Breakthrough Innovation and Economics for Mission-Critical Systems

Leading Mission-Critical Software Vendors Choose Intel® Xeon® Processors to Power Their Solutions

White Paper

Intel® Xeon® Processor E7 Family

"What we've been seeing over the past couple of years more and more is the ISVs in the mission-critical space moving their workloads, moving their applications over to the Xeon platform. Intel has produced a microarchitecture that is as mission-critical or capable of mission-critical performance as the applications that are dependent on it. The pure performance of the chip, throughput capabilities, memory and virtualization support are all at a level that we've never seen before in Intel products."

– Charles King, President, Principal Analyst, Pund-IT

Compelling Mission-critical Business Economics

As these SPECint_rate_base2006* benchmarks reveal, Intel® Xeon® Processor E7 family delivers a considerable price/performance benefit compared to RISC-based systems.
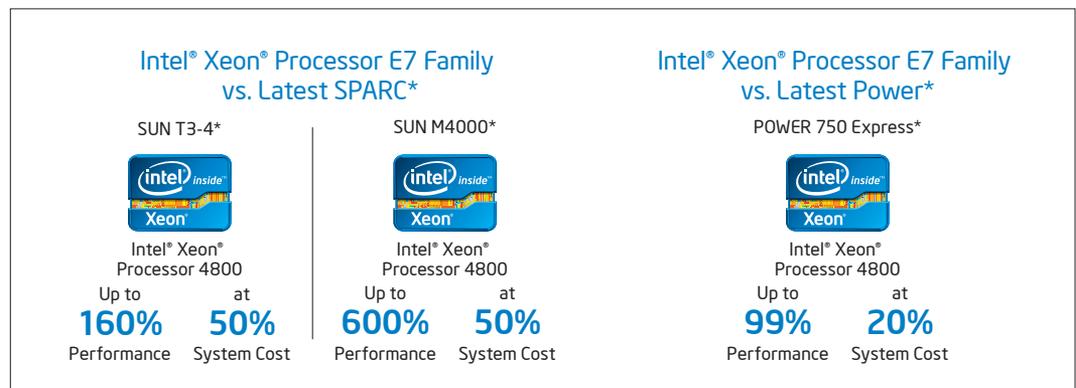

Intel® Xeon® Processor E7 Family vs. Latest SPARC*

SUN T3-4*
Intel® Xeon® Processor 4800
Up to **160%** Performance at **50%** System Cost

SUN M4000*
Intel® Xeon® Processor 4800
Up to **600%** Performance at **50%** System Cost

Intel® Xeon® Processor E7 Family vs. Latest Power*

POWER 750 Express*
Intel® Xeon® Processor 4800
Up to **99%** Performance at **20%** System Cost

Figure 1. SPECint_rate_base2006* benchmarks[1]

"Going from the general-purpose workload to now mission-critical, meaning database transaction-orientated applications, actually have a fiduciary or monetary value to the IT organization; that's where I see these new platforms moving upwards. No longer are they just simplified web hosting or infrastructure servers but really running commerce, really running business, in the way it was meant to be. Intel has brought things like availability and standardization to the masses, but at the same time not sacrificing the quality of service delivery."

– Vernon Turner, Senior Vice President, IDC

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Executive Summary

Today's IT departments face major challenges managing growing mission-critical data repositories and delivering instant answers mined from this data.

An explosion of structured and unstructured data is flooding data centers from an increasing number of sources. On top of this incredible growth, business managers demand instant and new insights from this data, requiring IT departments to deliver real-time business analytics and information that will help managers make critical decisions affecting the company's revenues and operations. Complicating IT managers' challenges, these demands need to be met with flat or even declining budgets.

Delivering on these mandates is a difficult challenge. Many installed proprietary solutions are built on systems that are not easily scalable, are under-powered for real-time analysis of massive data sets, and may require very costly upgrades of RISC-based proprietary hardware to meet the demands of today's businesses.

Intel® Xeon® processors and open, standards-based computing platforms are changing the economics of mission-critical computing. The latest advances in Intel Xeon processors offer new levels of scalable performance and mission-critical reliability, availability, and serviceability (RAS). With these performance and reliability features, plus an open, standards-based approach, Intel Xeon processor-based systems enable a more competitive business environment, benefiting solution providers, impacting the costs of effective, mission-critical solutions, and creating a compelling return on investment (ROI) for the customer.

Customers have asked for mission-critical solution offerings that take advantage of the economics and flexibility of these open, standards-based systems. Enterprise-class database and business intelligence (BI) software vendors are responding to customer demands and are delivering breakthrough mission-critical solutions based on Intel Xeon processors.

Intel has worked with key mission-critical software vendors to optimize and enhance their applications on Intel Xeon processors. Working closely with Intel software engineers and Intel® microarchitecture experts, IBM, Microsoft, Oracle, and SAP, plus a host of other independent software vendors (ISVs), are delivering innovative software and system solutions for enterprise-class mission-critical workloads.

This paper looks at the key data growth and business intelligence challenges that IT departments face. It surveys several solution offerings from industry stalwarts, IBM, Microsoft, Oracle, and SAP, plus from emerging entrepreneurial companies. These solutions address business and industry demands of online transaction processing (OLTP) and online analytic processing (OLAP) via scalable performance, reliability, availability, and serviceability (RAS), and security.

The paper also looks at the Intel Xeon processor features and benchmarks that make this breakthrough mission-critical performance and RAS possible, with a focus on the new Intel® Xeon® Processor E7 family.

Finally, several case studies illustrate real-world application of solutions running on Intel Xeon processors, and the benefits the companies and their IT departments reaped.

Managing Data Growth

Data – and the business information gleaned from it – is at the very heart of today's business operations and decision making. Maintaining ready access to this data – both historical and day-to-day operational data – has resulted in an explosion in business data repositories. According to industry analyst Gartner Group, data will have grown over 6X from 2009 through 2014,[2] resulting in one of the key challenges IT departments now face – managing that growth and delivering on business insights from it.

Transactional Data is Increasing

Transactional data is core to any business' daily operations. And it's coming from more places: mobile, telephone, online and brick and mortar merchant processing, business-to-business transactions, and other sources. Mergers and acquisitions are growing company transactional databases. Plus, core transactions create additional spinoff data of their own. And, all this data is being maintained longer, due in part to the benefits gained from analyzing it over time.

The pressures related to managing these expanding transactional databases have reached a critical point for IT managers.

Business Intelligence Demand on the Rise

Businesses depend on the insight and information gleaned from analyzing accumulated data. From customer data and operational transactions to industry, company, and social trends, harvested business intelligence can give companies a competitive edge, help improve operations and growth, and protect against losses.

Quickly gleaning this information has become a critical objective of more organizations. But, this move toward real-time business analytics requires fast and more reliable data access, especially when databases are used to drive customer-facing applications, where real-time activities can affect real-time business decisions.

The Great IT Challenge

As database repositories and demand for information continue to escalate, businesses need simpler and more cost-effective strategies for managing their database solutions. This leaves IT professionals with a charter to deliver a high-performance infrastructure that is easily scalable, highly reliable, and secure.

IT professionals have taken this challenge very seriously, examining anew their mission-critical initiatives and the infrastructures that support them. But, with their budgets stagnant – or worse, shrinking – and aging equipment and systems filling their data centers, their challenge has grown considerably.

Fortunately, with more powerful Intel® Xeon® processor-based systems, ever-advancing open standards and systems technologies, along with software breakthroughs, mission-critical software vendors are delivering innovative new powerful, scalable, and reliable mission-critical solutions. These systems deliver compelling return-on-investment (ROI) and features supporting the requirements of today's demanding businesses and IT departments.

"IT is increasingly becoming the business as opposed to just a function that supports the business. With each successive evolution of the Intel Xeon product line they get faster, they get much more work done at the same cost and they successively improve the reliability and the availability features."

– Richard Fichera, Vice President, Principal Analyst, Forrester Research

Mission-critical Solutions Innovation

For years, mission-critical business solutions meant proprietary, RISC-based systems, often built around mainframes, which locked businesses into particular vendors, resulting in escalating maintenance and upgrade costs. Or, they grew their own customized solutions from various sources, requiring a cadre of technicians and resources to keep them running.

Intel Xeon processors and open standards initiatives have given solution providers new alternatives to meet the demanding requirements of mission-critical systems. With performance and reliability features necessary to keep business system available, plus an open standards-based approach, Intel Xeon processors enable more vendors to deliver more powerful systems. This creates a more competitive environment, which drives down costs, while enabling greater innovation and adding competitive features.

Today, key software vendors are delivering mission-critical solutions optimized for platforms built on Intel Xeon processors, including the Intel® Xeon® processor 7500 series and the Intel® Xeon® processor E7 family. These Intel Xeon processors offer mission-critical performance and reliability features, enabling new scalable, high-performance mission-critical-grade platforms for the software that services mission-critical workloads.

