



Harness Enterprise Data with Microsoft® SQL Server® 2008 R2 and New Intel® Xeon® Processors

Turn growing data volumes into valuable business insights with Microsoft SQL Server® 2008 R2 and the latest Intel® Xeon® processors – an enterprise-grade data platform that offers preeminent query processing, performance, scalability, reliability, and flexibility.

IT departments are under pressure to deliver effective tools to the business that will turn large volumes of data available into business insights. In today's enterprise, effective data access and management are increasingly complex, urgent, and costly because of explosions in data volumes, complexity of the analysis, and pressure to do more with shrinking IT budgets. Data platforms must combine uncompromising scalability, performance, and reliability with innovative software features that take advantage of the latest query processes and hardware advances, all while reducing total costs.

A joint data platform composed of Microsoft® SQL Server® 2008 R2 and the latest Intel® Xeon® processors is an enterprise-grade solution to data management challenges. With advances in scalable performance and virtualization, in addition to reliability, availability, and serviceability (RAS), the combination of Intel hardware and Microsoft software offers a powerful, yet cost-saving alternative to costly proprietary architectures and older versions of the platform. This paper shows that a joint data platform from Microsoft and Intel can meet the mission-critical demands of the most demanding enterprise. Whether your organization is migrating from a proprietary RISC/UNIX* environment, refreshing older servers, consolidating servers, or planning new data-intensive solutions such as data warehousing, business intelligence (BI), or customer relationship management (CRM), the joint data platform from Microsoft and Intel delivers the scalability, performance, and reliability you need for mission-critical and data-driven applications.



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Introduction

Contemporary enterprises face data management challenges that are very different from those they faced 10 years ago. For example, these organizations are often driven by very large, rapidly growing data sets that affect everything from mission-critical applications to building access. As the data volumes grow, it becomes increasingly difficult to use that data to drive effective business decisions. Furthermore, these very large data sets are difficult and costly to maintain, and often involve significant risk and expense in terms of potential data loss and compliance mandates.

Organizations need a data platform that is built to handle these evolving challenges. Such a platform should:

- Scale easily to allow for growth
- Perform complex event queries in a timely manner
- Offer outstanding reliability, availability, and serviceability (RAS)
- Support exceptional virtualization performance with high consolidation ratios
- Help control costs through intelligent performance, energy efficiency, and choice of vendors

Organizations can meet these needs with a joint data platform comprising Microsoft SQL Server® 2008 R2 and Intel® Xeon® processors. This platform offers unflinching support for data-intensive workloads and delivers advances in software, hardware, and the way they interact.

This paper describes game-changing innovations in SQL Server 2008 R2, including self-service business intelligence (BI), server manageability, complex event processing (CEP), and Master Data Services. It also describes dramatic developments in the new Intel Xeon processors 5600 and 7500 series, including massive scalability, performance and virtualization enhancements, and intelligent power management capabilities.

The paper then shows how the innovations in SQL Server 2008 R2 and Intel Xeon processors work better together to give:

- Massive scalability
- Impressive performance
- Reassuring RAS
- Improved support for a virtualized data infrastructure
- Lower total cost of ownership (TCO)

With these benefits, a joint data platform from Microsoft and Intel can help organizations transform their exploding data volumes into opportunity while reducing costs.

Data Management Challenges Are Evolving

Ten years ago, database administrators were primarily concerned with tuning the performance of their database management system. In those days, the driving goal was efficient database administration – if administrators could just automate tasks, standardize data formats, and formalize maintenance processes, the database would do what it was supposed to do: store and retrieve data.

But that was before Web 2.0 and other technologies exploded the data volume that databases are expected to handle; before large object data, such as video and audio files, opened the door to tantalizing new possibilities; and before data permeated every facet of day-to-day business operations. Things are more complex for today's database administrator, and data-related challenges are still evolving. Some of the primary challenges include:

- **Rapid increase in volumes of data.** With ever-increasing speed and thanks to new technologies and new ways to use data, enterprises produce volumes of data that would have seemed outrageous a few short years ago. For example, many businesses of all sizes have now adopted enterprise resource planning (ERP) and customer relationship management (CRM) solutions in recent years – solutions that generate and store enormous amounts of data about customers, partners, employees, and other business assets.¹
- **Increase in data dependence.** New technologies have also created an explosion in the ways that data can be used. Everything that keeps a business running – from e-commerce Web sites to computer logon to inventory management to building access – relies upon data and the ability of the database management system to quickly deliver that data to the applications that consume it.
- **Costly server sprawl.** As a result of adding physical servers in response to growth, utilization of server computing capacity has plummeted while cooling costs become a USD 29 billion annual draw on IT budgets.
- **Tight IT budgets.** IT organizations must address these challenges in the face of ever-tighter budgets and under increasing pressure to do more with less. However, even as budgets shrink, costs associated with data and database management are on the rise.

- **Lost opportunity.** As data volumes grow, IT administrators also face the law of diminishing returns: more data about more customers does not automatically lead to more opportunity, more sales, or more security. In fact, data growth can lead to quite the opposite if that data cannot be effectively mined as a source of actionable information.

Data Platforms Must Evolve with the Challenges

To confront these challenges and turn raw data into a usable asset, organizations need a data platform that can support growing volumes and dynamic, data-intensive workloads generated by mission-critical applications such as ERP and CRM. Specifically, enterprises need a data platform that offers:

- **Scalable processing power.** Enterprises need raw processing power that can manage the heavy lifting of data-intensive workloads. Additional computing power and software that is prepared to harness it make it possible for organizations to turn mountains of raw data from disparate sources into actionable information. For example, SQL Server 2008 R2 empowers organizations to perform rich queries on data in motion to gain deep business insights in near real time – but only if their data platform has enough processing power to optimize performance of complex, multi-threaded applications.
- **Solid reliability.** Negative effects from a single database outage can ripple throughout an organization and do real damage to productivity, profitability, and brand equity. The data-driven enterprise needs a data platform that is highly reliable to help ensure that mission-critical applications are available when they are needed – and that's increasingly 24x7.
- **Flexible virtualization.** The platform must help IT build an agile infrastructure with technologies that support virtualization, including live migration and virtual machine (VM) management capability. Organizations whose agile infrastructure includes virtualization are better positioned to take advantage of new opportunities and can realize ongoing returns on IT investments.
- **Cost reduction.** The platform should help organizations keep capital expenditures down with price points that reflect a competitive ecosystem. It should also enable ongoing reductions in TCO through high consolidation ratios and efficient use of power that reduce licensing and cooling costs.

