A Better Platform for Mission-Critical Computing

Why Migrating from UNIX/RISC to Red Hat and Intel Solutions Makes Better Sense than Ever Before

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June 2010

ABSTRACT:

With ground-breaking advancements in performance, scalability, and reliability, Red Hat Enterprise Linux running on Intel® Xeon® processor-based servers now rivals high-end UNIX/RISC solutions as a robust platform for mission-critical deployments—and it can help companies cut total cost of ownership by as much as 75 percent. This whitepaper outlines the key benefits of migration and provides a step-by-step guide to planning and conducting a strategic and successful transition.

Developed by Mesh Communications Group, Inc.

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A Better Platform for Mission-Critical Computing

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EXECUTIVE SUMMARY

"This is huge. This is Intel taking its x86 architecture up into the mainframe space[1]."

– Robert Enderle, The Enderle Group

The proven value of open source software running on industry-standard servers has driven adoption deep into the enterprise datacenter in recent years. Many companies are standardizing on these open system solutions for all new deployments, and they are gradually replacing aging UNIX/RISC systems to cut costs and provide a more flexible foundation for growth.

More recently, the potential value of a migration has increased dramatically. Red Hat Enterprise Linux, running on the latest Intel® Xeon® processor 7500 series-based servers, delivers a tremendous leap forward in mission-critical capability. The combined platform now rivals high-end UNIX/RISC servers for scalability and reliability, but at a fraction of the cost and with far greater choice of hardware, software, and vendor support.

This robust new platform provides a highly optimized foundation for datacenter virtualization, consolidation, and management. IT organizations can create a more agile and cost-effective infrastructure while simultaneously establishing an open systems framework that will enable a smooth transition toward next-generation cloud computing models. They can also achieve immediate savings. As discussed later in this whitepaper, a recent total cost of ownership (TCO) study by Principled Technologies estimates total cost savings of over 75 percent for a typical migration. Comparable savings are documented in a number of real-world customer success stories.

The first half of this paper introduces key aspects of the combined platform that are delivering high value in enterprise computing environments. The second half offers guidance for business and IT decision makers who are interested in understanding the potential costs, benefits, and risks of migration for their specific applications and IT environments. It provides high-level guidelines for assessing cost and complexity and for planning a smooth, successful, and strategic migration. It also points to additional resources, including professional services that can help IT organizations transition with confidence toward a more flexible and cost-effective IT infrastructure.

CONTENTS

1 Source: As quoted in the article "Intel Elevates Its Mainstream x86 Processors into HPC Space," by Chris Preimesberger, eWeek.com, March 30, 2010.

http://www.eweek.com/c/a/IT-Infrastructure/Intel-Elevates-Its-Mainstream-x86-Processors-into-HPC-Space-639577/

PART I: THE BUSINESS CASE FOR MIGRATION

Increasing Value across Your IT Infrastructure

"The TCO and performance of SAS Analytics on Red Hat Enterprise Linux and Intel Xeon processor 7500 series-based servers is a game changer that allows our customers to more effectively leverage the power of analytics within the confines of today's shrinking IT budgets[2]."

– Ann Milley, SAS Sr. Director, Analytic Strategy

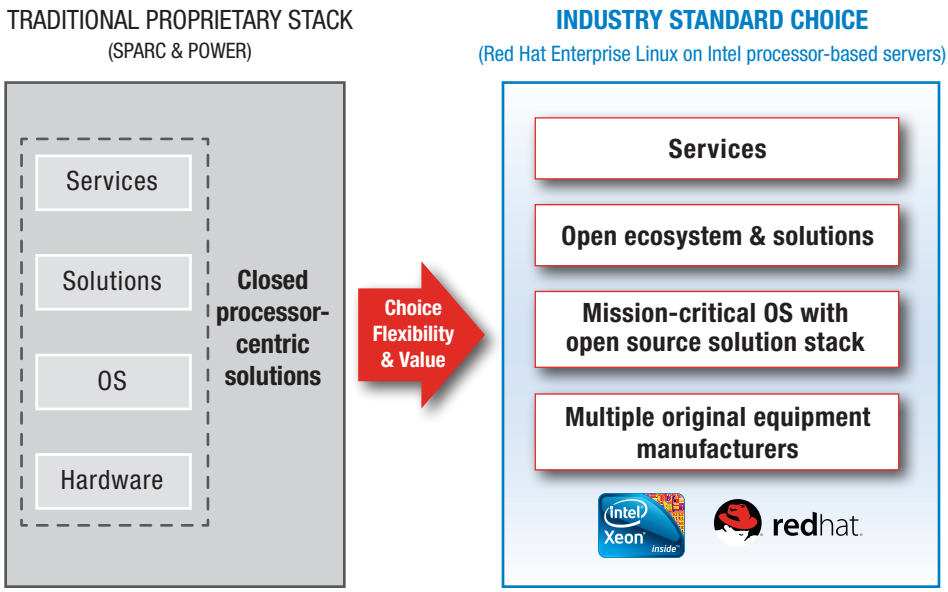

Figure 1. Open systems based on Red Hat Enterprise Linux and Intel processor-based servers deliver greater choice, flexibility, and value than proprietary UNIX/RISC architectures and have matured to support today's most demanding and mission-critical applications.