In the rest of this section, we provide an overview of a few such solutions:

▪ IBM DB2* pureScale*

▪ Microsoft SQL Server* 2008 R2 with PowerPivot* and SharePoint* Server

▪ Oracle Exadata* Database Machine

▪ SAP In-Memory Appliance* (SAP HANA*)

▪ Solutions from a select few entrepreneurial companies from the hundreds of other vendors in the market

IBM DB2* pureScale*

Intel and IBM have been working together for more than a decade to deliver optimized, enterprise-class database solutions based on IBM DB2 data management software and affordable Intel Xeon processor-based servers. IBM, with help from Intel, ported IBM pureScale from its mainframe technology, to IBM System x* server platforms. Breakthroughs in software, enhancements in Intel Xeon processor capabilities, and demands by customers to deliver mission-critical solutions based on Intel Xeon processors have resulted in IBM pureScale being offered on Intel Xeon processors.

A solution with near limitless scalability

IBM DB2 data management software on the latest IBM eX5* servers, based on the Intel Xeon processor 7500 series, delivers enterprise-class scalability, with unprecedented performance, reliability, and value. These powerful, highly optimized new database solutions from IBM and available on Intel Xeon processor-based systems, create a compelling economic incentive for IT centers needing to solve their mission-critical database challenges.

IBM DB2 pureScale, an optional feature of IBM DB2, delivers nearly unlimited capacity, continuous availability, and application transparency for transactional databases running on IBM eX5 servers (based on the Intel Xeon processor 7500 series) and IBM M3 servers (based on the Intel Xeon processor 5600 series). A unique clustering solution, IBM DB2 pureScale brings mainframe concepts to the best of distributed computing technology. When combined with IBM System x servers, the result is a database platform that can help reduce the risk and cost of business growth.

The best of mainframe in a clustered environment

DB2 pureScale software combines proven IBM DB2 for z/OS* mainframe technology with the latest distributed system techniques to create a highly scalable and extremely reliable high-performance database clustering solution. DB2 pureScale software employs a shared-disk architecture that gives every server in the cluster direct access to all data (see Figure 2).

Members of the pureScale cluster can simultaneously access the shared database for read and write operations. Cluster members are also connected directly to a central server through high-performance, point-to-point InfiniBand* Architecture network links. The centralized server provides global lock-management services, a global cache for data pages, and other services for the entire cluster. Global lock management, as compared to distributed lock management, results in less traffic across the network and faster recovery if a server fails. The benefit is a cluster of DB2 systems that – to database applications – looks and acts like a single, incredibly fast server.

In combination with IBM DB2 software and IBM eX5 servers, a single server can have up to eight sockets, 64 cores, 128 threads and 3 TB of memory. Up to 128 IBM System x servers can be combined as members into a high-performance cluster that provides virtually unlimited capacity with continuous availability and complete application transparency.
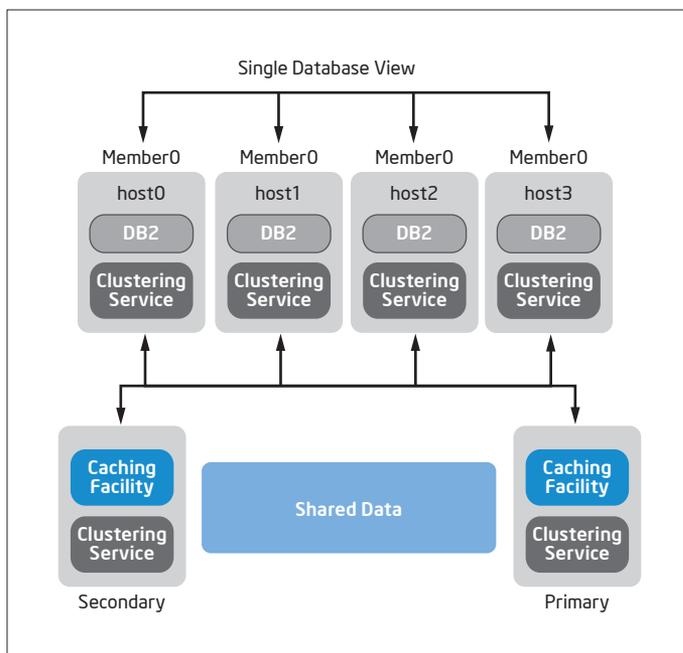

Figure 2. IBM DB2* pureScale* system diagram.

Extensive software optimizations by IBM and Intel for DB2 and pureScale running on Intel Xeon processors take advantage of Intel Xeon processor features that deliver the scalable performance today's transactional databases demand. These features include the processor's 24 MB last-level cache, Intel® QuickPath interconnects, Intel® QuickPath architecture, Intel® Hyper-Threading technology,[3] Intel® Turbo Boost technology,[4] encryption acceleration, and others.

Intel Xeon processor-based IBM System x servers are tuned for the thread- and memory-intensive workloads that are common with DB2 deployments, maximizing performance from up to eight cores per processor.

IBM eX5 servers offer more than just scalable performance. They also deliver major enhancements to improve data integrity and system resilience. Intel® Advanced Reliability Technology (in IBM eX5 servers only) provides high-end data integrity and availability for each individual node, enabling an even more powerful and reliable foundation that keeps data flowing.

A fully configured IBM eX5 server provides a powerful and resilient database engine. Add IBM DB2 pureScale and these servers become building blocks that can be combined to support truly massive data volumes and application workloads with exceptional performance and high availability.

Delivering on business objectives

The practical and economic implications of IBM DB2 pureScale and IBM System x servers built on Intel Xeon processors are compelling. Businesses can now use affordable, industry-standard-based servers to confidently support data volumes and application workloads of nearly any size. This unique combination enables IT to more easily meet their business service objectives, while easily scaling with data growth and delivering a reliable infrastructure to support continued business expansion – all within budget constraints.

"Two complementary advances make it possible to get high-volume, low-cost computing for online transaction processing: X5 servers based on the Intel Xeon processor 7500 series and IBM pureScale. pureScale is brought down from the mainframe to distributed systems. So you now have a combination of rock-solid hardware and rock-solid software."

– Sal Vella, Vice President of DB2 Development, IBM

Microsoft SQL Server* 2008 R2, SharePoint* Server, and PowerPivot*

For several years, Microsoft and Intel have worked together, optimizing Microsoft SQL Server R2 database on Intel® processors. With the technology advancements in Intel Xeon processors and software breakthroughs, Intel and Microsoft have delivered Microsoft SQL Server 2008 R2 with high-end database performance, scalability, reliability, and other features that offer businesses an enterprise-class mission-critical database solution.

A complete business solution in a single license

Microsoft SQL Server 2008 R2 is not only an enterprise-class database. It integrates a high-performance Business Intelligence (BI) component within the software stack, offering BI analytic processing with the standard software license. This offers organizations a complete solution in a single license, making it effective for IT departments seeking a cost-optimized solution for their business needs. Microsoft SQL Server 2008 R2 delivers on the following features:

Scalable processing power. SQL Server 2008 R2 takes advantage of the performance headroom offered by Intel Xeon processors, making it possible for organizations to extract business information from massive amounts of data. Rich queries can be performed on data in motion to gain deep business insights in near real time.

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. Supporting different types of event handling and rich query semantics, StreamInsight technology lets organizations make more effective business decisions through both historical data mining and continuous insights into data in motion.

Massive scalability. SQL Server 2008 R2 now supports up to 256 cores and more than 64 simultaneous threads for powerful processing of complex queries on large databases.

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. 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.

Application and multi-server management. New capabilities simplify management of multiple SQL Server instances. These tools help streamline consolidation and upgrade initiatives, and all more effective management of database environments.

Enhanced reliability. Windows Server 2008 R2 features reliability enhancements in Windows Hardware Error Architecture (WHEA). WHEA now supports Machine Check Architecture Recovery (MCA-r), which helps the platform contain and recover from multi-bit ECC errors in memory and cache without operating system or application interruption.

Redefining Business Intelligence with Microsoft SQL Server PowerPivot for Excel* and Microsoft SharePoint Server 2010

Many database solutions center around IT to deliver the BI tools and analytics the organization needs. Microsoft puts more of those capabilities into the hands of individual business departments with Microsoft PowerPivot and SharePoint Server 2010. These two additions enable a managed BI collaboration environment that offers greater insight for all users, plus gives the IT department effective new management tools to increase operational efficiency in a Microsoft SharePoint Server 2010 environment.

