and estimated server utilization rates. All dollar figures are approximate. SPECint_rate_base2006* performance and power results are measured for X7560 and Xeon 3.3 GHz based servers. Platform power was measured during the steady state window of the benchmark run and at idle. Performance gain compared to baseline was 20x. Costs and return on investment payback have been estimated based on internal Intel analysis and are provided for informational purposes only.

¹⁰ Up to 40 percent 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 measurements as of January 15, 2010.

Configuration details: server side java benchmark in conjunction with power consumption across a load line. Baseline platform: Intel preproduction server platform with two Quad-Core Intel® Xeon® processor X5570, 2.93 GHz, 8 MB L3 cache, 6.4 QPI, 8 GB memory (4x2 GB DDR3-1333), 1 PSU, Microsoft Windows Server* 2008 Enterprise SP2. New platform: Intel preproduction server platform with two six-core Intel® Xeon® processor X5670, 2.93 GHz, 12 MB L3 cache, 6.4 QPI, 8 GB memory (4x2 GB DDR3-1333), 1 PSU, Microsoft Windows Server* 2008 Enterprise SP2. Intel internal measurements as of January 15, 2010.

¹¹ TPC Benchmark* E – SQL Server* 2008 (score 2022 tpsE @ 493.92 USD/tpsE): IBM System x* 3850 X5 server platform with four Intel® Xeon® processors X7560 (24M cache, 2.26 GHz, 6.40 GT/s Intel® QPI), 1024 GB memory (64x 16 GB DDR3-1066 REG ECC), Microsoft SQL Server* 2008 R2 Enterprise x64 Edition database, Microsoft Windows Server* 2008 R2 Enterprise x64 Edition. TPC Benchmark* E (score 220 tpsE @ 1020.13 USD/tpsE): Results available at http://tpc.org/tpce/results/tpce_result_detail.asp?id=107082401. 9.2x claim calculated versus 4P/8C/16T Intel® Xeon® processor 7140M (16M Cache, 3.40 GHz, 800 MHz FSB) or 7150N (16M Cache, 3.50 GHz, 667 MHz FSB). TPC Benchmark* E (score 220 tpsE @ 1020.13 USD/tpsE): http://tpc.org/tpce/results/tpce_result_detail.asp?id=107082401.

¹² Source: InfoWorld, March 26, 2008.

¹³ Intel® Xeon® processor 5300 series data based on Intel® Xeon® processor X5365 SKU (B-3 stepping), Xeon® 5400 series based on Xeon® X5470 (E-0 stepping), and Xeon® 5500 based on Xeon® W5580 (D-0 stepping). Number of operating states includes all frequency operating points, including Turbo Boost and base frequency. Idle power based on C6 idle power for Xeon® 5500, and C1E for Intel® Xeon® processor 5300 and 5400 SKUs. C6 also requires OS support and may vary by SKU. Faster transitions based on Package C1E exit transition latency and PLL lock time for p-state transitions.

¹⁴ Lauri Minas and Brad Ellison. "The Problem of Power Consumption in Servers." Dr. Dobb's Portal. March 5, 2009.

¹⁵ Source: Customer measurements, February 2010. Microsoft Windows* Server 2008 R2 Datacenter with Hyper-V* (6.1.7600.16385) on Intel® Xeon® Processor X7500 series, 2.27 GHz; 64 GB, 16x4 GB DDR3-1066 vs. Intel® Xeon® Processor X7400 series, 2.67 GHz; 64 GB, 32x2 GB DDR2-667 FB.

¹⁶ Source: Intel internal measurements, February 2010. SAP ERP workload and Microsoft Windows* Server 2008 R2 Datacenter with Hyper-V* on Intel® Xeon® processor X7500 series, 2.27 GHz; 256 GB, 18x4 GB DDR3-1066 vs. Intel® Xeon® processor X7400 series, 2.67 GHz; 128 GB, 8x4 GB DDR2-667 FB.

¹⁷ Source: Internal tests conducted by Intel, Dell and Microsoft March 2010. Microsoft Dynamic CRM 4.0 and Microsoft Windows* Server 2008 R2 Datacenter with Hyper-V* (6.1.7600.16385) on two Dell PowerEdge* R910 4-socket servers with Intel® Xeon® processors X7560 2.27 GHz; 256 GB (12x4 GB) 1066 MHz. For more information, refer to <http://crmdynamics.blob.core.windows.net/builds/hyperv.pdf>

¹⁸ Intel® VT FlexMigration supports live VM migration across all Intel® Core™ microarchitecture-based servers and servers based on the new Intel microarchitecture (codenamed Nehalem). It is included in the new Intel® Xeon® processor 5600 series, Intel® Xeon® processor 6500 series, and Intel® Xeon® processor 7500 series. It provides backward compatibility for live VM migration with current multi-core Intel® Core™ microarchitecture products and forward compatibility with future multi-core processors. Contact your preferred VMM vendor for support requirements.

¹⁹ Source: Intel internal measurements, February 2010. Web ASP.NET banking workload and Microsoft Windows* Server 2008 R2 Datacenter with Hyper-V* (6.1.7600.16385) on Intel® Xeon® processor 5680, 3.33 GHz 6.4 GT/s; 48 GB, 12x4 GB DDR3-1066.

²⁰ Maximum of 8 sockets supported with Intel platforms only. Higher socket support available via use of third-party OEM node controllers.

⁵ 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>.

[†] 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 www.intel.com/info/hyperthreading for more information including details on which processors support HT Technology.

^² 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.

^³ 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.

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