IT costs and requirements are on a collision course for many businesses. Multiple software deployments over a span of many years have resulted in IT solutions that are costly to maintain and difficult to adapt, yet essential to the business. Supporting existing infrastructure now accounts for roughly two-thirds of total costs for many businesses, and rising energy bills are pushing datacenter costs ever higher. Difficult economic conditions magnify these concerns, forcing IT budgets downward despite growing requirements.

The discrepancy between costs and requirements is the primary driving force behind the increasing adoption of open source software running on industry-standard servers. Capital and operating costs tend to be much lower than for comparable proprietary solutions running on UNIX/RISC architectures (see Quantifying the Benefits of Migration on page 8). Vendor support is also much broader for open source solutions and includes a majority of today's leading hardware and software providers. This drives faster innovation and gives IT organizations greater flexibility for tailoring solutions and managing costs (Figure 1). These realities are strongly reflected in the marketplace. Despite the large installed base of UNIX/RISC implementations, sales for industry-standard solutions are considerably higher and are growing faster[3].

Red Hat Enterprise Linux running on Intel processor-based servers offers a high-value, low-risk path to realizing the benefits of open-systems computing. The combined platform is supporting mission-critical applications for many of today's largest and most successful companies, including the Tokyo Stock Exchange[4], Gap Inc.[5], Verizon Communications[6], and many others.

2 For more information about SAS scaling on Red Hat Enterprise Linux and Intel Xeon processor 7500 series-based servers, read the SAS and Red Hat paper, "Answers You Need. Performance You Can Afford." www.redhat.com/f/pdf/RH_SAS_Analytics_web.pdf

3 "Now that the fourth-quarter figures are out, the UNIX drop is 18.1 percent year-over-year. That adds up to worldwide UNIX revenues of $3.9 billion for the quarter, representing 29.9 percent of the total server spend — down from 36.2 percent in 4Q08. In comparison, x86 grew 12.6 percent in the same quarter to $7.3 billion." Source: "RISC to x86 Server Migration Buyer's Guide," by Drew Robb, ServerWatch, March 4, 2010. http://www.serverwatch.com/hreviews/article.php/3868681/RISC-to-x86-Server-Migration-Buyers-Guide.htm

4 Read the complete customer success story at: http://customers.redhat.com/2010/03/22/tokyo-stock-exchange-executes-millisecond-trading-with-new-system-based-on-red-hat-enterprise-linux/#more-2729

5 Read the complete customer success story at: http://www.redhat.com/f/pdf/customers/Red_Hat_Likewise_Gap_Inc_Direct.pdf

6 Read the complete customer success story at: http://rhcustomers.files.wordpress.com/2009/09/verizon_red-hat-innovaward-case-study.pdf

Complete Enterprise Solutions

"We believe that the combination of Red Hat Enterprise Linux and the latest Intel Xeon processor-based servers surpasses the capabilities of proprietary high-end systems, while offering true affordability and a flexible foundation for physical, virtual, and cloud computing."

– Tim Burke, Vice President of Engineering, Red Hat

Red Hat Enterprise Linux, running on Intel processor-based servers, scales easily to support enterprise requirements and gives organizations tremendous choice in vendors, systems, and applications. Today's Intel Xeon processor-based servers offer exceptional performance and energy efficiency across the widest range of configurations, from affordable two-socket servers to expandable and highly resilient eight-socket servers to massively scalable systems with up to 256 sockets (2,048 processor cores) and 16 terabytes (TB) of shared memory[7].

Software options are equally diverse. Thousands of applications are available from more than 2,300 Red Hat Enterprise Linux partners. This broad support simplifies migration and makes it easier for organizations to architect complete solutions, while optimizing total value with a best-fit combination of open source and third-party software.

Mission-Critical Service and Support

Intel and Red Hat have been working together for more than a decade to deliver complete enterprise solutions and have been offering mission-critical support options for many years. Their technology roadmaps are well aligned, engineering collaboration is extensive and ongoing, and customer service teams provide 24/7 service with a single point of contact. The Red Hat Advanced Mission-Critical Program, in combination with select hardware vendors, provides an even higher level of support for the most demanding applications. Through this program, IT organizations can

- Standardize on a minor release for up to 60 months, so they can defer costly software stack revalidation testing[8].
- Rely on a 10-year advanced mission-critical lifecycle.
- Receive advanced mission-critical service level agreements (SLAs).

For more information, visit: www.redhat.com/promo/mc_program/

THE OPEN SOURCE ADVANTAGE

"Open source gives organizations a really high-quality product for a very reasonable cost, along with a high return and low total cost of ownership."