PowerPivot, a free add-on to Microsoft Excel,* along with SharePoint Server, can help to expand the reach of business intelligence through a well-managed, self-service solution that can deliver deeper and faster

business insights. Users can draw on rich information available in the SQL Server 2008 R2 database using the high-performance BI engine in PowerPivot, right on their desktops, in the familiar work environment of Excel. They can drill down into any aspect of their business data and compress decision cycles. With SharePoint Server, they can then easily and securely share their findings with others throughout the organization, making their worksheets, formulas, even datasets available company-wide. And, IT can monitor and manage both the data and individual solutions being used.

Performance from generations of optimization

Intel and Microsoft have spent years closely working together to improve and optimize Microsoft SQL Server R2 software. Over several generations of Intel processors, organizations have benefited from continuous improvement (Figure 3).[5]

"I think people will be surprised at the raw performance and scale that the combination of Intel and Microsoft brings to mission-critical applications. Organizations can experience faster refresh rates, data compression and query speed."

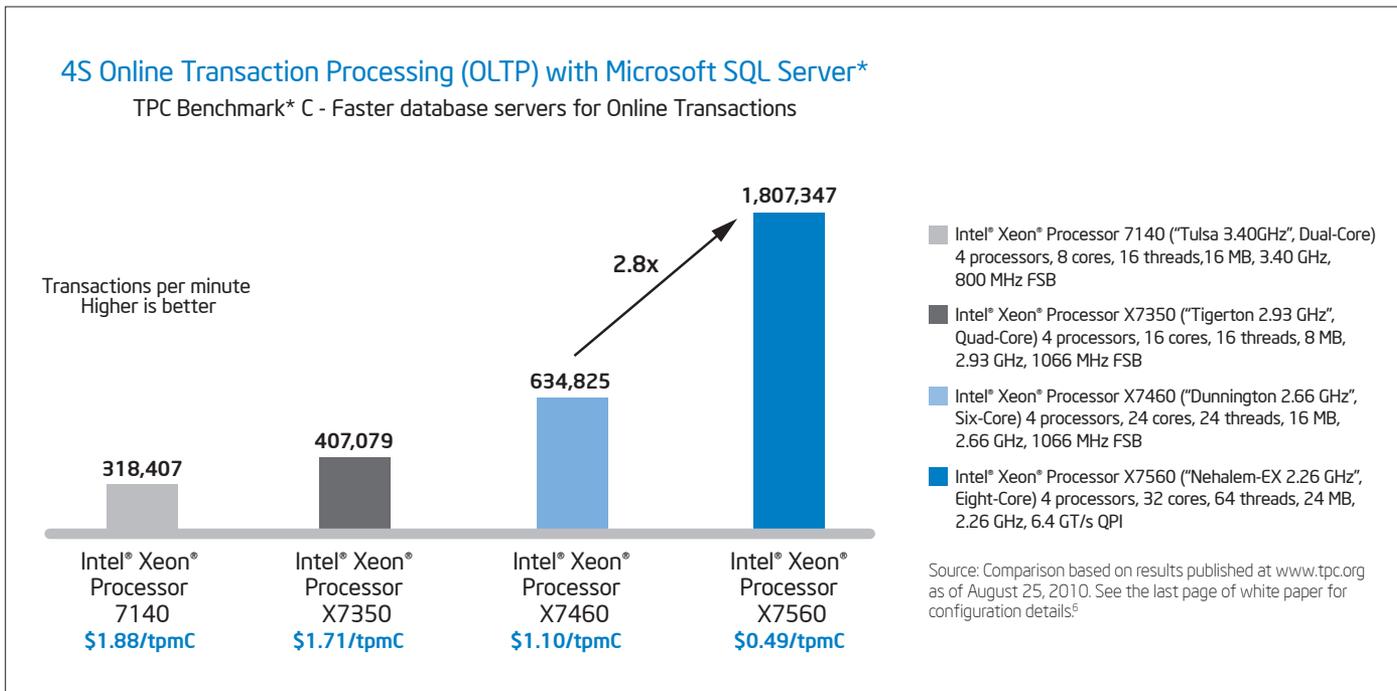– *Eugene Saburi, Business Platform General Manager, Microsoft*

4S Online Transaction Processing (OLTP) with Microsoft SQL Server*
TPC Benchmark* C - Faster database servers for Online Transactions

Transactions per minute
Higher is better

318,407 — Intel® Xeon® Processor 7140 — $1.88/tpmC
407,079 — Intel® Xeon® Processor X7350 — $1.71/tpmC
634,825 — Intel® Xeon® Processor X7460 — $1.10/tpmC
1,807,347 — Intel® Xeon® Processor X7560 — $0.49/tpmC

2.8x

Intel® Xeon® Processor 7140 ("Tulsa 3.40GHz", Dual-Core) 4 processors, 8 cores, 16 threads,16 MB, 3.40 GHz, 800 MHz FSB

Intel® Xeon® Processor X7350 ("Tigerton 2.93 GHz", Quad-Core) 4 processors, 16 cores, 16 threads, 8 MB, 2.93 GHz, 1066 MHz FSB

Intel® Xeon® Processor X7460 ("Dunnington 2.66 GHz", Six-Core) 4 processors, 24 cores, 24 threads, 16 MB, 2.66 GHz, 1066 MHz FSB

Intel® Xeon® Processor X7560 ("Nehalem-EX 2.26 GHz", Eight-Core) 4 processors, 32 cores, 64 threads, 24 MB, 2.26 GHz, 6.4 GT/s QPI

Source: Comparison based on results published at www.tpc.org as of August 25, 2010. See the last page of white paper for configuration details.[5]

Figure 3. Generational performance improvements of SQL Server.*

Oracle Exadata* Database Machine

The collaborative engineering relationship between Oracle and Intel stretches back more than a decade. Oracle develops its products with upcoming generations of pre-release Intel-based servers in the lab, and by the time customers deploy the solutions in their own environments, they get a fine-tuned solution stack built of components that work together seamlessly.

The Oracle Exadata Database Machine is an integrated, optimized solution built on Intel Xeon processor-based servers for hosting the Oracle Database and delivering excellent database performance for OLAP and OLTP. The Oracle Exadata Database Machine is composed of database servers, Oracle Exadata Storage Servers, an InfiniBand Architecture fabric for storage networking, and all other components required to host an Oracle Database.

Flexible, scalable configurations

There are two versions of Exadata Database Machine (Table 1), all housed in a single rack. Both versions run the Oracle Database 11g* Release 2 database software. The X2-2 provides a convenient entry point to the Exadata Database Machine family with the largest degree of expandability in a single rack. The X2-8 is for large deployments with large memory requirements or a need to consolidate many databases into a single rack.

Exadata Database Machine architecture

Figure 4 illustrates a simplified schematic of a Database Machine deployment. The Real Application Clusters (RAC) house an Oracle database; a deployment can support multiple database instances. The database(s) share the Exadata Storage Servers (also called Exadata cells). All the components are housed in the Database Machine rack.

Oracle Exadata is architected to scale out to any level of performance. To achieve higher performance and greater storage capacity, additional database servers and Exadata Storage Servers can be added to the configuration. As more Exadata Storage Servers are added to the configuration, storage capacity and I/O performance increase nearly linearly.

Exadata is totally transparent to the application using the database. The exact same Oracle Database 11g Release 2 that runs on traditional systems runs on the Database Machine – but on the Database Machine it runs faster.

Exadata Database Machine X2-8

The Exadata Database Machine X2-8 combines the best of scale-up and scale-out architectures by delivering a grid architecture containing large SMP database servers. Before now, a 64-core SMP system required a full rack of equipment by itself, with limited scale-out capability. The Exadata X2-8 uses two of Sun System's new ultra-compact, 64-core Intel Xeon processor-based servers to create a high-performance, highly-available database grid.

The X2-8 has the same storage grid architecture as the X2-2 with 14 Exadata Storage Servers providing intelligent query offload, 10X data compression, 336 TB of raw storage, and up to 1.5 million I/Os per second on 5.3 TB of high-performance PCI flash. The Exadata X2-8 can be easily expanded to an eight-rack grid with 2,368 CPU cores and 2.6 petabytes of raw storage.

Exadata Storage Servers – The Exadata Storage Server hardware components were carefully chosen to match the needs of high-performance database processing, including using Intel Xeon processors. The Exadata software is optimized to take the best possible advantage of the hardware components and Oracle Database.

Hardware-supported encryption accelerates queries – Building on the high security capabilities in every Oracle Database, Exadata storage provides the ability to query fully encrypted databases with near-zero overhead at hundreds of gigabytes per second. This is done by moving decryption processing from software into the Exadata Storage Server hardware, where Intel Xeon processors provide hardware-based Intel® Advanced Encryption Standard – New Instructions[7] (Intel® AES-NI) decryption.

