SUMMIT

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Intel® Xeon® Processor 7500 Series Servers: A Catalyst for Mission-Critical Transformation

Robert Shiveley
Product Manager, Mission Critical Servers, Data Center Group
Intel Corporation
Date: June 23, 2010 - 11:30am
Agenda

• Growing Demand for Big Servers
• Xeon® 7500 Processor
• Scalable Performance
• Flexible Virtualization
• Advanced Reliability
• Catalyst for Mission Critical Transformation
Emerging Server Trends

- Business Intelligence & Large In-memory Databases
- HPC Bigger Science Workloads
- Bigger Database, CRM and ERP Workloads
- Mission Critical High Availability Workloads
- Business Critical Virtualization Workloads
- Data Center Simplification (incl VM sprawl)
- Multi-tier Application Consolidation

Market Trends Driving Need for Ever-More Capable Hardware
Business Trends Driving Data Center Requirements

- Data Warehousing / Business Intelligence
  - More databases
  - Larger databases
  - More users, reports, applications
  - Approaching real-time, continuous analytics
- BI become integral to operational decision-making
  - Users need real-time data
  - Increasing pressure to provide timely BI reports

650% Growth in IT Data over the next 5 years¹

¹ source: Gartner Group 2009: “Hot Trends and Innovations in Data Centers”

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Business Intelligence (analytics) becoming more pervasive, sophisticated and cost-effective for business

“We have reached the point in the improvement of performance and costs that we can afford to perform analytics and simulation for each and every action taken in the business.”

Gartner

 “[Today] organizations are capturing ever-more relevant data, structured and unstructured, to inform their business decisions. And at their disposal are more sophisticated software tools (and cheaper underlying processing power) to identify patterns and make correlations in that data with greater accuracy”

InformationWeek
Delivering on SLAs As Information Requirements Grow

- BI/DW has evolved from off-line, batch processing to 24x7 real-time, all-the-time
- Data growth impacts more than storage…
- Performance requires keeping up with growth in: cache, memory, I/O, thread support
- High availability reaquires advanced RAS across all platform components (HW+SW)
Growing Demand for Big Servers

Cloud Computing
26% CAGR ’09-13

Data Growth & Information Demand

Real Time Business Intelligence

High Performance Computing

650% Data Growth
$6.8B Market by 2013

$11.1B Market by 2013, Supercomputers $3.8B

1 IDC eXchange, Worldwide IT Spending On Cloud Services, Cloud Computing 2010 An IDC Update, October 2009
2 Gartner Group “Hot Trends and Innovations in Data Centers” over next 5 years, 2009
3 IDC Multiclient Study Worldwide Server Workloads, June 2009

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Today’s High-End Computing Challenges
Current Usages and Trends Drive Hardware

Bigger Workloads

Higher & Bigger VM Densities

Accelerating Platform and Datacenter Modernization

High Performance Computing Super Nodes

Ongoing ROI and TCO Focus

Mission Critical Workloads require:

Application Performance

Scalability

High Availability

Best Performance/$ at Capacity
Agenda

• Growing Demand for Big Servers
• Xeon® 7500 Processor
• Scalable Performance
• Flexible Virtualization
• Advanced Reliability
• Catalyst for Mission Critical Transformation
Introducing the Intel® Xeon® 7500 Series Processor

Based on the Next Generation Intel® Microarchitecture

A New Generation of Intelligent Servers
Intel® Xeon® 7500 Series: Capable of handling the biggest workloads

Mission Critical Workload Categories

- Medium to Large Database
  - Database consolidation
  - Large monolithic databases
- Large In-Memory Applications
  - Business analytics (BI), point-of-purchase, real-time authorizations
- Virtualization of larger workloads
  - ERP, CRM, LOB applications
- Higher levels of server consolidation
  - Increasing VM density levels
- End-to-End Solutions-In-A-Box
  - Emerging model

Intel Xeon 7500 8-Socket System

Xeon 7500-based systems support Mission Critical workloads
• Transforming the Big-Server Market
• Xeon® 7500 Processor
• Scalable Performance
• Flexible Virtualization
• Advanced Reliability
• Catalyst for Mission Critical Transformation
### Intel® Xeon® Processor 7500 Performance Records