– Michael Fauscette, Group Vice President, Software Business Solutions IDC, March 2009. (IDC_749)

Open source software is freely available, widely deployed, and supported by an enormous community of developers, including some of the computer industry's most respected firms. The extensive community of developers helps to ensure rapid software innovation with broad and extensive interoperability and security testing. It has also made Linux a top priority platform for independent software vendors, leading to unprecedented levels of choice for enterprise customers.

Industry-leading vendors such as Red Hat and Intel help take the risk out of deploying open source software by integrating proven components into a stable, fully-integrated, thoroughly-tested, enterprise-class solution that supports certified hardware and software solutions from thousands of vendors. The combined platform is helping many of today's most successful businesses move away from the high costs of UNIX/RISC solutions toward an open systems computing model that provides higher value and a better foundation for future growth.

[7] Red Hat Enterprise Linux 5 Advanced Platform supports up to 255 processors, 1 terabyte of memory, and unlimited virtualization guests, which are the limits of the 2.6.18 kernel. Red Hat Enterprise Linux 6 is expected to meet and exceed the current scalability limits of the Intel Xeon processor 7500 series. For detailed information, visit: http://www.redhat.com/rhel/compare/. The ability to support specific configurations depends on server vendors certifying appropriately designed physical servers.

[8] The Advanced Mission-Critical Program is offered by select hardware vendors in specific geographies. Standard Red Hat support includes the ability to standardize on a minor release for up to six to eight months, and all customers have the option to extend support for a minor release up to 18 months through extended Red Hat programs.

Built-in Virtualization

Virtualization has become an essential technology for delivering better service levels at lower cost, and Red Hat Enterprise Linux supports enterprise-class server virtualization. Key features include the following:

- **Support for Large-Scale Consolidation.** Red Hat Enterprise Linux supports up to 255 processors and 1 TB of memory. It also supports unlimited virtual machines (VMs) per physical server, so consolidation ratios are limited only by the capacity of the host server and the nature of the workloads. Red Hat support teams have seen real-world deployments supporting more than 500 VMs per physical host server.
- **Scalability for Enterprise Workloads.** Each VM can be configured with up to 32 virtual processors and 256 gigabytes of memory, and near-native I/O performance is enabled through direct connection of VMs to I/O devices. Red Hat Enterprise Linux also supports Single Root I/O Virtualization (SR-IOV), as outlined in the PCI-SIG I/O Virtualization specification[9]. SR-IOV enables flexible sharing of I/O bandwidth in compliant devices, such as 10 Gigabit Intel® Ethernet Server Adapters. With these advancements, even I/O-intensive applications, such as databases, file servers, and high-throughput messaging workloads, can now be virtualized with little or no performance loss. As a result, IT organizations can extend the benefits of virtualization across their entire datacenter.
- **Live VM Migration.** Applications can be migrated from one physical host to another without downtime to support dynamic workload balancing and reduce or even eliminate planned downtime.
- **Powerful Clustering.** Red Hat Enterprise Linux supports workload sharing and automated failover with more than 50 hosts per cluster. With this support, IT organizations can create flexible and highly resilient pools of virtualized resources.
- **Datacenter Power Savings.** Red Hat system scheduler enables automated and dynamic consolidation of applications onto fewer servers based on workloads and IT policies. Since an idle server typically consumes only 10 to 15 percent as much power as an active server, this can substantially reduce total datacenter power consumption when workloads are light.

Intel® Virtualization Technology establishes the hardware foundation for these capabilities by providing hardware assists for core virtualization processes throughout the server platform. In tandem with Red Hat Enterprise Linux, it provides simpler and more robust virtualization solutions and enables a given server to support more VMs and heavier workloads.

The performance advantages can be compelling. Intel and Red Hat have demonstrated exceptional virtualization efficiency running enterprise workloads in VMs (Figure 2).The low overhead enables higher consolidation ratios, which increase the cost benefits of virtualization. It also enables organizations to virtualize a wider range of applications than ever before.