Table 1. Oracle Exadata* configurations

Component	Oracle Exadata* X2-2 Database Machine		Oracle Exadata 2-8 Database Machine
	X2-2 Minimum	**X2-2 Maximum**	
Number of Database Servers[a]	2 (24 cores total)	8 (96 cores total)	2 (128 cores total)
DB Server Configuration Cores/Socket Sockets/Server Cores/Server	6 cores/socket 2 sockets/server 12 cores/server	6 cores/socket 2 sockets/server 12 cores/server	8 cores/socket 8 sockets/server 64-cores/server
Memory	192 GB	768 GB	2 TB
Storage Servers[b]	3 Exadata Storage Servers	14 Exadata Storage Servers	14 Exadata Storage Servers

[a]Built on Intel Xeon processor 7500 series.
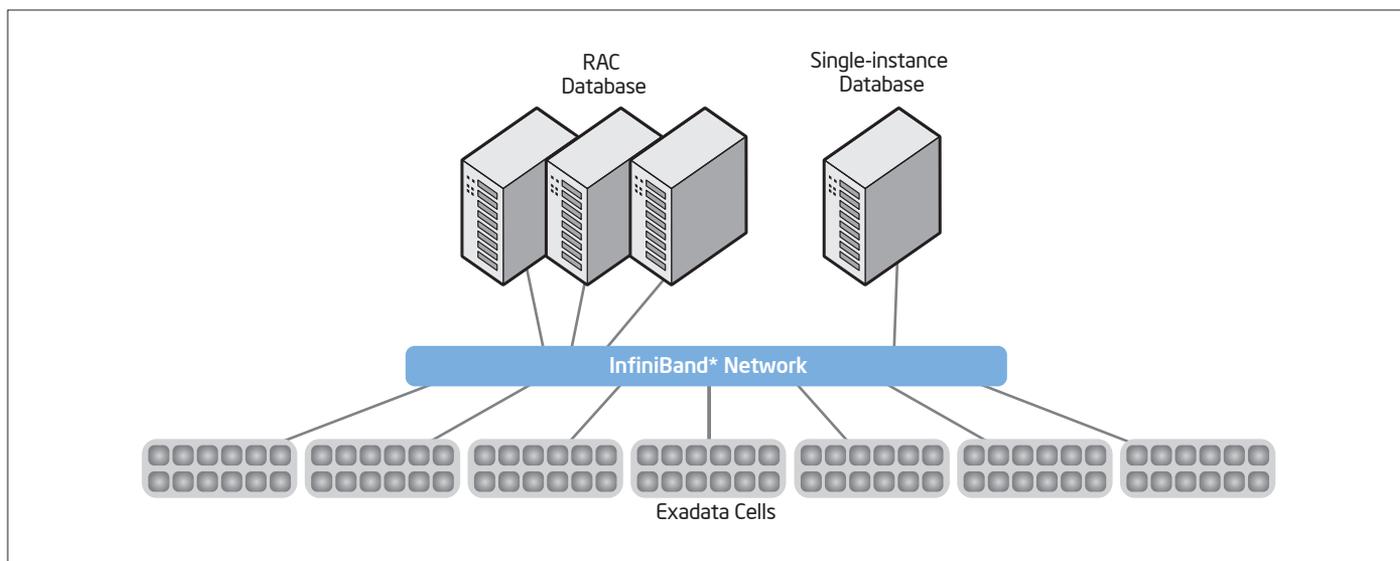[b]Built on Intel Xeon processors.

Figure 4. Oracle Exadata* Database Machine

Exadata Smart Flash Cache – Each Exadata Storage Server comes with 384 GB of Exadata Smart Flash Cache. With 14 servers in each Database Machine, there is 5.3 TB of Flash – larger than most databases. This solid state storage delivers dramatic performance advantages with Exadata storage. The Exadata software can simultaneously scan from Flash and disk to maximize bandwidth.

Oracle's high-performance solution

The Oracle Exadata Database Machine is designed to deliver I/O and SQL processing performance for OLTP, data warehousing (DW), and consolidation of mixed workloads that today's businesses demand. The system leverages a massively parallel grid architecture based on Real Application Clusters and Exadata storage to deliver nearly linear I/O scalability and mission-critical availability and reliability.

"The genesis of Exadata was to move database intelligence into storage, so we looked for a processor that provides a lot of processing power, lots of cores, very high I/O bandwidth, and would also have good power characteristics. Intel chips are perfect for that. We built capability into our database software to fully encrypt the database. Then the issue was that you make a tradeoff between performance and security. But Intel Xeon processors have built-in encrypt/decrypt, and that eliminates the tradeoff. So, we can deliver both security and performance; there's no performance tradeoff."

– Juan Loaiza, Senior Vice President, System Technologies, Oracle

SAP In-Memory Appliance (SAP HANA*)

Co-innovation between Intel and SAP has existed for more than a decade. The latest result of this engineering partnership is the excellent results from SAP In-Memory Appliance (SAP HANA) on the Intel Xeon processor 7500 series and Intel Xeon processor E7 family.

In-memory, real-time Business Intelligence

Today's organizations want business insight in real-time from all their operational data instead of from simplified models. But this takes real-time processing of massive amounts of data, which traditional disk-based databases cannot process within a reasonable time.

SAP focused on this IT problem set with its SAP HANA, an in-memory appliance that stores entire data sets in main memory instead of saving to disk. This allows organizations to instantly analyze all available data from multiple sources, so companies can gain insight into business operations in real-time. SAP HANA enables organizations to make better decisions, faster – and requires far less reliance on IT to gain the insight needed to deliver it.

SAP HANA software is optimized for Intel Xeon processors, including Intel Xeon processor 7500 series and Intel Xeon processor E7 family, and provided as an appliance by SAP's leading hardware partners.

Tuned for mission-critical computing

SAP's in-memory, real-time BI pushes processing-intensive operations from the application-server layer to the data layer, removing the need for resources to be invested on data transfers. Plus, the SAP HANA in-memory computing engine delivers technical breakthroughs at the most fundamental levels, such as CPU core utilization and massively parallel processing across nodes.

Performance – The SAP in-memory computing engine uses an in-memory columnar store to achieve breakthrough performance in scan, grouping, and aggregation operations that are the heart of analytics. Running exclusively on Intel Xeon processor 7500 series and Intel Xeon processor E7 family, SAP HANA can scan 2 million records per millisecond per core, and calculate over 10 million complex aggregations on the fly per second per core. This level of performance is the result of SAP HANA software design and optimization on the Intel Xeon processor 7500 series and Intel Xeon processor E7 family. SAP HANA takes advantage of the following:

▪ **Large and scalable memory –** Intel® Scalable Memory Interconnects support up to two terabytes of memory per server to deliver unmatched performance for memory-intensive SAP HANA workloads.

▪ **Optimized use of cache –** The Intel Xeon processor 7500 series' 24 MB L3 cache architecture increases the efficiency with which SAP HANA performs cache-to-cache data transfers, maximizing the bandwidth between the processor and main memory.

▪ **Fast inter-processor communications –** High-speed point-to-point connections between processors and with the I/O hub provide outstanding memory performance and flexibility for workloads.

▪ **SAP code is optimized by continuous performance improvements** of core database components on Intel Xeon processor reference platforms for next-generation Intel® microarchitectures and processors, and adaption of state-of-the-art microprocessor ISA extensions, like SSE4.x

Scalability – The core engine of SAP HANA was designed around a multi-core architecture, optimized on Intel Xeon processor 7500 series, Intel Xeon processor E7 family, and Intel microarchitecture. SAP HANA implements dynamic parallelization and dynamic partitioning for both OLAP and OLTP workloads, using adaptive, cache-aware algorithms. As a result, performance scales linearly across not only blades, but the number of cores per blade.

Mission-critical Reliability, Availability, and Serviceability (RAS) – The world's largest enterprises trust their mission-critical data to SAP systems. SAP HANA is enabled to survive hard memory errors under certain circumstances by actively handling Machine Check Architecture-recovery (MCA-r) events. MCA-r is a RAS feature of Intel Xeon processor 7500 series and Intel Xeon processor E7 family. This capability is implemented in the SAP code.

Benefits
SAP HANA enables organizations to analyze their business operations, using huge volumes of detailed information – in real time. Organizations can instantly explore and analyze all of their transactional and analytical data from virtually any data source across the organization, with far less reliance on IT to gain the insight needed to deliver it.
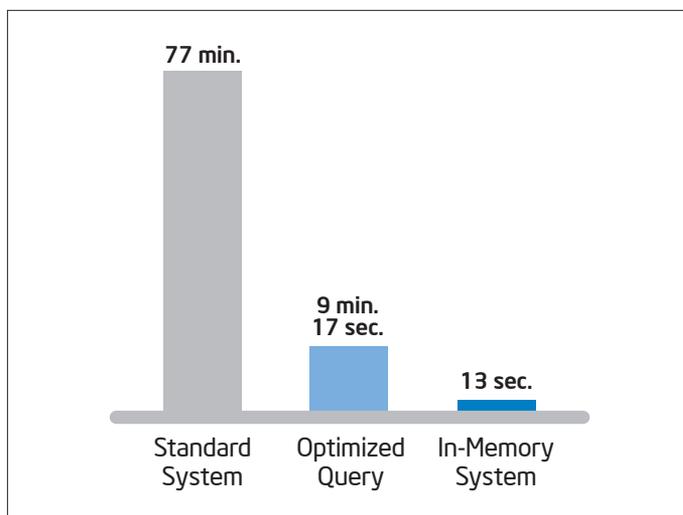

Figure 5. Query results from three scenarios (lower is better).