The Evolved Data Platform: SQL Server® 2008 R2 and New Intel® Xeon® Processors

You can meet the needs of today's changing data-related requirements by running SQL Server 2008 R2 on servers equipped with the latest Intel Xeon processors. This platform represents a dramatic evolution in computing technology and includes breakthrough enhancements in both the software and the hardware.

What's New in SQL Server 2008 R2?

SQL Server 2008 R2 delivers several innovations that can help your organization scale database operations with confidence, improve IT and developer efficiency, and enable well-managed BI on a self-service basis for your users. These innovations include:

- **Managed self-service business intelligence.** SQL Server 2008 R2 provides both end-users and IT with cutting edge tools to create, analyze, model, share, and manage BI data in a secure and streamlined way. Self-service analysis tools, such as the Microsoft PowerPivot for Microsoft Office Excel® add-in, enable end users to quickly find the information they need to make better business decisions. With PowerPivot for Excel, they can create solutions from both IT-managed and external sources, allowing them to quickly carry out rich ad-hoc analysis and modeling. This is accomplished in RAM using very high compression so that users can perform complex operations on huge data sets in near real time. This innovation allows users to extract value from data faster and more easily for greater business insight across the whole organization.
- **Complex event processing.** SQL Server 2008 R2 includes Microsoft StreamInsight technology, which can process large volumes of events across multiple data streams in less than a second. This technology also provides built-in support for different types of event handling and rich query semantics. With StreamInsight technology, your organization can make more effective business decisions through both historical data mining and continuous insights into data in motion.
- **Massive scalability.** You can run the most demanding data-driven applications with SQL Server 2008 R2, which now supports up to 256 logical processors and more than 64 threads. These innovations let you take advantage of multi-socket Intel Xeon processor-based servers to help optimize the performance of complex, multi-threaded applications that access your data.

- Master Data Services.** SQL Server 2008 R2 includes Master Data Services, which helps enterprises standardize the data people rely on to make critical business decisions. With Master Data Services, IT organizations can centrally manage critical data assets companywide and across diverse systems, enable more people to securely manage master data directly, and ensure the integrity of information over time. Consistent master data improves the quality of data systems for the entire enterprise and helps maintain operational and business intelligence requirements.
- Data warehousing scalable to hundreds of terabytes.** SQL Server 2008 R2 Enterprise scales to meet the demands of growing data warehouses – from tens to hundreds of terabytes.²
- Application and multi-server management.** New capabilities in SQL Server 2008 R2 simplify management of multiple SQL Server instances. For example, SQL Server 2008 R2 includes tools that deliver centralized visibility into resource utilization so that you can proactively manage database environments. These tools can also help you streamline consolidation and upgrade initiatives across the application lifecycle.
- Support for Hyper-V™ live migration.** SQL Server 2008 R2 now supports Hyper-V live migration, enabling you to move running VMs between hosts with no perceptible downtime.

- Support for Sysprep.** SQL Server 2008 R2 now supports the Microsoft System Preparation (Sysprep) utility so you can prepare an image for deployment and then quickly provision a new server when it is needed.

What’s New in Intel Xeon Processors?

The Intel Xeon processor 7500 and 5600 series build on the success of their predecessors with dramatic innovations in scalability, performance, RAS, and flexible virtualization. For example, both of these Intel Xeon processor series feature micro-architecture improvements that reduce virtualization latency and increase virtualization performance in benchmark tests.³ These processor series also include Intel® Virtualization Technology† (Intel® VT) FlexMigration, which makes it possible for administrators to add cross-generation Intel Xeon processors to server virtualization pools. This capability brings additional flexibility to your virtualized infrastructure.

Developments in the Intel Xeon Processor 7500 Series

Designed for large-scale deployments and mission-critical applications, the Intel Xeon processor 7500 series (formerly codenamed Nehalem-EX) delivers the greatest performance leaps in the history of the Intel Xeon processor family. These leaps include:

- Scalable performance.** The Intel Xeon processor 7500 series is scalable to more than eight sockets and combines up to eight cores per socket and 16 threads in a single processor. Its large memory capacity – up to 2 terabytes (TB) in an eight-socket configuration – reduces latency, which enhances the database performance and the ability of SQL Server 2008 R2 to deliver self-service BI to end users based on data in motion. This processor series also offers four advanced, high-bandwidth interconnect links that allow multiple processors to be directly connected to each other. With these and other innovations, the Intel Xeon processor 7500 series can deliver up to 20 times the performance of single-core servers.⁴
- Uncompromising RAS.** The Intel Xeon processor 7500 series-based servers help keep your business running with more than 20 new RAS features. These include dynamic reassignment of workloads across processors, interconnect error detection and recovery, and individual virtual machine recovery in virtualized environments. In addition, with Intel Machine Check Architecture Recovery, Intel Xeon processor 7500 series-based servers can automatically detect errors and then work with Windows Server 2008 R2 to correct them.