<table>
<thead>
<tr>
<th>#1 World Record</th>
<th>#1 x86 Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>64S SPECint* _rate_base2006</td>
<td>64S SPECfp* _rate_base2006</td>
</tr>
<tr>
<td>10,400 score</td>
<td>6,840 score</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#1 World Record</th>
<th>#1 8-Socket Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>8S TPC Benchmark* E</td>
<td>8S SAP* SD 2-Tier (Unicode)</td>
</tr>
<tr>
<td>3,141 tpsE @ $768.92/tpsE (8P/64C/128T)</td>
<td>16,000 Benchmark Users</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#1 Two-Tier Record</th>
<th>#1 8-Socket Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>4S SAP BI Datamart</td>
<td>8S SPECjbb*2005</td>
</tr>
<tr>
<td>854,649 query navigation steps</td>
<td>3,321,826 BOPS @ 103,807 BOPS/JVM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#1 4-Socket Record</th>
<th>#1 4-Socket Windows* Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>4S TPC Benchmark* E</td>
<td>4S SAP* SD 2 Tier (Unicode)</td>
</tr>
<tr>
<td>2,022 tpsE @ $493.92/tpsE (4P/32C/64T)</td>
<td>10,450 Benchmark Users</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#1 single-node World Record</th>
<th>#1 single-node Record</th>
<th>#1 4-Socket x86 Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>4S SPECjAppServer*2004</td>
<td>4S LS-Dyna* Crash Simulation</td>
<td>4S SPECint* _rate_base2006</td>
</tr>
<tr>
<td>11,057 JOPS@Standard</td>
<td>41,727 seconds car2car</td>
<td>723 score</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#1 World Record</th>
<th>#1 2-Socket Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>4S VMmark* v1.1</td>
<td>2S SPECjbb*2005</td>
</tr>
<tr>
<td>71.85 score @ 49 tiles</td>
<td>1,011,147 BOPS @ 126,393 BOPS/JVM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#1 2-Socket x86 Record</th>
<th>#1 2-Socket Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>2S SPECint* _rate_base2006</td>
<td>2S SPECjbb*2005</td>
</tr>
<tr>
<td>362 score</td>
<td>1,011,147 BOPS @ 126,393 BOPS/JVM</td>
</tr>
</tbody>
</table>

### Over 20 New x86 Server World Records!


1. NEC: Availability is June 24, 2010.
2. NEC x86 server is planned to be generally available March 31, 2010. The total solution availability for the TPC-E benchmark is July 30, 2010.
3. 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.

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<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Xeon X7460 Baseline</th>
<th>Intel® Xeon® Processor X7560</th>
<th>Relative results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Bandwidth (GB/s)</td>
<td>1.0</td>
<td>8.24</td>
<td>Higher is better</td>
</tr>
<tr>
<td>SPECfp* _rate_base2006</td>
<td></td>
<td>3.82</td>
<td></td>
</tr>
<tr>
<td>VMmark*</td>
<td></td>
<td>3.50</td>
<td></td>
</tr>
<tr>
<td>SAP* SD 2-tier</td>
<td></td>
<td>3.42</td>
<td></td>
</tr>
<tr>
<td>SPECjbb*2005</td>
<td></td>
<td>3.18</td>
<td></td>
</tr>
<tr>
<td>TPC Benchmark* E</td>
<td></td>
<td>2.77</td>
<td></td>
</tr>
<tr>
<td>SPECint*_rate_base2006</td>
<td></td>
<td>2.64</td>
<td></td>
</tr>
<tr>
<td>SPECjAppServer*2004</td>
<td></td>
<td>2.51</td>
<td></td>
</tr>
<tr>
<td>Xeon®X7460 Baseline</td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

Xeon X7460 = Intel Xeon processor X7460 (16M Cache, 2.66GHz, 1066MHz FSB, formerly codenamed Dunnington)
Xeon X7560 = Intel Xeon processor X7560 (24M Cache, 2.26GHz, 6.40GT/s Intel® QPI, formerly codenamed Nehalem-EX)

Source: Best published / submitted results comparison of best 4-socket Xeon X7460 and X7560 models as of March 26, 2010. See previous “Broad Performance Claim” foil and notes for more information.