As a system platform, SAP HANA provides a foundation for delivering a host of next-generation in-memory computing applications, such as planning, forecasting, and simulations, plus enables rethinking data-intensive applications altogether.

Proven Results: Reduced Query Times – Figure 5 shows data queries from among the following scenarios.[8]

1. **Standard System:** a conventional query from a relational database.

2. **Optimized Query:** the same query as scenario 1, after task-specific tuning.

3. **In-Memory System:** a native query performed on an in-memory system, similar to SAP HANA.

SAP HANA, running on Intel Xeon processor 7500 series-based platforms and Intel Xeon processor E7 family-based platforms, offers a system that delivers scalable performance and mission-critical reliability at a dramatically favorable price point, relative to more expensive proprietary server platforms such as RISC.

"For over 10 years, SAP and Intel have collaborated to create visionary solutions that enable customers to gain competitive advantage and run better. SAP In-Memory Appliance (SAP HANA), delivered on the Intel Xeon processor, provides customers with real-time results from analyses and transactions that enable better decisions and improved operations. It's just the latest example of how game-changing innovation between industry leaders can alter how enterprises do business and succeed."

– Stefan Sigg, Senior Vice President In-Memory Platform, SAP

Entrepreneurial Software Innovators

In addition to the stalwarts of the mission-critical technology software sector, there are literally hundreds of emerging players that are building ever-more robust solutions on Intel Xeon processors. These solutions enhance daily business operations across a wide range of markets. Here are a few examples of innovative solution providers that have optimized on the Intel Xeon processor E7 family.

Cost-efficiently meeting performance and security demands of regulated securities

The systems that support stock transactions are as highly scrutinized as systems used across other key financial services. Kingdom Stock Transaction System, a China-based stock trading software solution provider, needed their software to inspire confidence among customers and regulators in terms of its reliability, availability, and serviceability (RAS), and especially its security. Plus their choice of system needed to scale to support very large implementations, while being energy efficient to meet strict budgets.

To achieve these goals, Kingdom Stock Transaction System optimized on the Intel Xeon processor E7 family. With built-in Intel AES-NI, Kingdom Stock Transaction System software delivers high levels of security to meet regulatory demands without compromising performance. Energy efficient with scalable performance, Intel Xeon processor E7 family-based platforms can maintain service levels to customers, while helping minimize operating costs.

To support continued high levels of service, performance, and security, Kingdom Stock Transaction System takes advantage of the resources available when optimizing on Intel architecture-based systems:

- **Relationships with Intel experts.** The company is in regular contact with application engineers from Intel, giving them access to the people who know the platform best, from the processor out. Day-to-day decisions by Kingdom Stock Transaction System engineers are informed by technical and business disclosures from Intel.

- **Intel® Performance Primitives (Intel® IPP).** Using these functions, which are highly tuned for the hardware, provides an excellent short-cut for Kingdom Stock Transaction System, and also helps ensure high performance. In addition, the functions are maintained by Intel, which streamlines optimization for future platforms.

- **Energy efficiency.** Drawing on the platform's features to reduce energy consumption gives Kingdom Stock Transaction System the ability to deliver very favorable results in terms of operating costs.

Delivering performance and reliability to connect a mobile world

The mobile-telecommunications field places a premium on supporting the largest possible number of transactions per server, while also maintaining very high levels of quality. By building performance and efficiency into its products, including the Aspire Info Mobile Telecom OSS Solution,* Aspire Info helps its customers reduce their total cost of ownership, with a positive impact on everyone's success.

Both Aspire Info Mobile Telecom and its customers have found that servers based on the Intel Xeon processor E7 family are an outstanding choice as the target platform for the company's mobile telecom solution. The exploding growth of China's mobile user base places extreme demands on server infrastructure, and the scalable performance, reliability, and energy efficiency of these platforms make them an excellent choice.

Deploying the Aspire Info Mobile Telecom OSS Solution on the Intel Xeon processor E7 family lets some of the leading mobile telecommunications providers in China add customers rapidly and cost-effectively. The solution delivers excellent quality and cost-effectiveness.

To help ensure that its customers will continue to meet the challenges of success in this world of opportunity, Aspire Info's solutions are engineered to take advantage of the Intel Xeon processor E7 family:

- **Optimization for the hardware.** Throughout the application life cycle, the team at Aspire Info evaluates the value their solution gets from hardware capabilities, such as symmetric multi-processing, Intel Hyper-Threading technology, and Intel Turbo Boost technology.

- **Direct contact with Intel engineers.** Aspire Info makes excellent use of technical and business disclosures provided by Intel application engineers to ensure that Aspire Info products are ready to get the full benefit of current and upcoming Intel platforms.

- **A focus on customers' bottom lines.** The quality and platform optimization built into the Aspire Info solution help ensure that customers can flexibly and cost-effectively support large numbers of end-users by means of the Intel Xeon processor E7 family.

Providing advanced intelligence at the speed of business

QlikTech's QlikView* product generates insights to support advanced decision making as fast as the company's business customers need it. QlikView uses in-memory database technology that contains the entire data store in system memory, eliminating the latency associated with disk access during queries. Highly optimized for the Intel Xeon processor E7 family, the solution combines speed advantages with very high scalability.

Companies that deploy QlikView on the latest Intel Xeon processor-based platforms can offer their users a rich, user-friendly business intelligence platform that takes advantage of familiar productivity tools. It also scales exceedingly well, delivering excellent value from hardware investments.

As adopters of advanced business intelligence technology, QlikTech's customers push the envelope. They place high demands on their compute resources, always pushing for more comprehensive analysis and reports to gain new insights into business trends and opportunities.

Because in today's business climate, it is more vital than ever to balance resource needs with budget realities, those customers are poised to benefit from the advantages in scalable performance enabled by the Intel Xeon processor E7 family. More cores, larger caches, and higher levels of accessible memory compared to predecessor platforms deliver higher performance and allow larger groups of users to do more with larger universes of business data.

To help their customers get the most out of their infrastructures, QlikTech has focused on a number of goals in optimizing the QlikView environment for the Intel Xeon processor E7 family:

▪ **Performance tuning.** QlikTech carefully follows optimization best practices to ensure that QlikView takes excellent advantage of the latest hardware features. In particular, their tuning process benefits from deep hotspot analysis using Intel® VTune™ Performance Analyzer.

▪ **Enhanced software parallelism.** Using Intel® Thread Profiler and Intel® Thread Checker, QlikTech created a robust threading model that takes excellent advantage of the large core count and Intel Hyper-Threading technology built into the latest Intel Xeon processors.

▪ **Ongoing platform testing.** Each new generation of server platforms represents an expanded set of opportunities for QlikTech to better meet its customers' needs, and the company tests its solution exhaustively against new platforms, such as the Intel Xeon processor E7 family to ensure smooth interoperability.

Reducing the cost of healthcare with highly scalable performance

Carestream Health is a worldwide provider of dental and medical imaging systems and healthcare IT solutions; molecular imaging systems for life science research and drug discovery/development; x-ray film and digital x-ray systems for non-destructive testing; and other products; and advanced materials for the precision films and electronics markets.[9]

For companies that make products to support the delivery of healthcare services, helping customers minimize TCO is a strategic imperative. To this end, Carestream Health set out to enable their medical imaging customers to reduce the capital and operational expenses associated with their picture archiving and communication system (PACS) solutions, providing greater operational efficiency for the customers and a competitive advantage for the solution provider.

The PACS used in medical imaging facilities are designed to economically provide rapid storage and retrieval of images and reports from multiple sites and using multiple modalities (such as MRI and CT imaging). Medical necessity requires that the PACS server infrastructure be able to provide high standards of service to large numbers of simultaneous operators. The Intel Xeon processor E7 family is well suited to those demands for highly scalable performance.

Without any platform-specific software optimization, Carestream SuperPACS* takes excellent advantage of the scalable performance features and capabilities of servers based on the Intel Xeon processor E7 family, including increased core count and larger last-level cache. The 1.28x performance of SuperPACS on the Intel Xeon processor E7 family, relative to the Intel Xeon processor 7500 series, equates to a higher number of users per server at customer locations.[10] That increase lets customers reduce the number of servers they need, for a healthier bottom line.