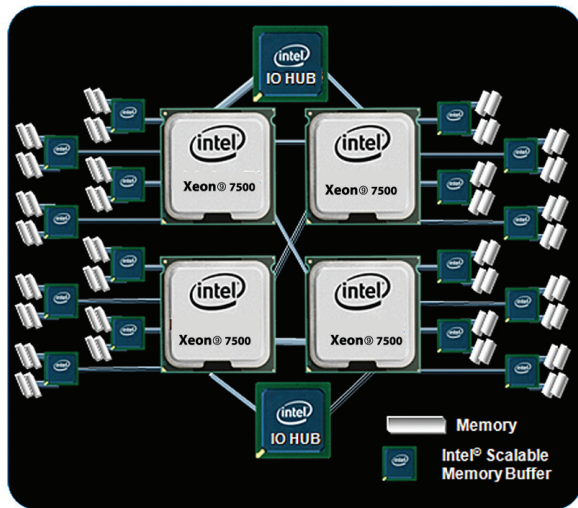


Figure 1. Intel® Xeon® processor 7500 series is scalable to eight sockets (four shown here). Configurations with more than eight sockets are possible with support from OEM node controllers.

Developments in the Intel Xeon Processor 5600 Series

Developed for mainstream deployments in cost-conscious organizations, the Intel Xeon processor 5600 series (formerly codenamed Westmere-EP) delivers outstanding performance and reductions in energy costs. It features:

- **Dependable performance.** With two sockets and up to six cores, the Intel Xeon processor 5600 series delivers up to 60 percent higher performance than its predecessor⁵ and 15 times the performance of single-core servers.⁶ This processor series supports up to 12 threads with 12 MB of shared cache and an integrated memory controller with three DDR3 channels. Two Intel® QuickPath Interconnect links maximize data transfer performance for multiprocessor and/or multi-core platforms. They provide two-way interconnects between processors that can reach speeds up to 25.6 GB per second.
- **Automated energy efficiency.** Featuring Intel® Intelligent Power Technology, Intel Xeon processor 5600 series-based servers reduce energy costs by automatically controlling power consumption. Integrated power gates allow individual idle cores to be reduced to near-zero power independent of other operating cores. In addition, the processor is available with lower-power processors and memory options to help you further optimize energy savings.

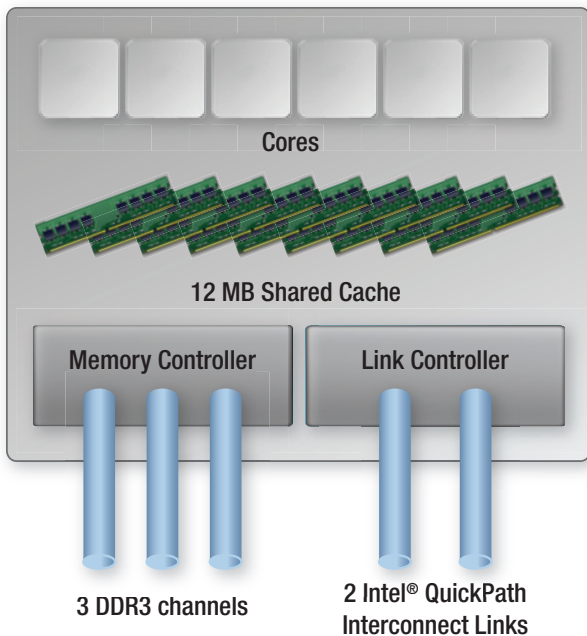


Figure 2. The Intel® Xeon® processor 5600 series features up to six cores and 12 MB of shared cache.

Realize Large Performance Gains on the Evolved Data Platform

These innovations in SQL Server 2008 R2 and Intel Xeon processors matter because of the rapid increase in data volumes discussed at the beginning of this paper. If that data is to become a source of business growth and sound business decisions, users must be able to analyze it quickly while it is “in motion,” not weeks or months after its placement in an archive. Near real-time analysis and complex queries on very large data sets, such as that offered by SQL Server 2008 R2, require significant processing power, such as that found in multi-core, multi-socket Intel Xeon processors.

When you deploy SQL Server 2008 R2 on servers powered by Intel Xeon processors, your organization can enjoy enterprise-grade performance that helps users make better business decisions based on more current data. BI innovations in SQL Server 2008 R2 take advantage of scalable Intel Xeon processor-based servers to empower users with self-service analysis tools, such as the PowerPivot for Excel add-in. With PowerPivot for Excel, users can use the familiar Excel interface to interact with enormous data sets to get the view of the data they need to make effective business decisions. On the client side, these capabilities can be enhanced by 2010 Intel® Core™ vPro™ processors, which automatically deliver extra performance when users need it most for an incredibly responsive end user experience with complex, data-intensive applications. SQL Server 2008 R2 also delivers StreamInsight technology to support BI initiatives. Supported by the massively scalable Intel Xeon processor 7500 series, StreamInsight lets administrators perform complex queries on huge, dynamic datasets in near real time so that organizations can more quickly identify and act on emerging trends.

These capabilities help businesses move beyond the storage and retrieval of data to making intelligent use of data as a valuable asset. They are enhanced by the following technologies found on the Intel Xeon processor 5600 and 7500 series:

- **Intel® Turbo Boost Technology[§]** This technology gives “performance on demand,” allowing cores to run faster than base operating frequency when below specified power, current, and temperature thresholds. When a processor detects that it is below these limits, it increases its clock frequency to boost performance of the active cores. This boost gives you extra performance when and where it’s needed, for a dynamically scalable solution to database demands.

- **Intel® QuickPath Technology.** This technology maximizes data transfer performance for multiprocessor or multi-core platforms with high-speed two-way interconnects between processors. Intel QuickPath Technology and the integrated memory controller speed up traffic between processors and I/O controllers. Separate data paths for I/O and memory access make memory access faster because the processor no longer has to communicate first with an external controller.
- **Intel® Hyper-Threading Technology[®] (Intel® HT Technology).** This technology delivers thread-level parallelism on each processor, resulting in more efficient use of processor resources – higher processing throughput – and improved performance on the multi-threaded software.

In servers powered by the Intel Xeon processor 7500 series, these technologies help large organizations realize the performance they require for mission-critical applications and large data-intensive workloads. In servers powered by the Intel Xeon processor 5600 series, these technologies deliver intelligent performance to cost-conscious organizations with a solution that helps them keep energy costs in check.