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• Transforming the Big-Server Market
• Xeon® 7500 Processor
• Scalable Performance
• Flexible Virtualization
• Advanced Reliability
• Catalyst for Mission Critical Transformation
Intel® Xeon® 7500 Series optimizes virtualization through processor, chipset, and I/O Enhancements

Consolidation
More Resources, Hardware Assist

CapEx and OpEx Reduction
Improved Utilization

Live Migration
Enhanced I/O, Compatible Architecture

Fluid Movement of VMs Over Network

Virtualization Enables Investment Protection, Versatility and Flexibility
Xeon® 7500: Meeting the Highest Virtualization Needs

**Xeon® 7500**
- 8C/16 threads per socket
- 2-256 socket scaling
- 256GB memory per skt
- 2X I/O capacity
- Mission Critical RAS

**Intel Platform Virtualization Technologies**
- Intel® VT-x Processor
- Intel® VT For Directed I/O Chipset
- Intel® VT For Connectivity Network

**Intel® VT Flex Migration**

- **Large Scale, Mission Critical Virtualization (>8GB)**
- **Infrastructure Consolidation (of multi-tier Applications)**
- **Headroom for Peak & Unpredictable Demand**
- **Live Migration of Big Workloads**

**Optimized for the most demanding virtualization workloads**

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Advanced Reliability Starts With Silicon; and Requires An Ecosystem

System

Software

Silicon

Sophisticated Workload Management & Tools

Mission Critical OS

OEM Innovation

Optimized for Next Generation Database & Apps

Intel Xeon 7500 Series-based Solutions Span Silicon, OS, System
## Advanced Reliability Starts With Silicon

### Xeon® Processor 7500 Series Reliability Features

#### Memory
- Inter-socket Memory Mirroring
- Intel® Scalable Memory Interconnect (Intel® SMI) Lane Failover
- Intel® SMI Clock Fail Over
- Intel® SMI Packet Retry
- Memory Address Parity
- Failed DIMM Isolation
- Memory Board Hot Add/Remove
- Dynamic Memory Migration*
- OS Memory On-lining *
- Recovery from Single DRAM Device Failure (SDDC) plus random bit error
- Memory Thermal Throttling
- Demand and Patrol scrubbing
- Fail Over from Single DRAM Device Failure (SDDC)
- Memory DIMM and Rank Sparing
- Intra-socket Memory Mirroring
- Mirrored Memory Board Hot Add/Remove

#### I/O Hub
- Physical IOH Hot Add
- OS IOH On-lining *
- PCI-E Hot Plug

#### CPU/Socket
- Machine Check Architecture (MCA) recovery
- Corrected Machine Check Interrupt (CMCI)
- Corrupt Data Containment Mode
- Viral Mode
- OS Assisted Processor Socket Migration*
- OS CPU on-lining *
- CPU Board Hot Add at QPI
- Electronically Isolated (Static) Partitioning
- Single Core Disable for Fault Resilient Boot

#### Intel® QuickPath Interconnect
- Intel QPI Packet Retry
- Intel QPI Protocol Protection via CRC (8bit or 16bit rolling)
- QPI Clock Fail Over
- QPI Self-Healing

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Over 20 New RAS features across the entire platform

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Advanced RAS Delivers Value For IT

Protects Your Data
- Reduces circuit-level errors
- Detects data errors across the system
- Limits the impact of errors

Increases Availability
- Heals failing data connections
- Supports redundancy and failover for key system components
- Recovers from uncorrected data errors

Minimizes Planned Downtime
- Helps predict failures before they happen
- Maintain partitions instead of systems
- Proactively replace failing components

Support for Highly Available System Deployments
- Parity Checking And ECC
- Memory Thermal Throttling
- Memory Demand & Patrol Scrubbing
- Corrupt Data Containment Mode
- Viral Mode
- Intel QPI Protocol Protection Via CRC (8bit Or 16bit Rolling)
- MCA Recovery With OS Support
- Intel® SMI Lane Failover
- Intel® SMI Clock Fail Over
- Intel® SMI & QPI Packet Retry
- QPI Clock Fail Over
- QPI Self-healing
- SDDC Plus Random Bit Error Recovery
- Memory Mirroring
- Memory DIMM And Rank Sparing
- Dynamic CPU And Memory Migration
- Electronically Isolated (Static) Partitioning
- MCA Error Logging (CMCI) With OS Predictive Failure Analysis
- Memory Board Hot Add/Remove
- OS Memory On-lining*
- CPU Board Hot Add At QPI
- OS CPU On-lining