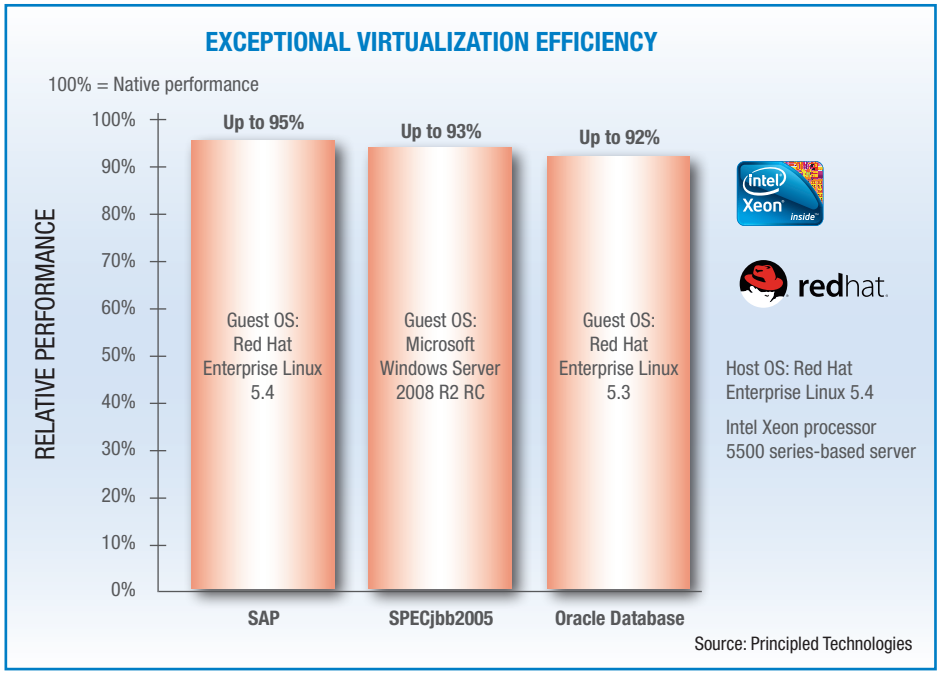

Figure 2. Intel Xeon processor-based servers running Red Hat Enterprise Linux support virtualization with exceptionally low overhead, enabling IT organizations to virtualize even their most demanding applications. For details, see Red Hat Virtualization performance reports at: http://www.redhat.com/virtualization/rhev/server/performance/

[9] For more information about the Peripheral Component Interconnect Special Interest Group I/O Virtualization (PCI-SIG IOV) specification, visit the PCI Web site: http://www.pcisig.com/specifications/iov/

A Smooth Path to Cloud Computing

Red Hat Enterprise Linux running on Intel Xeon processor-based servers is the most widely deployed platform for cloud computing. With its high-performance virtualization capabilities, it provides a powerful foundation for both public and private cloud solutions. With its broad interoperability, it makes it relatively easy to incorporate and manage heterogeneous hardware and software assets as a single cloud.

Intel and Red Hat are deeply involved in developing and standardizing next-generation cloud solutions and are focused on empowering customers to transition toward cloud solutions incrementally and at their own pace. All Red Hat Enterprise Linux applications are certified to work in infrastructure provided by Red Hat Certified Premier Cloud Providers. This provides considerable flexiblity for using internal and external computing resources. For example, with Red Hat Cloud Access, customers can move their Red Hat Enterprise Linux subscriptions between their traditional on-premise servers and Amazon Web Services. As a result, they can select appropriate computing resources for their needs, without the need for new business or support models.

For more information, visit the Red Hat web site at http://www.redhat.com/solutions/cloud/ and the Intel web site at http://software.intel.com/en-us/articles/intel-cloud-builder/.

A Better Platform for Growth

For many years, Intel Xeon processor-based servers have delivered exceptional performance and price/performance in mainstream two-socket and four-socket servers designs. The latest Intel Xeon processor 7500 series extends those benefits to eight-socket and larger systems designed to host the most demanding enterprise workloads (see the sidebar, Exceptional Scalable Performance). With these advancements, the world's most widely deployed computing architecture now delivers optimized support for the full range of business computing requirements.

Mainstream Business and High-Performance Computing (HPC) Servers

Two-socket servers based on the Intel Xeon processor 5600 series provide leading performance and energy-efficiency for mainstream workloads by dynamically adapting server performance and energy consumption as workloads vary. This processor family also includes new security features that can help IT organizations protect hardware and software assets more effectively in both virtualized and non-virtualized environments[10].

Two-socket servers are also available configured with the Intel Xeon processor 6500 or 7500 series. These servers provide significantly more processing resources and support larger memory configurations and advanced reliability, availability, and serviceability (RAS) features. They are ideal for increasing consolidation ratios and for supporting heavier and more mission-critical workloads, while retaining the benefits of a scale-out server environment.

EXCEPTIONAL SCALABLE PERFORMANCE

Intel Xeon processor 7500 series-based servers deliver the scalable performance businesses need to support their most demanding workloads. As one example, eight-socket (64-core) servers running Red Hat Enterprise Linux demonstrated best-in-class results for two of today's most widely referenced computing benchmarks:

- **SPECint_rate_base2006** measures performance for general-purpose business computing. Published result: 1,250[a]

- **SPECfp_rate_base2006** measures performance for floating-point intensive workloads, which are common in high-performance computing (HPC). Published result: 887[b]

For more information about these and many other best-in-class performance benchmarks, visit the Intel web site at: www.intel.com/p/en_US/products/server/processor

[a] Configuration details: Fujitsu PRIMEQUEST 1800E server platform with eight Intel Xeon processors X7560 (24 M cache, 2.26 GHz, 6.40 GT/s Intel QuickPath Interconnect), 256 GB memory (128x 2GB DDR3-1066 REG ECC), Red Hat Enterprise Linux Server release 5.4, Intel® C++ Compiler and Fortran Compiler for Linux version 11.1. Referenced as published score of 1,250. Source: www.spec.org/cpu2006/results/res2010q1/cpu2006-20100315-10023.html as of 6 April 2010.