Optimize Scalability and Performance with the Intel Xeon Processor 7500 Series

Intel Xeon processor 7500 series delivers massive scalability – up to eight sockets or more, with up to eight cores per socket, and up to 16 processing threads per processor and 2 TB of memory capacity in an eight-socket configuration. This large memory capacity, delivering up to eight times the memory bandwidth of the Intel Xeon processor 7400 series,⁷ helps drive up to 20 times the performance of single-core servers.⁸

In addition, the Intel Xeon processor 7500 series intelligently adapts processor frequency to optimize performance for SQL Server 2008 R2 workloads. This joint data platform from Intel and Microsoft now delivers the kind of performance that was previously only possible on very expensive, power-hungry RISC servers and mainframes. The combination delivers unbeatable performance and value.

Reduce Energy Consumption on Data-Intensive Workloads with Intelligent Performance from Intel Xeon Processor 5600 Series

When the massive scalability of Intel Xeon processor 7500 series-based servers is not necessary, organizations can achieve outstanding power-efficient performance from SQL Server 2008 R2 and its dependent applications by deploying Intel Xeon processor 5600 series. Because all database workloads do not require the same power, the platform intelligently adapts system performance and power to workload needs. With two sockets, up to six cores, and 12 threads, Intel Xeon processor 5600 series-based servers can deliver a lot of power when it is needed. When it is not, SQL Server 2008 R2 and Windows Server® 2008 R2 can automatically maximize energy savings by parking idle cores.

Intel Xeon processor 5600 series-based servers can help optimize the performance of data-driven workloads by taking advantage of the powerful new features of SQL Server 2008 R2. With this joint platform you can reduce power consumption through automated energy efficiency and improve performance over older versions of the platform. The Intel Xeon processor 5600 series delivers up to 40 percent higher performance per watt than its predecessor⁹ and more than 15 times the performance of single-core servers.¹⁰ That efficient performance means that you can refresh older servers and enjoy better performance without increasing your energy consumption. Furthermore, in benchmark tests of high-performance computing workloads, Intel Xeon processor 5600 series delivered 63 percent better performance than the Intel Xeon processor 5500 series.¹¹

SQL Server 2008 R2 also brings significant cost-savings to the platform with its support for database page compression. Page compression greatly reduces the amount of space required to store data on disk and in the SQL Server buffer pool, simultaneously reducing the amount of energy required for storage. You can take advantage of page compression with the applications you currently have, so you can begin to realize savings without massive new software rollouts.

These advances can help you achieve lower TCO and rapid payback on your investment while taking advantage of the new self-service BI capabilities in SQL Server 2008 R2. The platform also helps reduce server sprawl and provides the intelligent performance you need for demanding data-driven enterprise applications and the automated energy efficiency you need to keep energy costs in check.

Working with Windows Server 2008 R2, the Intel Xeon processor 5600 series intelligently adapts processor frequency to optimize performance of SQL Server 2008 R2 workloads.

Optimize Virtualization with the Evolved Data Platform

Virtualization is an increasingly important part of IT strategy in businesses worldwide, and it's easy to see why. The technology offers often astonishing cost saving benefits through consolidation, as well as flexibility and agility that can help businesses seize new opportunities and improve return on IT investments. Furthermore, flexible virtualization technology assists organizations as they move toward a cloud computing model and the agility and low-cost service delivery this model promises.

SQL Server 2008 R2 and Intel Xeon processors are optimized for virtualization and can help your organization build an agile data center while reducing TCO with high resource utilization and flexible, powerful VMs. Virtualization technologies built into both the platform software and hardware can help organizations:

- Consolidate more servers
- Improve the raw performance of VMs
- Reduce power consumption by dynamically moving VMs to fewer servers and parking idle cores
- Increase the flexibility of a virtualized infrastructure

Virtualization Enhancements in SQL Server 2008 R2

SQL Server 2008 R2 builds on the solid virtualization performance of SQL Server 2008 by increasing the number of logical processors supported from 64 to 256 so that it can take advantage of multisolet hardware such as Intel Xeon processors. In addition, SQL Server 2008 R2 supports Hyper-V live migration so that administrators can move running Hyper-V virtual machines between physical hosts with little or no perceptible downtime.

With these enhancements, each physical host can support more virtual systems, leading to potential cost reductions while increasing the scalability and flexibility of your virtual infrastructure.

Data centers with multiple Hyper-V physical hosts can move running VMs to the physical computer that is best equipped to process the database workload efficiently. This capability reduces energy consumption and helps improve performance, scaling, and consolidation with no perceptible downtime for users. It also helps data centers deliver the level of business continuity necessary while minimizing downtime caused by hardware or power failures or natural disasters.

Adding to the flexibility of your virtual infrastructure, SQL Server 2008 R2 now supports the Microsoft System Preparation utility, or Sysprep. Support for this technology makes it easier for administrators to create SQL Server images and then quickly deploy them to VMs whenever they are needed.

Scalable Performance on the Intel® Xeon® Processor 7500 Series

More than three times the performance of Intel® Xeon® processor 7400 series

24 MB of shared cache

Up to 1 TB of RAM (in a four-socket configuration)

Scalable from 2-8+ sockets^a

Nine times the memory bandwidth of Intel Xeon processor 7400 series

More than 20 times the performance of single-core servers (in a four-socket configuration)

Processing Power for Mission-Critical Applications

^aConfigurations of more than eight sockets are dependent on OEM node controllers. Please consult your server documentation

Virtualization Enhancements in Intel Xeon Processors

Intel Xeon processors enhance these virtualization capabilities with hardware-assisted Intel Virtualization Technology (Intel® VT-x), which improves the characteristic flexibility and robustness of software-based virtualization.¹² This technology helps reduce VM latency by allowing the guest operating system more direct access to the hardware and by reducing computing-intensive software translation from the virtual machine monitor (VMM). Intel VT-x enables flexible workload migration and performance optimization across the full range of 32-bit and 64-bit operating environments.