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Delivering System Reliability, Availability, & Serviceability

- Detect And Correct Errors Where Possible
- Recover From Uncorrectable Errors
- Prevent Future Errors
Scalable Memory Subsystem Error Detection & Correction

**Demand and Patrol Scrubbing:**
- Proactively searches for memory errors
- If an error is detected, data is written back corrected or contained if uncorrectable

**Explicit Write-Back:**
- Proactively checks for errors as data is written from last level cache
- If an error is detected, data is written back corrected or contained if uncorrectable

**Single DRAM Device Data Correction Plus 1 Bit:**
- Failover from single DRAM device error
- Single bit error correction continues after DRAM failover
Built-In Redundancy & Failover Throughout

**Socket Redundancy & Failover**
- Dynamic OS Assisted Processor Socket Migration*
- Electronically Isolated (Static) Partitioning

**Memory Redundancy & Failover**
- Inter-socket Memory Mirroring
- Intra-socket Memory Mirroring
- Intel® SMI Lane Failover
- Intel® SMI Clock Fail Over
- Intel® SMI Packet Retry
- Memory DIMM and Rank Sparing
- Dynamic Memory Migration
- Fail Over from Single DRAM Device Failure (SDDC)
- Recovery from Single DRAM Device Failure (SDDC) plus random bit error

**Intel® QPI Redundancy & Failover**
- QPI Self-Healing
- QPI Clock Fail Over
- Intel QPI Packet Retry

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Intel® QPI = Intel® QuickPath Interconnect
Intel® SMI = Intel® Scalable Memory Interconnect
Intel® QuickPath Interconnect (QPI) Self-Healing

• Intel® QPI Self-Healing maintains system availability in the event of persistent interconnect errors

• On detecting persistent errors the QPI port automatically reduces to half the current width and keeps operating at a reduced level

• The system administrator sets the threshold at which to go into self-healing mode
**Intel® Scalable Memory Interconnect (SMI) Lane Failover**

- Intel® SMI allows the memory interconnect to automatically failover and recover from partial link failures maintaining availability and performance.
- Intel® SMI provides an additional interconnect lane in each direction (memory write & read).
- If a single lane failure is detected, the failed lane is automatically mapped out by the CPU and the spare lane is enabled.

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Machine Check Architecture Recovery

First Machine Check Recovery in Xeon®-based Systems
Previously seen only in RISC, mainframe, and Itanium-based systems

MCA Recovery
System works in conjunction with OS or VMM to recover or restart processes and continue normal operation

System Recovery with OS

Normal Status With Error Prevention

Error Detected*

Error Contained

Error Corrected

HW Correctable Errors

Un-correctable Errors

Error information passed to OS / VMM

Bad memory location flagged so data will not be used by OS or applications

Allows Recovery From Otherwise Fatal System Errors

*Errors detected using Patrol Scrub or Explicit Write-back from cache

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Hardware Corrected Errors & Predictive Failure Analysis

- Most hardware errors are detected and corrected internally without any interruption in availability
  - e.g. parity checking and error correcting code
- Corrected Machine Check Interrupt (CMCI) signals the OS with information about corrected errors
- The tools in the OS perform Predictive Failure Analysis to isolate failing components for replacement

Helps to Identify Failing Components Before They Fail

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Intel® QPI = Intel® QuickPath Interconnect
Nehalem = Intel® microarchitecture, codenamed Nehalem

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Software Community & System vendors Align around Large Mission Critical Solutions (8 sockets)

OEMs with Scalable, Mission Critical Xeon® Server Designs

OS and VMM Vendors Integrating Support for Advanced RAS Features

Delivering an Integrated Solution For Highly Available Deployments

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• Catalyst for Mission Critical Transformation
Xeon® 7500: A Catalyst for Mission Critical Transformation

“Red Hat Enterprise Linux has a well-deserved reputation for reliability, availability, serviceability, scalability and performance and is designed to take advantage of these new capabilities. **We believe the combination of Red Hat and Intel are a game-changer for Mission-Critical computing.**”

Paul Cormier, Exec VP & President, Products and Technologies

“Both the Xeon 7500 and its associated ecosystem are today **fully capable of running a wide range of workloads that were historically more associated with mainframes or RISC/Unix systems.**”

-Gordon Haff, Principle IT Advisor, Illuminata, Inc.