[b] Configuration details: Fujitsu PRIMEQUEST 1800E server platform with eight Intel Xeon processors X7560 (24 M cache, 2.26 GHz, 6.40 GT/s Intel QuickPath Interconnect), 512 GB memory (128x 4GB DDR3-1066 REG ECC), Red Hat Enterprise Linux Server release 5.4, Intel® C++ Compiler and Fortran Compiler for Linux version 11.1. Referenced as published score of 887. Source: www.spec.org/cpu2006/results/res2010q2/cpu2006-20100326-10143.html as of 20 April 2010.

[10] Intel's AES (Advanced Encryption Standard) technology improves processor performance for encryption by as much as 52 percent to enable more secure Internet transactions without requiring specialized hardware accelerators. Intel® Trusted Execution Technology helps to ensure that operating systems and hypervisors boot only into known good states to establish trusted platforms for greater security in virtualized and cloud-based environments. Note: 52 percent encryption acceleration is based on internal Intel measurements using a web banking workload running PHP and Windows Server 2008 R2, comparing number of banking sessions (users) for an Intel Xeon processor X5680 (3.33 GHz) versus an Intel Xeon processor X5570 (2.93 GHz).

Scalable and Highly Available Enterprise Servers

Four-socket, eight-socket, and larger servers based on the Intel Xeon processor 7500 series offer breakthrough support for mission-critical enterprise workloads. This new processor series delivers the biggest performance leap ever for an Intel processor generation, with roughly triple the performance across a range of benchmarks and excellent performance versus comparable RISC-based servers (Figure 3). With up to 64 high-performance cores, 128 threads, 2 TB of memory, and 144 I/O cards, a single eight-socket server provides ample capacity for all but the most extreme workloads—and larger systems are available from a number of vendors.

Tests have shown excellent performance and near-linear scalability on these large, multi-processor servers. As one example, Red Hat, SAS, NEC, and Intel collaborated to verify scalability for highly demanding business intelligence workloads. According to Craig Rubendall, SAS director of Research and Development, the tests "have proven to us that Red Hat Enterprise Linux can scale vertically to exploit the potential of these servers while also delivering the intense I/O throughput that is characterized by SAS Analytics[11]."

This processor family also includes integrated support for more than 20 new mainframe-inspired RAS features, including advanced error detection and correction, OS-assisted predictive failure analysis, automatic system recovery, and hard partitioning to simplify maintenance cycles and reduce planned downtime (see Appendix D). These servers effectively close the gap between proprietary RISC architectures and industry-standard solutions, delivering comparable capabilities at a fraction of the cost.

Red Hat is integrating extensive support for the new silicon-based RAS features into Red Hat Enterprise Linux to enable better data integrity and increased system resiliency. Red Hat also supports multi-node failover clustering and network load balancing for high availability through system-level redundancy.

Quantifying the Benefits of Migration

Many IT organizations are aware of the value delivered by Red Hat Enterprise Linux on Intel processor-based servers, but are concerned about the cost of migrating away from existing UNIX/RISC deployments. Although every migration is different, the cost of migration in the vast majority of cases will be considerably less than the cost of upgrading to new UNIX/RISC servers.

A recent TCO study by Principled Technologies estimated the total costs for upgrading a Java-based enterprise workload from existing Oracle SPARC-based servers to new Oracle SPARC T5440 servers and compared that to the cost of migrating the same workload to new Intel Xeon processor 7500 series-based servers.

Based on SPECjbb2005 results, the study found that 10 Intel Xeon processor 7500 series-based servers could do the work of 22 Oracle SPARC T5440 servers, while costing 75 percent less per server and consuming 54 percent less energy per server. The study went on to estimate total three-year costs for both solutions, including acquisition costs (hardware, software, training,