Carestream engineers have taken a multifaceted approach to ensuring that SuperPACS delivers excellent performance and readily takes advantage of the new platform's capabilities:

▪ **Multi-threading.** Carestream has built a proprietary threading library that efficiently divides tasks among the growing number of available processor cores.

▪ **Intel® Software Development Products.** Intel VTune Performance Analyzer helps locate hotspots and optimize the environment, while Intel Thread Profiler helps balance workloads on highly parallel hardware.

▪ **Industry best practices.** The SuperPACS development team keeps abreast on documentation from Intel on topics, such as performance optimization, and takes advantage of new memory subsystem architectures.

Carestream's ongoing diligence in enabling SuperPACS for the latest Intel architectures helps ensure that medical-imaging customers will continue to get optimal performance and value from their server investments.

Mission-critical in Action

Many Enterprise IT shops are making the switch to mission-critical computing solutions based on Intel Xeon processors. Here are a few examples.

Anixter

As a global distributor of communication and security products, electrical and electronic wire and cable, fasteners, and other small parts, Anixter maintains a complex inventory of more than 425,000 products. To keep revenue flowing for this Fortune 500 company, sales teams around the world need fast and highly reliable access to product information and to the company's inventory and ordering systems.

When business teams at Anixter wanted to deploy mission-critical applications that were not supported in its mainframe environment – yet were essential to its sales, ordering, and invoicing processes – a solution was needed to deliver comparable levels of service for the underlying database. Anixter found that solution in IBM DB2 pureScale running on IBM System x X5 servers powered by the Intel Xeon processor 7500 series.

Anixter was looking to upgrade two key business applications and add another.

- **VAT,** a new third-party vendor application, calculates taxes across the company's diverse global markets and integrates with Anixter's ordering system.

- **PCM,** an Anixter application based on third-party code, originates all product and parts information. It also populates Anixter's online and print catalogs, brochures, and other key sales and marketing publications.

- **eInvoice,** another Anixter application based on third-party software, publishes invoices for reprints and research. Unlike VAT and PCM, it operates in batch mode, imaging and electronically filing all invoices at the end of each day.

According to Bernie O'Connor, Director of Information Technology at Anixter, "Performance and scalability are important for all three applications. High availability is even more critical. Downtime would be disruptive to our sales, ordering, and invoicing processes. It could also impact our customers in negative ways, so we absolutely need to keep these applications up and running."

Anixter's IT department tested both performance and failover for the clustered solution, and O'Connor was more than happy with the results. "Performance is very impressive, and so is the resilience of the cluster. If a server goes down, DB2 pureScale recovers in milliseconds, and we

have continuous access to the data through the remaining servers. In most cases, this solution will completely shield our customers from a partial outage in our data center." The solution will also help reduce planned downtime, since it enables rolling maintenance of the servers without bringing down the cluster.

Anixter is currently evaluating an upgrade to the next-generation Intel Xeon processor E7 family for the clustered database servers. The upgrade would allow the database cluster to support heavier workloads without increasing the data center footprint or overall power consumption. And, with the built-in hardware encryption support of the Intel Xeon processor E7 family, Anixter could potentially use encryption more pervasively to protect business data, without overloading the database servers or slowing response times.

With IBM DB2 pureScale running on IBM System x3690 X5 servers based on Intel Xeon processor 7500 series, Anixter has found a powerful, flexible, and cost-effective database solution for supporting mission-critical applications for its global users. It has also established a foundation for supporting unpredictable growth and change in the future. With today's growing dependence on real-time, data-intensive business processes, that combination could provide substantial value for many other large and growing companies.

BMW[11]

With its BMW, MINI, and Rolls-Royce brands, the BMW Group concentrates exclusively on the premium segments of the international automobile and motorcycle markets. BMW Group's IT infrastructure is extensive and vital to the smooth running of the organization, supporting over 106,000 employees worldwide and 24 production sites in 13 countries. SAP enterprise software and business solutions form the backbone of this complex infrastructure and are used for a variety of mission-critical applications.

Increasingly complex management, spiraling costs, and the restrictions of being tied to a proprietary system, prompted Intel to help migrate BMW Group's worldwide SAP environment from a RISC infrastructure to x86 server architecture based on the Intel Xeon processor 7300 series.

Numerous UNIX*-based servers are being replaced with 400 IBM System x3650 and IBM System x3850 servers powered by the Intel Xeon processor 7300 series. This new x86-based architecture runs on a Linux* operating system, alongside an Oracle 10g* database. Consolidating onto standard Intel® x86-based architecture removes the complexity associated with managing a multi-vendor, RISC-based environment. Hardware utilization has improved, as it is now much easier to scale server resources to meet business needs, and the new rack-mounted servers take up much less floor space than the old RISC systems.

The new infrastructure offers greater operational and system flexibility thanks to its open standards architecture. Plus, performance has increased.

Together with Intel, BMW Group carried out an evaluation of the new server architecture. Using the SPECint CPU 2006 benchmark, it found that the Intel Xeon processor 7300 series performed 2.75-3X faster than the implemented RISC-based servers.[12]

In addition to the performance, the Intel Xeon processor 7300 series also offers greater energy efficiency. Based on the Intel® Core™ micro-architecture, it is manufactured using new materials, which significantly reduce electrical leakage. BMW Group has increased the number of servers deployed without increasing the power consumption as a result of these servers having lower levels of power consumption. Together, these benefits result in a lower total cost of ownership for the server infrastructure behind BMW Group's SAP enterprise software and business solutions.

NCH

NCH Corporation is a leading global provider of industrial maintenance solutions. When its European operation wanted to customize some of its operations, NCH decided to establish a new instance of its global Oracle database specifically for Europe. But it needed to do so without affecting the global business logic and at a more attractive cost than duplicating its existing 16-processor RISC-based platform.

The cost just to purchase the hardware to upgrade their current RISC-based environment would have been over a million dollars (US), and the ongoing maintenance and support costs would have been high as well, due to vendor lock-in. They discovered purchasing brand-new Intel Xeon processor-based systems was less expensive than buying used RISC equipment.

In addition to splitting the database while maintaining consistency, the company also examined the growth path for NCH's corporate database. They anticipated the need for a new database platform for the corporate system within two years. After working through a decision tree to develop the company's platform strategy going forward, managers realized the cost benefit of moving to Intel-based products was "huge." The company expects to save USD 5.5 million over five years in hard costs, while tripling performance, reducing risk, and delivering critical business functionality.

NCH's IT team created the new instance of the European database – replicating what ran on a 16-processor RISC platform – on an Intel Xeon processor 7540-based server with four six-core processors (24 cores total) running the Linux operating system. When the corporate instance is ready for a refresh in 2012, NCH will move it to the Intel processor-based platform as well.

The company's move is enabling operations in Europe to implement a very robust and well-planned solution that will streamline manufacturing and tie it to sales and customer relationship management. They're doing it on systems that are faster than the RISC platform. The hardware has been proven in NCH's business, and it has more flexible and convenient support.

Paycor

Founded in 1990, Paycor is one of the largest independently owned payroll processing service providers in the United States. Based in Cincinnati, Ohio, United States, the company has 19,000 clients, offices in 18 cities, and 550 employees.

On a busy day, Paycor executes 1.7 million transactions to support the processing of 130,000 paychecks. Payroll processing is characterized by peak workloads. For Paycor, the result is a very short production window in which to take in data, generate checks, process secure direct deposits, and handle wire transfers to banks. During these periods, delayed access to data while servicing clients on the phone can have a negative impact on quality of service.

Paycor is growing at 15 to 20 percent per year and expects to double revenue every three years. In the summer of 2010, Paycor knew that to keep up with growth the company needed to upgrade their IT infrastructure. To manage expected growth, they needed more performance headroom. They also needed more computing horsepower to maintain the superior one-to-one client service that is the heart of Paycor's business philosophy. And there was a sense of urgency. It was July, and any upgrade had to be completed by the end of November to lock down the systems in time for the peak loads generated by year-end tax reporting.

Paycor chose the HP ProLiant* DL980 server, because it delivers a combination that would meet the company's needs: exceptional x86 performance in an eight-socket architecture, high-availability architecture with Intel Xeon processors, and available Proactive Services.

Paycor's in-house-developed payroll processing software is the key to Paycor's outstanding service. Clients are able to get a secure log-in to directly access the application and their service associates. This gives clients a level of control and flexibility that is a major selling point for Paycor.

The two new DL980 servers are the database servers for the payroll processing application. Configured in a cluster of one active and one failover server, they provide both business continuity and the high performance required. Payroll processing is an exceptionally complex application that puts an extra burden on the database servers. The DL980 servers log and verify millions of transactions daily, and also perform numerous calculations needed to generate paychecks.