“This is huge. **This is Intel taking its x86 architecture up into the mainframe space.**”

-Robert Enderle, Senior Analyst, The Enderle Group

“The new levels of reliability and performance delivered by the Intel Xeon processor 7500 series are impressive. We expect customers to benefit when used together with innovative SAP enterprise solutions.”

Vishal Sikka, Member of The Executive Board of SAP AG

“Nehalem EX’s core platform attributes make it very capable to further disrupt parts of a declining RISC market.”

-Vernon Turner, Senior Vice President IDC

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Sun* UltraSPARC IV+* Refresh: 2010
8-socket Sun Fire V890* → 8-socket Xeon® 7500

2007 Sun
Sun 8-Socket UltraSPARC IV+* Servers
8 racks Sun Fire V890 servers

2010 Intel
Efficiency Refresh 8:1
1 rack of Intel® Xeon® 7500 Based Servers
89% Annual Energy Cost Reduction (estimated)
As Low as 27 Month Payback

Performance Refresh 1:1
8 racks of Intel® Xeon® 7500 Based Servers
Up to 8x Performance Improvement
13% Annual Energy Costs Estimated Reduction (estimated)

Source: Intel measurements as of May 2010. Performance comparison using server SPECint_rate_base2006. Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance. For detailed calculations, configurations and assumptions refer to the legal information slide in backup.

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Server Refresh & Consolidate

Single Core 4-socket → Xeon® 7500 8-socket

2005

36 Racks of Intel® Xeon® Single Core, 4-socket Servers

2010

Performance Refresh
1:1

Up to 36x Performance (Estimated)

1 Rack of Intel® Xeon® 7500 Based 8-socket Servers

Up to 91% Annual Energy Costs Reduction (Estimated)

As Little as 14 months Payback (Estimated)

Efficiency Refresh
36:1

1 Rack of Intel® Xeon® 7500 Based Servers

– OR –

2005

36 Racks of Intel® Xeon® Single Core, 4-socket Servers

Source: Intel measurements as of March 2010 of Xeon 7500 and single-core 4-socket systems. Performance comparison using SPECint_rate_base2006. Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance. For detailed calculations, configurations and assumptions refer to the legal information slide in backup.

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CASE STUDY—Migration in Action: Odyssey Logistics and Technology

“Red Hat Enterprise Linux running on Intel Xeon processors is truly a rock-solid platform. We absolutely trust Red Hat and Intel with our most mission-critical systems.”
– Brad Massey, IT Director, Odyssey Logistics and Technology

- Exponential business growth; **83 percent compounded growth rate in IT transactions**
- Logistics applications are directly integrated with the supply chain operations & ensuring high levels of performance, scalability, and availability critical
- Needed to upgrade IT infrastructure, but **concerned about the cost of upgrading existing UNIX/RISC infrastructure**.
- Moved mission-critical batch services to virtualized Intel Xeon processor-based servers running Red Hat Enterprise Linux.
- Initial migration so painless and the savings so immediate that **OL&T decided to completely eliminate UNIX from its environment and is now transitioning to Red Hat Enterprise Linux on Intel processor-based servers across its entire infrastructure**.
CASE STUDY—Migration in Action: Wall Street Systems

“Our clients are completely comfortable knowing that they can run their largest, most critical systems on Red Hat® Enterprise Linux® and that they’ll get enterprise-class support.”
- Mark Tirschwell, Chief Technology Officer, Wall Street Systems