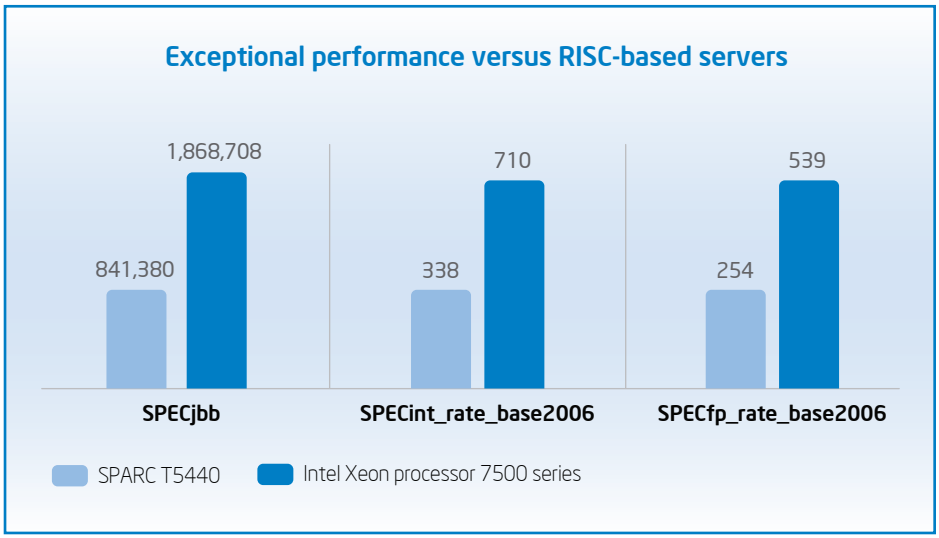

Figure 3. Intel Xeon processor 7500 series-based servers deliver exceptional performance versus comparable RISC-based servers across a range of industry-standard benchmarks. (See the end of this paper for more information about the benchmark results shown.)

[11] For more information, read the full report, "Proven Scalability for SAS 9.2." http://www.redhat.com/f/pdf/partners/RH_SAS_9_2_Scalability_web.pdf

planning, and migration) and support costs (software support, power, cooling, and datacenter and server administration). Results showed a 76 percent lower TCO over three years for the Intel and Red Hat solution, with a total savings of USD 4.4 million (Table 1). Download the full TCO study at: www.principledtechnologies.com/clients/reports/Dell/R910_TCO.pdf

We believe this is a conservative estimate of potential gains. In many cases, substantial additional cost savings can be realized by using open source software more extensively across the enterprise solution stack (see Appendix B).

Even Better Value for New Deployments

For companies considering new deployments, the advantages of Red Hat Enterprise Linux and Intel Xeon processor-based servers versus UNIX/RISC architectures are even more compelling. IT organizations can take advantage of more choice and better cost models across virtually all key parameters, including hardware, software, and vendor services. In essence, they can benefit from all the TCO gains documented in the previous section, without any of the costs and risks associated with migration. Perhaps even more importantly, they can avoid the considerable long-term risks associated with vendor lock-in that are introduced by proprietary architectures and their tightly-coupled hardware and software stacks.

PART II: STRATEGIC MIGRATION PLANNING—AN OVERVIEW

Important: *The following is a high-level guide only and is not designed to provide comprehensive or detailed guidance. However, it should give you a good idea of what a successful migration entails. Additional information and resources are readily available (see Appendix A).*

Intel and Red Hat have developed proven methodologies and best practices for migrating UNIX/RISC applications to Red Hat Enterprise Linux on Intel processor-based servers across thousands of successful migration projects. Since Red Hat Enterprise Linux has been designed as a UNIX replacement, it is relatively easy to migrate and maintain in existing UNIX/RISC environments[12]. Depending on your current applications and operating environment, migration can be simple, even trivial. However, careful planning is essential to ensure you have realistic expectations and understand potential pitfalls so you can minimize your total cost and risk.

A successful migration begins with building a business case for migration, establishing technical viability, estimating cost and complexity, and overcoming any internal resistance among business and IT staff. The remainder of this paper offers insights into these issues and how you can address them.

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

Along with exponential business growth, Odyssey Logistics and Technology (OL&T) was experiencing an 83 percent compounded growth rate in IT transactions and was concerned about the cost of upgrading its existing UNIX/RISC infrastructure. Since the company's logistics applications are directly integrated with the supply chain operations of its customers, ensuring high levels of performance, scalability, and availability was critical to success.

To address these challenges, OL&T began by moving its mission-critical batch services to virtualized Intel Xeon processor-based servers running Red Hat Enterprise Linux. The company also implemented Red Hat Satellite for fast provisioning and streamlined management. This initial migration was 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.

Read the complete case study at: http://rhcustomers.files.wordpress.com/2009/08/rh_odysseylogistics.pdf

[12] "Moving as a user or administrator from Linux to UNIX, or vice versa, brings some inconsistencies, but overall is fairly seamless. Even though the file systems or kernels might differ and require specialized knowledge to optimize, the tools and APIs are consistent. In general, these differences are no more drastic than variations among different versions of UNIX." Source: Differentiating UNIX and Linux, by David Dougall, March 14, 2006. www.ibm.com/developerworks/aix/library/au-unix-difflinux.html

Table 1. Principled Technology RISC Migration TCO Study

	Intel Xeon Processor 7500 Series-based Servers	Oracle SPARC T5440 Servers	Savings with Red Hat Enterprise Linux and Intel Processor-based Servers	
Cost per server Including 3-year support costs	USD 40,890	USD 163,265	USD 122,375 (per server)	75%
Energy consumption per server Based on typical workloads[a]	804 Watts	1,766 Watts	962 Watts (per server)	54%
Number of servers required Based on SPECjbb2005 results	10	22	12 fewer servers	54%
Total acquisition costs Including hardware, software, training, planning, migration, and 3-year support costs	USD 784,617	USD 4,377,258	USD 3,592,641	82%
Three-year operating costs Including software support, power, cooling, and datacenter and server administration costs	USD 586,740	USD 1,399,200	USD 812,460	58%
Three-year TCO	**USD 1,371,357**	**USD 5,776,458**	**USD 4,405,101**	**76%**

[a] Represents consumption during typical usage, which was determined by averaging consumption when idle with consumption under a full (100 percent) workload.