The new infrastructure began to prove itself right away. Prior to the new server implementation, Paycor maintained 75 percent to 80 percent CPU utilization during peak processing times, but with the new DL980 servers, the CPU maintained below 20 percent utilization. User response has also been enthusiastic with initial data downloads for new customers running twice as fast.

The new servers help give Paycor a competitive advantage. The DL980 servers give Paycor customer associates the level of processing and I/O performance they need to provide clients with quick, accurate information. By helping Paycor associates be more efficient, the performance of the DL980 servers results in higher client satisfaction.

United States Customs and Border Protection (CBP)

CBP is the United States of America Department of Homeland Security (DHS) agency responsible for securing the borders of the United States of America, while it simultaneously facilitates the flow of legitimate trade and travel. It is the largest law enforcement organization of sworn officers in the U.S. Its charter to prevent terrorism, balance trade and travel with security, and protect America while modernizing and managing for results is a complex and difficult challenge, especially in the face of deep budget cuts.

With over 40,000 square feet of "raised floor" space in a data center more than 70,000 square feet in size, CBP maintains the largest data center in the DHS. It takes over 2,000 government employees and more than 3,000 contractors to operate and maintain it. On a typical day it will process

- 1.1 million passengers and pedestrians
- Nearly 300,000 incoming international air passengers
- Over 43,000 persons arriving by ship
- Nearly 71,000 truck, rail, and sea containers
- Over 330,000 incoming privately owned vehicles
- 85,300 shipments of goods approved for entry
- Collect $90.4 million in fees, duties, and tariffs
- Analyze over 400 lab and forensic samples

And that does not include the daily enforcement and operation actions.

The CBP manages hundreds of communications sites using thousands of radio circuits supporting tens of thousands of radio subscribers. Its data systems use more than 6.5 petabytes of SAN/NAS storage with 45 petabytes of total storage, supporting 5,400 servers and 1.35 billion messages per day. It claims the largest IBM MQSeries* message processing organization in the world.

CBP solutions depend on being robust, secure, scalable, and adaptable to meet changing user requirements and demands. And the organization faces one of its most difficult challenges ever: to implement departmental mandates of modernization and increased efficiencies, while preserving quality of service, in an environment of deep budget cuts.

They are accomplishing these goals by changing the infrastructure to improve efficiencies, leveraging cost-effective managed servers, automating management, leveraging enterprise services and partners, and building applications and services, not systems that require a massive support and maintenance infrastructure.

Part of this strategy relies on deploying prebuilt appliances, optimized for the workloads it processes and built and backed by world-class vendors. This allows CBP to merely provide operators, processes, and the data.

One of its key deployment solutions is Oracle Exadata Database Machine built on Intel Xeon processor 7500 series. CBP is the largest Exadata user in the United States with 15 Exadata Database Machines in operation. CBP found their Oracle Exadata Database Machine deployments were one-quarter the cost of their aging SMP mainframe, ran 10X faster, and easily scaled out using industry-standard Intel Xeon processor-based servers.

Deploying Oracle Exadata Database Machines supported CBP's requirements of lower cost of ownership, scalability, high availability, security, open interfaces, and integration with other products.

Conclusion

The great IT challenge to manage exploding data repositories and deliver on business intelligence services is made easier with enterprise-class, mission-critical solutions built on Intel Xeon processors. From the IBM DB2 pureScale database and Oracle Exadata Database Machine, to Microsoft SQL Server R2 2008 with PowerPivot and SharePoint Server, and SAP In-Memory Appliance (SAP HANA), high-performance solutions are readily available for the most challenging database and BI issues today. And these industry leaders are not alone, with literally hundreds of software vendors across the globe – large and small – optimizing on Intel Xeon processor-based systems.

These vendors have chosen to work with Intel closely to optimize their software on platforms based on Intel Xeon processors, including Intel Xeon processor 7500 series and Intel Xeon processor E7 family, which deliver scalable performance, enhanced RAS features, and built-in security acceleration, along with many other Intel microarchitecture technologies, making Intel Xeon processors a key component in delivering high-end solutions that are changing the economics of mission-critical computing in today's IT data centers.

Data centers around the world have chosen these solutions based on Intel Xeon processors for their performance, scalability, reliability, and economic returns. As IT managers and CIOs look for new solutions to their growing data and BI challenges, they should consider what others have done and why, and critically examine these, and other, enterprise-class solutions optimized for Intel Xeon processors.

Intel® Xeon® Processor E7 Family

With more mission-critical computing solutions being optimized for Intel® Xeon® processors, the Intel® Xeon® processor E7 family is designed for the highest-end computing solutions that enterprise IT services demand. The Intel Xeon processor E7 family enables business software solutions to deliver incredibly fast answers to the toughest business questions at costs below proprietary, RISC-based systems with the reliability IT managers expect from their high-end computing systems.
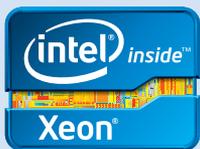
Optimized Performance

- Up to 10 cores and 20 threads with Intel® Hyper-Threading technology, 30 MB of last-level cache, and supporting up to 32 GB DIMMs – 25 percent more cores, threads, and cache than Intel® Xeon® processor 7500 series.

- Intel® QuickPath Interconnect accelerates communications between processors and between the processors and I/O hub. Tightly integrated RAS features improve system and application uptimes. Systems can be scaled from two to eight sockets, and higher with third-party node controllers.

- Quad Channel Integrated Memory Controller enables up to 1 TB of memory with 16 GB DIMMs in a 4-socket system (up to 2 TB in an eight-socket system).

- The Intel Xeon processor E7 family, with Intel® Intelligent Power Technology,[13] delivers higher performance from 25 percent more cores, threads, and last-level cache, *at the same maximum rated power (TDP)* as the Intel Xeon processor 7500 series. The Intel Xeon processor E7 family cores can independently shut down to 0W when idle, and the entire processor can reach near-0W power at idle.

Enhanced Security Performance

- Intel® Advanced Encryption Standard – New Instructions (Intel® AES-NI) deliver a high-performance engine for online transactions and ubiquitous, enterprise-wide data protection using supported software from leading vendors, such as Oracle, Microsoft, and McAfee.

Advanced Reliability, Availability, and Serviceability (RAS)

The latest Intel Xeon processor E7 family can be expected to dramatically accelerate the trend toward using open system solutions for business-critical applications requiring 24/7 application availability. To satisfy today's high availability requirements, these processors provide more than 20 advanced reliability, availability, and serviceability (RAS) features often seen in high-end RISC-based servers.

Broad operating system (OS) support is available for these advanced RAS features today, and hardware vendors are delivering scalable and highly resilient servers that are ideal for mission-critical applications and large-scale consolidation. Depending on the vendor and OS, these systems provide:

- Superior data integrity with advanced support for error detection, correction, and containment across all major components and communication pathways.

- High system and application availability with multiple levels of redundancy using advanced failover capabilities built in at the silicon level, and OS-assisted system recovery from certain uncorrectable errors that would have brought down previous-generation servers.

- Predictive failure analysis to detect failing components and notify IT before they cause problems.

- Static hard partitioning with electrical isolation to provide strong workload isolation to satisfy service level agreements and support efficient maintenance cycles.

Hardware-supported Virtualization

- Intel® Virtualization Technology,[14] a suite of processor hardware enhancements, which assist virtualization software to deliver more efficient virtualization solutions and greater capabilities including 64-bit guest OS support.

Resources

The following non-Intel sources provided content for this white paper.

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Insight. Messages from Oracle OpenWorld 2010: Exadata Exceeds Expectation and MySQL Thrives, IDC, 2010.

National City Standardized on Red Hat* Enterprise Linux* to Scale in Support of Rapid Business Growth. Red Hat, Inc., 2009.

[1] Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information on performance tests and on the performance of Intel products, go to: http://www.intel.com/performance/resources/benchmark_limitations.htm.

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- Intel, procecomputer system can provide absolute security under all conditions. Intel® Trusted Execution Technology (Intel® TXT) requires a computer system with Intel® Virtualization Technology, an Intel TXT-enabled processor, chipset, BIOS, Authenticated Code Modules and an Intel TXT-compatible measured launched environment (MLE). Intel TXT also requires the system to contain a TPM v1.s. For more information, visit http://www.intel.com/technology/security.

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- Intel does not control or audit the design or implementation of third party benchmarks or Web sites referenced in this document. Intel encourages all of its customers to visit the referenced Web sites or others where similar performance benchmarks are reported and confirm whether the referenced benchmarks are accurate and reflect performance of systems available for purchase.

Relative performance is calculated by assigning a baseline value of 1.0 to one benchmark result, and then dividing the actual benchmark result for the baseline platform into each of the specific benchmark results of each of the other platforms, and assigning them a relative performance number that correlates with the performance improvements reported.

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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, reference www.intel.com/software/products.