- Global provider of mission-critical financial applications; needs applications to deliver high-end performance, scalability, availability, and value.
- Migrated all flagship products from UNIX/RISC to Red Hat Enterprise Linux running on Intel Xeon processor-based servers
- New platform reduces capital costs for a typical customer implementation from around USD 1 million to about USD 250,000 (75% reduction in costs)
- Headroom to grow: New platform used to support software as a service (SaaS) offerings and its internal development and quality assurance activities.
- Transition enabled the company to consolidate 15 server racks down to 12 racks using built-in Red Hat Enterprise Linux virtualization
CASE STUDY—Migration in Action: YPF SA

“Our systems are more operationally efficient, and we still have the high performance our business demands, coupled with decreased costs.”
– Adriana Marisa Vazquez, UNIX administration group, YPF

- Argentina’s largest oil and gas company
- Began moving critical business applications from multiple proprietary UNIX/RISC architectures to Red Hat Enterprise Linux on Intel Xeon processor-based servers as far back as 1999.
- Impact on cost and performance immediate and positive; now runs more than 80 percent of its Oracle databases and 90 percent of its SAP applications on the new Red Hat/Intel platform.
- Relies on Red Hat Network to simplify administration and Red Hat virtualization to greatly simplify new deployments, eliminate server sprawl, and enable maintenance without downtime through live VM migration.
- Read the complete case study at: www.redhat.com/f/pdf/customers/RH_CS_YPF.pdf
CASE STUDY—Migration in Action: Sabre Holdings, Travelocity

“Compared to proprietary UNIX/RISC solutions, our testing has shown that Red Hat Enterprise Linux on Intel performs three times faster and at a fraction of previous costs.”

– Robert Wiseman, Chief Technology Officer at Sabre Holdings

- Sabre Holdings operates the largest travel distribution service in the world
- Solutions must withstand extremely high sustainable volumes; peaking at 32,000 transactions per second, available 24x7, with five-nines uptime.
- Need to capitalize on business growth opportunities while containing infrastructure costs and meeting those rigorous requirements
- Has successfully migrated numerous mission-critical applications from its previous UNIX/RISC architecture to Red Hat Enterprise Linux running on Intel processor-based servers; new corporate standard.
- Currently exploring virtualization and cloud computing opportunities as a way to further improve the quality and cost effectiveness of its IT solutions.
- Read the complete case study at: www.redhat.com/f/pdf/blog/RH_SabreHoldings_CS_734891_0808_cw_web.pdf
Linux on Intel Xeon 7500 Series can result in dramatic cost savings

**76 percent lower TCO over three years; total savings of $4.4 million**

(1) Download the full TCO study at: www.principledtechnologies.com/clients/reports/Dell/R910_TCO.pdf

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Solution running on Intel® Xeon® Processor 7500 Series-based Servers</th>
<th>Solution running on Oracle SPARC* T5440 Servers</th>
<th>Savings with Red Hat Enterprise Linux® and Intel® Processor-based Servers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost per Server</strong></td>
<td>Including 3-year support costs</td>
<td>USD 40,890</td>
<td>USD 122,375 (per server)</td>
</tr>
<tr>
<td><strong>Energy Consumption per Server</strong></td>
<td>Based on typical workloads</td>
<td>804 Watts</td>
<td>962 Watts (per server)</td>
</tr>
<tr>
<td><strong>Number of Servers Required</strong></td>
<td>Based on SPECjbb*2005 results</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total Acquisition Costs</strong></td>
<td>Including hardware, software, training, planning, migration, and 3-year support costs</td>
<td>USD 784,617</td>
<td>USD 3,592,641</td>
</tr>
<tr>
<td><strong>3-Year Operating Costs</strong></td>
<td>Including software support, power, cooling, and data center and server administration costs</td>
<td>USD 586,740</td>
<td>USD 812,460</td>
</tr>
<tr>
<td><strong>3-Year Total Cost of Ownership</strong></td>
<td></td>
<td>USD 1,371,357</td>
<td>USD 4,405,101</td>
</tr>
</tbody>
</table>

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Migration Best Practices:

1. Understand your business goals
2. Define your deployment strategy
3. Create your strategic migration plan
   1. Infrastructure application analysis & standard build
   2. Functional applications analysis and high level cost estimate
   3. Readiness and risk analysis
   4. Strategic migration roadmap
   5. Implementation

Download the Migration Guide here: http://www.xxx
Intel® Xeon® 7500—OEM System Innovation

2-socket Expandable

4-Socket Blades

8-sockets or Greater

First Ever!