Understand Your Business Goals

Before you get down to the practical matters of assessing your migration environment, it is important to clarify your goals for migration because they will have a significant impact on the decisions you make along the way. There are many reasons for migrating to Red Hat Enterprise Linux on Intel processor-based servers. A few high-level drivers include:

- **Cost reduction.** Your migration can be expected to deliver considerable capital and operational cost savings. If cost is a key driver, there are many additional ways to increase your savings, such as consolidating more applications onto fewer and more powerful servers and increasing your use of open source software versus third-party vendor applications.
- **Migrating from aging hardware and software.** Solutions nearing the end of their useful life or vendor support cycles often offer particularly good candidates for migration, since they need to be upgraded or replaced anyway. Of course, high operating and maintenance costs often justify migration long before a solution reaches end-of-life or a lease comes up for renewal.
- **Changing business requirements.** Growing workloads, new performance requirements, and mergers and acquisitions can all trigger necessary changes and provide opportunities to inject higher value into the infrastructure.
- **Datacenter relief.** Migration to the latest Intel Xeon processor-based servers can often dramatically reduce datacenter space, power, and cooling requirements, especially if you take advantage of virtualization technologies offered in Red Hat Enterprise Linux and Intel processors to consolidate multiple workloads per server.

Define Your Deployment Strategy

Your migration strategy will depend not only on your business goals, but also on your long-term datacenter plans. In general, there are four basic deployment strategies, all of which can be used with Red Hat Enterprise Linux on Intel processor-based servers to deliver very robust solutions.

- **Consolidation.** Red Hat Enterprise Virtualization can be used to consolidate multiple workloads per physical server. Servers can be sized (two-socket, four-socket, eight-socket, and larger) to optimize performance and value across the datacenter.
- **Dispersion.** Workloads running on one or more large systems can be distributed onto smaller servers in a very flexible and highly managed environment. Virtualized server blades are increasingly popular for this deployment strategy.

- **Aggregation.** Large numbers of existing applications can be migrated onto a single, highly scalable, fault-tolerant Intel Xeon processor 7500 series-based server. With this approach, customers can use hardware (physical partitioning) or software (Red Hat Enterprise Virtualization) to control access to system resources.
- **Cloud computing.** Customers can run some or all of their applications on third-party infrastructure. Red Hat Enterprise Linux on Intel Xeon processor-based servers is a widely deployed cloud computing platform, and this trend can be expected to continue[13]. Using the same operating environment in your own datacenter can make it easier to transition your in-house datacenter solutions toward a cloud computing model when desired.

Create Your Strategic Migration Plan

The following five steps have been used successfully by Red Hat and Intel across hundreds of migration projects. While performing these steps, it's important to evaluate requirements and design solutions within the context of an integrated environment that takes into account applications, solutions, and systems; the enterprise IT infrastructure; system and solutions performance; and related interdependencies (Figure 4).

1. Infrastructure Application Analysis and Standard Build

The first step in migration is to assess your existing UNIX architecture and identify equivalent capabilities in the Red Hat Enterprise Linux ecosystem. In most cases, you'll find that Red Hat Enterprise Linux provides the same or