Additional hardware-assisted virtualization features on Intel Xeon processor 5600 and 7500 series include:

- **Extended Page Tables (EPT)**, which offload some of the virtualization overhead from software to hardware, removing the primary cause of exits from the VM and resulting in better VM performance
- **Virtual Processor ID (VPID)**, which reduces the frequency of invalidation of TLB entries. This technology saves a set of TLBs in the hardware itself upon VM exit, which reduces memory-related latency
- **Intel VT FlexMigration**, which enables administrators to easily add multiple generations of Intel Xeon processor-based servers to virtualization pools
- **More memory capacity**, which reduces latency
- **Intel Quick Path Technology**, which improves I/O and inter-processor performance
- **An integrated memory controller** for each core and native DDR3 memory, which delivers increased memory capacity and improves memory access and speed

Working together, Windows Server 2008 R2, SQL Server 2008 R2, and Intel Xeon processors can reduce virtualization overhead by sharing the processor, memory, and I/O resources more efficiently among VMs. They can help drive high consolidation ratios to help you reduce space, power, and cooling requirements; and can improve interoperability between diverse operating systems, versions, and applications by providing a reliable hardware-based foundation for virtualization.

Flexible Virtualization with Intel Xeon Processor 7500 Series and SQL Server 2008 R2

The evolved data platform from Microsoft and Intel helps to protect your investments in your virtual infrastructure by delivering long-term returns through impressive consolidation and flexibility.

Enterprise-Level Consolidation

SQL Server 2008 R2 support for up to 256 logical processors and the massive scalability of the Intel Xeon processor 7500 series make the joint data platform from Intel and Microsoft an ideal one on which to consolidate large numbers of physical servers. With Intel VT-x, large memory capacity (24 MB shared cache and up to 2 TB in an eight-socket configuration), and up to eight cores and 16 processing threads in a single processor, the Intel Xeon processor 7500 series can support multiple VMs and their data-intensive workloads and can deliver better VM performance than its predecessor. These large servers allow you to assign more processors, memory, and I/O per VM to provide better performance for SQL Server 2008 R2 workloads running on VMs.

Flexible Virtualization with the Intel® Xeon® Processor 7500 Series

Massive scalability lets you run more VMs on each physical server

Improved raw performance for VMs

Live migration across multiple generations of Intel® Xeon® processor-based servers

Outstanding VM Capability and Investment Protection

Together, the Intel Xeon processor 7500 series and SQL Server 2008 R2 can help reduce costs while enabling centralized management, policy-based control, and rapid configuration and deployment. These capabilities increase the scalability and flexibility of a virtual infrastructure so that you can continue to gain returns on existing investments.

Mainstream Virtualization with Intel Xeon Processor 5600 Series and SQL Server 2008 R2

Like its expandable counterpart, the Intel Xeon processor 5600 series is optimized for virtualization. Organizations can reduce costs and increase performance by refreshing servers based on prior-generation Intel Xeon processors. For example, the Intel Xeon processor 5600 series can deliver up to eight times the virtualization performance of the dual-core Intel Xeon processor 5100 series.¹³ With that boost in performance, an organization could consolidate dual-core servers onto Intel Xeon processor 5600-based servers at the rate of 15:1 without sacrificing performance. With savings in energy costs, software licensing, and maintenance fees, the organization could recover the cost of the new servers in as little as five months.¹⁴

Adding to the energy-saving capabilities of virtualization, Windows Server 2008 R2 can park unused cores in Intel Xeon processor 5600 series-based servers. With this platform, administrators can also reduce data center power consumption by dynamically increasing consolidation ratios and powering off unused servers during times of lower demand.

A Common Consolidation Example

Organizations can realize rapid savings by moving many databases from physical servers to virtual machines powered by the Intel Xeon processor 7500 series, Windows Server 2008 R2, and SQL Server 2008 R2.

For example, you could refresh and consolidate single-core servers at a ratio of 20:1 and reduce annual energy costs of consolidated servers by as much as 94 percent. These energy savings and reductions in software, licensing, and maintenance costs can help drive an estimated payback of your refresh investment in less than one year.¹⁵

Achieve Enterprise-Level RAS with the Evolved Data Platform

As data volumes grow and applications that interface with the data spread to every corner of the enterprise, the reliability and availability of the data platform become paramount. With just one database failure and the cascade of problems that follow in its wake, organizations can lose customers, brand credibility, opportunity, and profit. But now you can deploy data-intensive and mission-critical applications with more confidence on servers powered by SQL Server 2008 R2 and Intel Xeon processors.

Microsoft and Intel went to great lengths to build additional reliability into the evolved data platform. Windows Server 2008 R2 features reliability enhancements in Windows Hardware Error Architecture (WHEA). WHEA now supports Machine Check Architecture Recovery, which helps the platform contain and recover from multi-bit ECC errors in memory and cache without operating system of application interruption – capabilities previously seen only on costly RISC/UNIX platforms or mainframes. Additional RAS features delivered by Windows Server 2008 R2 include dynamic hardware partitioning for “hot swap” of processors, RAM and I/O resources, and increased operating system componentization.

Also, SQL Server 2008 R2 now supports Hyper-V live migration. This allows you to move running Hyper-V virtual machines between hosts with no perceptible downtime, which increases reliability and availability of a virtualized environment.

Enjoy High Availability for Mission-Critical Applications with SQL Server 2008 R2 and the Intel Xeon Processor 7500 Series

Together with SQL Server 2008 R2 and Windows Server 2008 R2, the Intel Xeon processor 7500 series provides a solid foundation for running mission-critical applications with confidence. You can benefit from more than 20 new hardware-based RAS features that help your data platform detect and correct errors and then prevent them from happening again. With built-in redundancy and failover throughout its microarchitecture, the Intel Xeon processor 7500 series helps to ensure the business continuity you expect from your foundational software.¹⁶ These

features strengthen system reliability with advances at all levels of processor architecture – memory, CPU/socket, Intel QuickPath links, and the I/O hub. New additions include:

- **At the memory level**, inter-socket memory mirroring and failed DIMM isolation
- **At the CPU/socket level**, corrected machine check interrupt and corrupt data containment
- **At the Intel QuickPath Interconnect (Intel QPI) level**, Intel QPI packet retry and Intel QPI self healing
- **At the I/O hub level**, physical IOH hot add and dynamic OS IOH on-lining

For a complete list of new RAS features on the processor, see Table 1.