75% Increase¹

5X¹

Greater Choice Way Beyond 4-socket Racks
Transforming Enterprise

- Biggest performance leap in Xeon history
- 20:1 consolidation of older, single-core 4S servers
- Est. 12 months ROI payback via lower operating costs
- Flexible design broadens MP category well beyond 4S

Transforming Mission Critical

- Over 20 new RAS features including MCA-recovery
- Scalability from 2 to 256 sockets
- As low as 1/5th the cost of RISC-based systems

Transforming Enterprise and Mission Critical workloads
Legal Disclaimers

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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.


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

Hyper-Threading Technology requires a computer system with a processor supporting HT Technology and an HT Technology-enabled chipset, BIOS and operating system. Performance will vary depending on the specific hardware and software you use. For more information including details on which processors support HT Technology, see here

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

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BACKUP
Sun* UltraSPARC IV+* Refresh: 2010 ROI Claim – Back up

15 month ROI claim estimated based on comparison between 2S Dual Core Intel® Xeon® 5160 (3.0GHz) and 2S Intel® Xeon® X5680 based servers. Calculation includes analysis based on performance, power, cooling, electricity rates, operating system annual license costs and estimated server costs. This assumes 8kW racks, $0.10 per kWh, cooling costs are 2x the server power consumption costs, operating system license cost of $900/year per server, per server cost of $7200 based on estimated list prices and estimated server utilization rates. All dollar figures are approximate. Performance and power comparisons are based on measured server side java benchmark results (Intel Corporation Feb 2010). Platform power was measured during the steady state window of the benchmark run and at idle. Performance gain compared to baseline was 5x.

Baseline platform: Intel server platform with two Dual-core Intel® Xeon® Processor 5160, 3.33GHz, 1333MHz FSB, 8x2GB FBDMIMM DDR2-667 memory, 1 hard drive, 1 power supply, Microsoft* Windows* Server 2003 Ent. SP1, Oracle* JRockit* build P27.4.0-windows-x86_64 run with 2 JVM instances

New platform: Intel server platform with two Intel® Xeon® Processor X5680 (12M Cache, 3.33 GHz, 6.40 GT/s Intel® QPI), 24 GB memory (6x4GB DDR3-1333), 1 SATA 10krpm 150GB hard drive, 1 800w power supply, Microsoft Windows Server 2008 64 bit SP2, Oracle* JRockit* build P28.0.0-29 run with 4 JVM instances

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### Sun® UltraSPARC IV+® Refresh: 2010 Calculation Details

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2010</th>
<th>Delta / Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
<td>UltraSPARC IV+ (2.10GHz)</td>
<td>Intel® Xeon® X7560 (2.93GHz)</td>
<td></td>
</tr>
<tr>
<td><strong>Performance per Server</strong></td>
<td></td>
<td></td>
<td>Intel internal measurements on a server SPECint_rate_base2006 benchmark as of March 2010</td>
</tr>
<tr>
<td><strong>Up to 10x increase</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Server Power</strong></td>
<td>1452.9W idle / 2906W active</td>
<td>1360W idle / 2424W active</td>
<td>Server idle for 16 hours per day and active for 8 hours per day</td>
</tr>
<tr>
<td><strong>Idle / Active Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong># Servers needed</strong></td>
<td>80</td>
<td>10</td>
<td>8:1 server consolidation</td>
</tr>
<tr>
<td><strong># Racks needed</strong></td>
<td>8 racks</td>
<td>1 rack</td>
<td>8:1 Rack Consolidation</td>
</tr>
<tr>
<td><strong>Annual kWhr</strong></td>
<td>1,531,473</td>
<td>166,193</td>
<td>Estimated 80% lower energy costs</td>
</tr>
<tr>
<td><strong>Annual Energy Costs</strong></td>
<td>$306,294.57</td>
<td>$33,238.66</td>
<td>$273,055.91 electricity cost reduction per year. Assumes $0.10/kWhr and 2x cooling factor</td>
</tr>
<tr>
<td><strong>OS Licensing Costs</strong></td>
<td>$72,000</td>
<td>$9,000</td>
<td>$63,000 less per year. Assumes a RHEL 1yr license at $900</td>
</tr>
<tr>
<td><strong>Cost of new HW</strong></td>
<td>n/a</td>
<td>$750,000</td>
<td>Assume $75,000 per server</td>
</tr>
</tbody>
</table>