Sun SPARC Enterprise M4000 Server (2009): 4 SPARC64 VII processor, 2.66 GHz, 4 cores/processor, 64 GB memory, Solaris 10 9/10, Oracle Solaris Studio 12.2, SPECint_rate_base2006* result: 158, SPECint_rate2006 result: 179.

https://shop.sun.com/store/product/ba987151-d0cc-11db-9135-080020a9ed93; Pricing for Oracle M4000 server, $80,738, 4x 2.66 GHz SPARCVII+, 32 GB memory (16 x 2GB DIMMs), 2x 146 GB 10k RPM SAS HDDs, 1 CD-RW/DVD-RW, Solaris 10 pre-installed.

Oracle SPARC T3-4 (2011): 4x SPARC T3 processors 1.65 GHz, 16 cores/chip, 8 threads/core, 512 GB memory (64 x 8GB DIMMs), Oracle Solaris 10 9/10, Oracle Solaris Studio 12.2,), SPEC int_rate_base2006 = 614, SPECint_rate2006 = 666

https://shop.sun.com/store/product/578414b2-d884-11de-9869-080020a9ed93; Oracle T3-4 pricing: $86,817.00: 4x SPARC T3 processors 1.65 GHz 16-core, 128 GB memory (32 x 4GB DIMMs), 2 x 300 GB 10k RPM SAS HDDs, Solaris 10 9/10, Oracle VM 2.0, Electronic Prognostics 1.1 pre-installed.

IBM Power 750 Express, 4 Power7 processors, 4 chips, 8 cores/chip, 3.55 GHz with energy optimization up to 3.86 GHz, 256GB DDR3 memory, RedHat Enterprise Linux Server Release 6.0, IBM XL C/C++ for Linux, V11.1 updated with Nov10 PTF, SPECint_rate_base2006 result 1020, SPECint_rate2006 result 1140, http://www.spec.org/cpu2006/results/res2010q4/cpu2006-20101108-13737.html; IBM Power 750 Express Pricing: 4x 3.55 GHz Power7 processors, 128 GB memory, 2x73.4 GB SFF SAS 15k rpm HDDs. Pricing: $200,000 per call quote on 3/3/2011 for model 8233-E8B13.

IBM Power 795 server, 4 Power7 processors, 4 chips, 8 cores/chip, 4.04GHz with energy optimization up to 4.14GHz, 256GB DDR3 memory, IBM Aii v7.1, IBM XL C/C++ for AIX, V11.1; SPECint_rate_base2006 result 1270, SPECint_rate2006 result 1440; http://www.spec.org/cpu2006/results/res2010q3/cpu2006-20100817-12973.html; IBM Power 795 server pricing starts at $500,000: http://www.pcworld.com/businesscenter/article/203422/ibm_unleashes_256core_unix_server_its_biggest_yet.html.

Intel Xeon Processor E7-4870. Based on Intel Internal measurements SPECint_rate_base2006 result 1010 on Intel internal testing with pre-production hardware, assumes price of $40k with 128 GB memory, 2 HDDs.

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While Intel believes our compilers and libraries are excellent choices to assist in obtaining the best performance on Intel® and non-Intel microprocessors, Intel recommends that you evaluate other compilers and libraries to determine which best meet your requirements. We hope to win your business by striving to offer the best performance of any compiler or library; please let us know if you find we do not.

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[2] Gartner Group 2009: Hot Trends and Innovations in Data Centers.

[3] Requires an Intel® HT Technology enabled system, check with your PC manufacturer. Performance will vary depending on the specific hardware and software used. Not available on Intel® Core™ i5-750. For more information including details on which processors support HT Technology, visit http://www.intel.com/info/hyperthreading.

[4] Requires a system with Intel® Turbo Boost Technology capability. Consult your PC manufacturer. Performance varies depending on hardware, software and system configuration. For more information, visit http://www.intel.com/technology/turboboost.

[5] 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, Go to: http://www.intel.com/performance/resources/benchmark_limitations.htm.

[6] 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, Go to: http://www.intel.com/performance/resources/benchmark_limitations.htm.

Warehouse On-Line Transaction Processing (OLTP) Performance benchmark

TPC Benchmark* C (TPC-C) performance benchmark

TPC-C is an OLTP (online transaction processing) benchmark developed by the Transaction Processing Performance Council (TPC). The TPC-C benchmark defines a rigorous standard for calculating performance and price/performance measured by transactions per minute (tpmC) and $/tpmC, respectively. More information is available at http://www.tpc.org/.

Competitive numbers shown reflect results published on www.tpc.org as of 25 August 2010. The comparison presented is based on the best non-clustered, 4-socket results.

4S Intel® Xeon® processor 7140M based platform details: Hewlett-Packard* ProLiant* ML570 G4 platform with four Intel Xeon processors 7140M (16MB L3 cache, 3.40GHz, 1066MHz FSB), 64GB memory, Microsoft* SQL Server* 2005 Enterprise x64 Edition SP1. Referenced as published at 318,407 tpmC @ $1.88 / tpmC available 4/19/2007. Source: http://www.tpc.org/tpcc/results/tpcc_result_detail.asp?id=106101901 as of August 25, 2010.

4S Intel® Xeon® processor X7350 based platform details: HP ProLiant DL580 G5 2.93GHz 2x4MB L2, Intel Xeon QC 2.93GHz 2x4MB L2 cache, 128 GB Memroy, Windows Server 2003 Enterprise x64 Edition R2, Microsoft SQL Server 2005 Enterprise x64 Edition SP2, Referenced as published at 407,079 tpmC @ USD $1.71 available 9/5/2007, http://tpc.org/results/individual_results/HP/HP_ProLiant_DL580G5_080507_es.pdf

4S Intel® Xeon® processor X7460 based platform details: Hewlett-Packard* ProLiant* DL580 G5 server platform with four Intel® Xeon® processors X7460 (16MB cache, 2.66GHz, 1066MHz FSB), 256GB memory, Oracle Database 11g Standard Edition. Referenced as published at 639,253 tpmC @ $0.97 / tpmC available 1/26/2009. Source: http://www.tpc.org/tpcc/results/tpcc_result_detail.asp?id=109012001 as of August 25, 2010.

4S Intel® Xeon® processor X7560 based platform details: HP ProLiant* DL580 G7 server using four Intel Xeon processors X7560 (24M cache, 2.26GHz, 6.40GT/s Intel QPI), 1TB memory, Microsoft SQL Server 2005 Enterprise x64 Edition SP3. Referenced as published at 1,807,347 tpmC @ $0.49 / tpmC available 10/15/2010. Source: http://www.tpc.org/tpcc/results/tpcc_result_detail.asp?id=110083001 as of August 25, 2010.

[7] Intel® AES-NI requires a computer system with an AES-NI enabled processor, as well as non-Intel software to execute the instructions in the correct sequence. AES-NI is available on Intel® Core™ i5-600 Desktop Processor Series, Intel® Core™ i7-600 Mobile Processor Series, and Intel® Core™ i5-500 Mobile Processor Series. For availability, consult your reseller or system manufacturer. For more information, see http://software.intel.com/en-us/articles/intel-advanced-encryption-standard-instructions-aes-ni/.

[8] Internal SAP results performed with SAP Business By Design and the SAP In-Memory Computing Engine on a simulated workload, identifying outstanding accounts receivable items in a data store of 154,000 business partners. Within the data set, approximately 1.8 million rows were read and 70 items for each of 1,000 partners were selected. System configuration: server based on four Intel® Xeon® processors X7560, with eight physical (16 logical) cores per processor.

[9] http://www.carestream.com/history-company.html.

[10] Performance testing by Intel and Carestream Health. Configurations: Intel® Xeon® processor E7 family at 2.4 GHz, 64-GB RAM, Microsoft Windows Server* 2008 R2, Carestream SuperPACS* 11.3, Intel® Hyper-Threading Technology disabled, Intel® Turbo Boost Technology enabled, NUMA disabled. Intel Xeon processor 7500 series at 2.06 GHz, 64-GB RAM, Microsoft Windows Server 2008 R2, Carestream SuperPACS 11.3, Intel Hyper-Threading Technology disabled, Intel Turbo Boost Technology enabled, NUMA disabled. http://www.intel.com/assets/PDF/casestudies/MC_Carestream.pdf.

[11] BMW Case Study: http://www.intel.com/references/pdfs/bmwdriving.pdf.

[12] 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, reference http://www.intel.com/performance/resources/benchmark_limitations.htm.

[13] 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.

[14] Intel® Virtualization Technology requires a computer system with an enabled Intel® processor, BIOS, virtual machine monitor (VMM). Functionality, performance or other benefits will vary depending on hardware and software configurations. Software applications may not be compatible with all operating systems. Consult your PC manufacturer. For more information, visit http://www.intel.com/go/virtualization.