In addition to these features, Intel Xeon processor 7500 series brings a RAS feature never before seen on x86 hardware: Machine Check Architecture Recovery. This technology enables Intel Xeon processor 7500 series-based servers to automatically detect otherwise-fatal errors and then work with Windows Server 2008 R2 to correct them to help ensure the level of business continuity you need for mission-critical applications.

Protect Business Continuity while Reducing Energy Costs with SQL Server 2008 R2 and Intel Xeon Processor 5600 Series

For mainstream database deployments, SQL Server 2008 R2 and the Intel Xeon processor 5600 series can provide the business continuity your data-driven applications need while reducing energy costs. This processor series includes 12 RAS features that help ensure hardware reliability, including:

- At the memory level, memory thermal throttling and memory sparing
- At the CPU/socket level, out-of-band access to uncore MCA registers
- At the Intel QuickPath Interconnect (Intel QPI) level, Intel QPI packet retry

These RAS features, used in conjunction with the automated energy-saving features of the Intel Xeon processor 5600 series, can help ensure that your data-intensive applications remain available and consume only the power they need as workloads change, helping you keep energy costs in check.

With these and other RAS features, Windows Server 2008 R2, SQL Server 2008 R2, and Intel Xeon processors provide a more scalable and reliable alternative to expensive proprietary systems or older versions of the platform. The platform also delivers impressive return on investment (ROI) when you refresh older versions of the joint data platform that do not include the value-added RAS features.

Reduce Costs with the Evolved Data Platform

Global economies show signs of optimism and growth, but enterprises are still cautious. Many are ready to spend on infrastructure projects that were postponed during the recession, but spending must offer solid value to appease jittery investors and board members. Stung by the recent recession and under constant pressure to do more with less, IT organizations are scrutinizing their costs closely and feel intense pressure to deliver measurable business value with IT spending decisions.

That's where servers built on Intel Xeon processors can help. The microarchitecture of Intel Xeon processors, codenamed Nehalem, makes it much easier for server designers (OEMs) to create more scalable but affordable systems that have huge memory and I/O bandwidth, and more importantly, predictably low memory latencies under intense load. Because these server designers do not need to invest in their own silicon to build these high-powered servers, they can offer servers that deliver high-end performance at a price that is a reflection of a highly competitive marketplace.

As a result of these conditions, now could be an ideal time to migrate away from expensive proprietary data platforms and toward platforms from a wider range of hardware vendors. It could also be an ideal time to refresh older servers. SQL Server 2008 R2 and Intel Xeon processor-based servers help businesses reduce TCO and increase ROI. Businesses can capture these benefits in two ways:

- They can take advantage of a larger vendor ecosystem and servers with better price/performance ratios.
- They can refresh older servers to platforms based on SQL Server 2008 R2, Windows Server 2008 R2, and new Intel Xeon processors and take advantage of the TCO benefits of improved power management, flexible virtualization, and enhanced RAS features.

Table 1: The Intel® Xeon® Processor 7500 series includes more than 20 new RAS features.

New RAS Features in the Intel® Xeon® Processor 7500 Series			
Memory	CPU/Socket	Intel® QuickPath Interconnect	I/O Hub
Inter-socket Memory Mirroring	Machine Check Architecture (MCA) recovery	Intel QPI Packet Retry	Physical IOH Hot Add ^b
Intel® Scalable Memory Interconnect (Intel® SMI) Lane Failover	Corrected Machine Check Interrupt (CMCI)	Intel QPI Protocol Protection via CRC (8-bit or 16-bit rolling)	Dynamic/OS IOH On-lining (capacity change) ^a
Intel® SMI Clock Fail Over	Corrupt Data Containment	QPI Clock Fail Over	
Intel® SMI Packet Retry	Dynamic OS Assisted Processor Socket Migration ^a	QPI Self-Healing	
Memory Address Parity	OS CPU on-lining (capacity change) ^a	QPI Viral Mode	
Failed DIMM Isolation	Physical CPU Board Hot Add/remove ^b		
Physical Memory Board Hot Add/remove	Electronically Isolated (Static) Partitioning ^b		
Dynamic Memory Migration ^a			
Dynamic/OS Memory On-lining (capacity change) ^a			
Recovery from Single DRAM Device Failure (SDDC) plus random bit error			
Memory Thermal Throttling			

^aFeature requires operating system support; check with your operating system vendor for support plans.

^bFeature is supported by Intel, but requires OEM server implementation and validation; may also require operating system support.

Migrate from RISC/UNIX to SQL Server 2008 R2 and the Intel Xeon Processor 7500 Series to Reduce TCO

As alternatives become available and IT organizations become increasingly cost conscious, many decision makers feel less tolerant of supporting high-cost platforms just because “that’s the way we’ve always done it.” Innovation and improvements are not only possible – they are imperative, and businesses can take a more proactive approach to platform evaluation and deployment.

Proprietary data platforms, often based on RISC or SPARC architecture and running UNIX-based software, require not only high initial expenditures, but also high ongoing costs in the form of licensing, maintenance, and training. Organizations that are serious about reducing TCO of enterprise systems should consider migrating to hardware and software based on industry standards.

Companies that migrate from RISC/UNIX data platforms to servers running SQL Server 2008 R2 and powered by Intel Xeon processor 7500 series can reduce costs without sacrificing performance, manageability, or security. These savings are realized in the areas of hardware costs, software licensing and support costs, and training and maintenance costs.