*Estimated Annual Cost Savings of $336,055.91

**Estimated 27 Month Payback**

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Server Refresh & Consolidate ROI Claim – Back up

15 month ROI claim estimated based on comparison between 2S Dual Core Intel® Xeon® 5160 (3.0GHz) and 2S Intel® Xeon® X5680 based servers. Calculation includes analysis based on performance, power, cooling, electricity rates, operating system annual license costs and estimated server costs. This assumes 8kW racks, $0.10 per kWh, cooling costs are 2x the server power consumption costs, operating system license cost of $900/year per server, per server cost of $7200 based on estimated list prices and estimated server utilization rates. All dollar figures are approximate. Performance and power comparisons are based on measured server side java benchmark results (Intel Corporation Feb 2010). Platform power was measured during the steady state window of the benchmark run and at idle. Performance gain compared to baseline was 5x.

Baseline platform: Intel server platform with two Dual-core Intel® Xeon® Processor 5160, 3.33GHz, 1333MHz FSB, 8x2GB FBDMIMM DDR2-667 memory, 1 hard drive, 1 power supply, Microsoft* Windows* Server 2003 Ent. SP1, Oracle* JRockit* build P27.4.0-windows-x86_64 run with 2 JVM instances

New platform: Intel server platform with two Intel® Xeon® Processor X5680 (12M Cache, 3.33 GHz, 6.40 GT/s Intel® QPI), 24 GB memory (6x4GB DDR3-1333), 1 SATA 10krpm 150GB hard drive, 1 800w power supply, Microsoft Windows Server 2008 64 bit SP2, Oracle* JRockit* build P28.0.0-29 run with 4 JVM instances

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# Server Refresh & Consolidate Calculation Details

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>Delta / Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
<td>(Intel® Xeon® MP CPU 3.3Ghz (Single core w/ HT, 1MB L2, 8MB L3)</td>
<td>Intel® Xeon® X7560 (2.93GHz)</td>
<td>Intel internal measurements on a server SPECint_rate_base2006 benchmark as of March 2010</td>
</tr>
<tr>
<td><strong>Performance per Server</strong></td>
<td>1</td>
<td><strong>Up to 36x increase</strong></td>
<td><strong>Up to 36x increase</strong> for Intel® Xeon® X7560 (2.93GHz) compared to Intel® Xeon® MP CPU 3.3Ghz (Single core w/ HT, 1MB L2, 8MB L3)</td>
</tr>
<tr>
<td><strong>Server Power Idle / Active Power</strong></td>
<td>480W idle / 780W active</td>
<td>1360W idle / 2424W active</td>
<td>Server idle for 16 hours per day and active for 8 hours per day</td>
</tr>
<tr>
<td><strong># Servers needed</strong></td>
<td>360</td>
<td>10</td>
<td><strong>36:1 server consolidation</strong></td>
</tr>
<tr>
<td><strong># Racks needed</strong></td>
<td>36 racks</td>
<td>1 rack</td>
<td><strong>36:1 Rack Consolidation</strong></td>
</tr>
<tr>
<td><strong>Annual kWhr</strong></td>
<td>1,992,211</td>
<td>166,193</td>
<td><strong>Estimated 91% lower energy costs</strong></td>
</tr>
<tr>
<td><strong>Annual Energy Costs</strong></td>
<td>$398,442.24</td>
<td>$33,238.66</td>
<td><strong>$365,203.58 electricity cost reduction per year. Assumes $0.10/kWhr and 2x cooling factor</strong></td>
</tr>
<tr>
<td><strong>OS Licensing Costs</strong></td>
<td>$324,000</td>
<td>$9,000</td>
<td><strong>$315,000 less per year</strong></td>
</tr>
</tbody>
</table>

**Estimated Annual Cost Savings of $680,203.58**

| **Cost of new HW**    | n/a                                                                  | **$750,000**                                                       | Assume $75,000 per server                                                                                                                   |

**Estimated 14 Month Payback**