Reduce Hardware Costs

You can significantly reduce hardware costs when you run Windows Server 2008 R2 and SQL Server 2008 R2 on hardware powered by Intel Xeon processor 7500 series. Lower hardware costs result, in part, from market conditions. The multiprocessor server market offers a broad range of servers from a variety of leading vendors in stark contrast to the one-vendor model of proprietary platforms. This competition is healthy and benefits customers by driving lower initial costs, ongoing development, and competitive support options. The joint data platform from Microsoft and Intel offers an industry-standard solution that is much less costly than one based on proprietary architecture.

For example, Intel Xeon processor 7500 series-based servers can cost much less than IBM Power* servers and can handle an equivalent workload.

Reduce Software and Licensing Costs

Servers powered by Windows Server 2008 R2, SQL Server 2008 R2, and Intel Xeon processor 7500 series can deliver substantial savings in software support and licensing costs. Because UNIX-based software is often priced per processor core (instead of per socket), the savings multiply with scale. In addition, SQL Server 2008 R2 running on Windows Server 2008 R2 can be less costly than Oracle* because Microsoft does not charge extra for online analytical processing (OLAP), data mining, data compression, partitioning, encryption, and other features.

Reduce Training and Maintenance Costs

Organizations can reduce costs associated with hiring and training staff members to maintain Intel Xeon processor-based servers. Those who manage RISC/UNIX systems are paid significantly higher salaries than their Windows counterparts. Because UNIX administrators can command higher salaries, UNIX training can be more expensive than Windows Server training. These initial and ongoing training costs can be a significant and sometimes overlooked portion of TCO.

Refresh Older Servers and Reduce Energy Costs

Companies eager to reduce costs without sacrificing performance should look to the data center first for ways to make drastic reductions in energy consumption and costs. Under-utilized servers and servers that do not use power efficiently are easy opportunities to cut costs. Businesses can realize dramatic savings by refreshing these servers to Intel Xeon processor-based servers.

Business Scenario: Refreshing Older Servers to Intel Xeon Processor 5600 Series-based Servers

The Intel Xeon processor 5600 series can work with Windows Server 2008 R2 to automatically regulate power consumption and intelligently adjust server performance according to your application needs. You can achieve up to 40 percent more

performance per watt than the Intel Xeon processor 5500 series and you can drastically reduce energy costs by refreshing single- or dual-core servers.

For example, Internal Intel tests show that organizations refreshing single-core servers to Intel Xeon processor 5600 series-based servers at the rate of 15:1 can reduce annual energy costs by as much as 95 percent.¹⁸ In a 5:1 refresh from dual-core servers to Intel Xeon processor 5600 series-based servers, organizations can reduce annual energy costs by as much as 85 percent.¹⁸

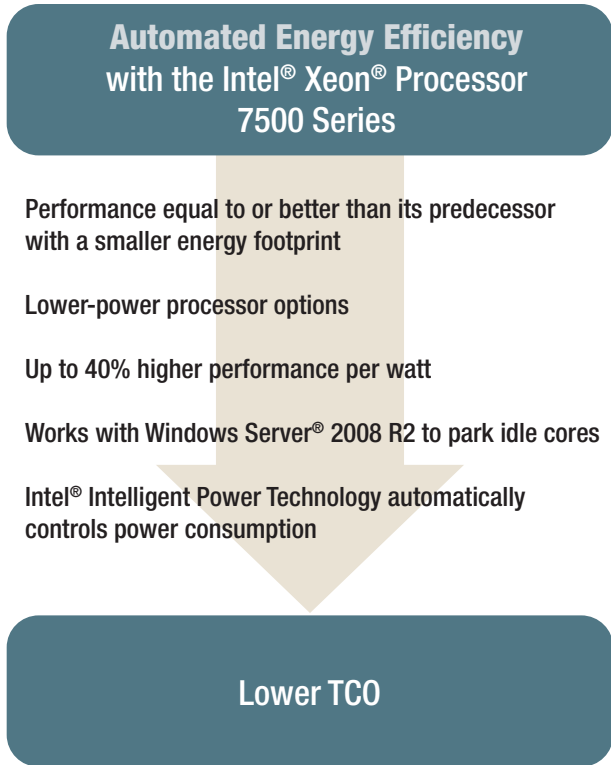
Featuring Intel® Intelligent Power Technology, Intel Xeon processor 5600 series-based servers reduce energy costs by automatically controlling power consumption. Power-efficient hardware advances in the Intel Xeon processor 5600 series include:

- **Lower-power processor options** to give you greater control over power consumption
- **Power control unit improvements** that optimize power consumption through more efficient use of Intel® Turbo Boost Technology and better memory power management
- **Integrated power gates** that allow individual idle cores to be reduced to near-zero power independent of other operating cores

SQL Server 2008 R2 running on Windows Server 2008 R2 takes advantage of these new features to adapt system power to workload and data center requirements. The Windows and Intel platform automatically and transparently determines the appropriate number of cores needed to service the current workload, “parks” unneeded cores in a deep power-down state, and scales the power of active cores to fit workload performance needs.

Business Scenario: Refreshing Older Servers to Intel Xeon Processor 7500 Series-based Servers

Organizations that are ready for a heavy-duty multiprocessor data platform can refresh older servers to Intel Xeon processor 7500 series-based servers and realize substantial savings. Compared to Intel Xeon processor 5500 series the Intel Xeon processor 7500 series offers more than three times the memory capacity, four times as many threads, and eight times as many sockets. This raw power makes it possible to refresh and virtualize large numbers of single-core servers.



Internal Intel measurements show that a consolidation rate of 20:1 – consolidating 20 single-core physical servers onto one Intel Xeon processor 7500 series-based server – can reduce energy costs associated with the servers by up to 92 percent, driving a payback of the refresh investment in less than one year.¹⁹ In a 1:1 server refresh of single-core servers without consolidation, organizations can realize up to 20 times the performance within an existing data center design.²⁰ The increased performance can help organizations achieve rapid and long-term returns on the server refresh investment.

Conclusion: Get More from Enterprise Data

Data management is no longer merely a store-and-retrieve proposition. Just as emerging technologies are pushing the boundary of what kinds of data can be created and captured – look no further than GPS devices and online mapping – SQL Server 2008 R2 and the new Intel Xeon processors push the boundary of what businesses can do with their exploding volumes of data. For example, you can empower users with valuable business insights; quickly

identify market trends as they are developing; use customer geospatial data to tailor Web-based content and offerings while the customer is still shopping; and manage enterprise resources with greater accuracy.

With the right data platform in place, database administrators can help business users turn mountains of raw data into actionable information. The right platform is one built on industry standards with Microsoft software and Intel hardware. New BI tools in SQL Server 2008 R2 enable users to perform complex queries on enormous data sets, to analyze the results using familiar tools in Excel, and then to share results with colleagues in Microsoft Office SharePoint® Server – all without IT having to write custom BI applications or scripts. Intel Xeon processors enhance these capabilities with scalable performance, flexible virtualization, and RAS features that help ensure your database and the many applications that rely on it are available when you need them.

SQL Server 2008 R2 and Intel Xeon processors are enterprise-grade solutions that can support ambitious data-intensive solutions such as data warehousing, BI, CRM, and others. Businesses worldwide are discovering that the joint data platform from Microsoft and Intel can meet the mission-critical demands of the most sophisticated enterprise.

Next Steps

Learn how you can deploy the joint data platform from Microsoft and Intel with confidence to:

- Reduce TCO by migrating from expensive proprietary RISC/UNIX* platforms
- Drive down energy costs and realize rapid ROI by refreshing and consolidating older servers to high-volume multi-core servers
- Use complex data analysis to drive business decisions

Visit the Intel Microsoft Alliance Web site to learn more about the Intel® Xeon® processor 5600 series and 7500 series and SQL Server® 2008 R2.

For More Information

For general information, visit:

Intel and Microsoft Alliance:

<http://www.intelalliance.com/microsoft>

Learn more about Intel Xeon processors:

http://www.intel.com/p/en_US/products/server/processor

<http://www.intel.com/itcenter/system/server/index.htm>

What's New in SQL Server 2008 R2:

<http://www.microsoft.com/sqlserver/2008/en/us/whats-new.aspx>

Learn more about managed self-service business intelligence in SQL Server 2008 R2:

<http://www.microsoft.com/sqlserver/2008/en/us/R2-SSBI.aspx>

Read more about Microsoft StreamInsight in SQL Server 2008 R2:

<http://download.microsoft.com/download/F/D/5/FD5E855C-D895-45A8-9F3E-110AFADBE51A/Microsoft%20CEP%20Overview.docx>

- ¹ Intel® Virtualization Technology requires a computer system with an enabled Intel® processor, BIOS, virtual machine monitor (VMM) and, for some uses, certain computer system 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.
- ² 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.
- ³ Intel® Turbo Boost Technology requires a PC 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 PC manufacturer on whether your system delivers Intel Turbo Boost Technology. For more information, see <http://www.intel.com/technology/turboboost.>
- ⁴ "Managing the data explosion," available at http://www.it-director.com/technology/data_mgmt/content.php?cid=11025
- ⁵ Learn more about SQL Server 2008 R2 data warehousing options at <http://www.microsoft.com/sqlserver/2008/en/us/R2-Trust.aspx>
- ⁶ Intel Xeon processor 5600 series performed up to 45 percent better than Intel Xeon processor 5500 series in VMmark tests. Best published VMmark results as of 10/19/09. 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 www.intel.com/performance/resources/limits.htm
- ⁷ Intel performance comparison as of February, 2010 using SPECjbb2005* business operations per second between 5-year-old single-core Intel® Xeon® processor 3.33GHz based servers and one new Intel Xeon processor X7560 based servers. 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.
- ⁸ Internal Intel measurements as of February 25, 2010, based on Intel® Xeon® processor X5680 vs. Intel® Xeon® processor X5570 – results on SPECint*_rate_base2006 and OLTP workload. 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 Intel performance comparison as of February, 2010, 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 X5600-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.
- ¹⁰ Intel internal memory BW measurement 3/2/2010.
- ¹¹ See endnote 4.
- ¹² Up to 40 percent higher performance per 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 as of January 15, 2010. 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.
- ¹³ See endnote 6.
- ¹⁴ Results are based on internal Intel measurements as of February, 2010. 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 www.intel.com/performance/resources/limits.htm
- ¹⁵ Intel® VT is a set of technologies residing on the processor, chipset, and network interface card of select Intel-based server platforms. Intel VT-x refers to the component of Intel VT that resides on the processor.
- ¹⁶ Best published VMmark results as of October 19, 2009. 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 www.intel.com/performance/resources/limits.htm
- ¹⁷ 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.
- ¹⁸ 1 year ROI claim estimated based on comparison between 4-socket (4S) Single-Core Intel® Xeon® 3.33GHz and 4S 2.26GHz Intel Xeon processor 7500 series-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 estimation of ~\$32,000 based on estimated list prices and estimated server utilization rates. All dollar figures are approximate. Performance and power comparisons are based on Intel internal 4S Nehalem-EX 2.26 GHz processor-based platform measurements on key server workloads over a Single-Core Intel® Xeon® 3.33GHz processor-based platform. Platform power was measured during the steady state window of the benchmark run and at idle. Performance gain compared to baseline was up to 20x.
- ¹⁹ Some RAS features require operating system support and some might also require OEM server implementation and validation. Check with your hardware vendor for support of specific RAS features.
- ²⁰ See endnote 9.
- ²¹ Intel measurements as of February, 2010. Performance comparison using server side java bops (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 on performance tests and on the performance of Intel products, visit www.intel.com/performance/resources/limits.htm
- ²² Calculation includes analysis based on performance, power, cooling, electricity rates, operating system annual license costs, and estimated server costs. See also endnote 15.
- ²³ Based on Intel internal measurements (January, 2010) of the Intel® Xeon® processor 7500 series compared to single core Intel® Xeon® processors from 2005.

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