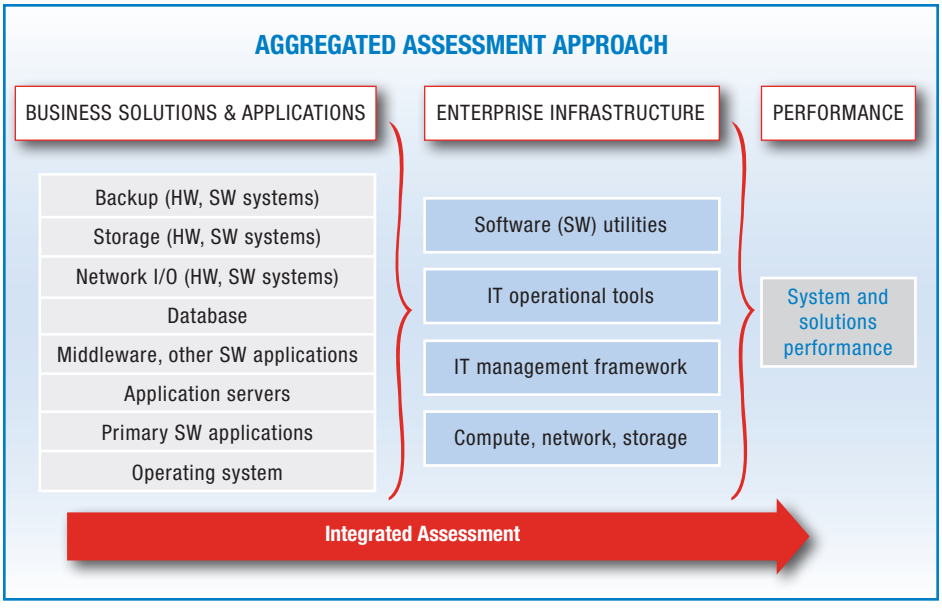

Figure 4. When assessing requirements and designing solutions, it is important to consider issues within the context of a comprehensive and integrated IT environment.

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

As a global provider of mission-critical financial applications, Wall Street Systems needs its applications to deliver high-end performance, scalability, availability, and value. That's why the company migrated all its flagship products from UNIX/RISC to Red Hat Enterprise Linux running on Intel Xeon processor-based servers. According to Mark Tirschwell, the company's chief technology officer, the new platform reduces capital costs for a typical customer implementation from around USD 1 million to about USD 250,000.

Wall Street Systems is also using the new platform to support its planned software-as-a-service offerings and its internal development and quality assurance activities. The transition has enabled the company to consolidate 15 server racks down to 12 racks using built-in Red Hat Enterprise Virtualization. According to Tirschwell, his IT staff has been well satisfied with the move. "My administrators love the Red Hat Enterprise Linux interface—it's intuitive and the tools are easy-to-use."

Read the complete case study at: www.redhat.com/f/pdf/customers/RH_CS_WallStreetSystems_web.pdf

[13] "Open source is very much part of cloud computing. The benefit of open source to the cloud providers is clear at several levels." Source: Open Source in the Next Computing Wave, by Gordon Haff, Illuminata, Inc., January 9, 2009. www.redhat.com/f/pdf/Illuminata_Open_Source.pdf

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, Head of YPF's UNIX administration group, YPF

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. The impact on cost and performance was immediate and positive, and the company now runs more than 80 percent of its Oracle databases and 90 percent of its SAP applications on the new platform.

YPF 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 virtual machine migration. According to Adriana Marisa Vazquez, head of YPF's UNIX administration group, "Our systems have become more agile and flexible with the combination of Red Hat virtualization technology and Intel's reliable platforms. We look forward to growing with Red Hat in the future."

Read the complete case study at: www.redhat.com/f/pdf/customers/RH_CS_YPF.pdf

very similar functionality. You're also likely to find additional functionality built into Red Hat Enterprise Linux, and you may want to consider taking advantage of that functionality to simplify your target environment and reduce total costs. In addition, there is an extensive assortment of open source and third-party software available to address a wide range of issues.

As you begin to identify components and replacements, it is important to note any significant differences between the components built into your existing OS and those built into Red Hat Enterprise Linux. There may be version, syntactic, or functional differences that will need to be considered during migration. The same may be true for third-party infrastructure components, such as a vendor-supplied storage and backup solution. By identifying differences between these components early in the planning stage, you can avoid potential disruptions during implementation.

The goal of this step is to create a standard build for your new environment that maps each of your existing infrastructure components to components in Red Hat Enterprise Linux or in third-party applications. An example is shown in Appendix C.

2. Functional Applications Analysis and High-Level Cost Estimate

The next step in creating your strategic migration plan is to evaluate your third-party functional and business applications. As in step one, the goal is to identify equivalent capabilities in the Red Hat Enterprise Linux ecosystem and identify differences that might impact migration. The complexity of migrating these applications can range from trivial to highly challenging. Begin by examining documentation and conducting interviews with IT and business stakeholders to gather as much information as possible about the applications in question. This should be a comprehensive assessment, including factors such as version levels and independent software vendor (ISV) support, SLAs, supporting hardware and software dependencies, development languages and platforms, external integration points, software optimization and tuning requirements, and testing and staging environment details.

Once you have this information, you can begin evaluating the complexity of the proposed migration. For example, migration would be extremely simple for a third-party application that is certified on Red Hat Enterprise Linux at the same version level as your currently deployed application.

Migration is generally more complex for custom applications. However, it can still be relatively simple if the code is highly portable (for example, you have well-established porting methods, clean code, well-understood dependencies, good documentation, access to knowledgeable developers, and so on). The size of the code base should also be taken into account, because porting costs will be roughly proportional to the amount of code. For large and complex custom applications, it may be more cost effective to write a new application from scratch. You might also consider moving to an appropriate vendor or open source application. In this case, key stakeholders should be consulted to generate and prioritize a list of features.

With the application knowledge you have gathered up to this point, you can create a high-level cost estimate for migrating your application. You can also make a rough estimate of hardware requirements. This will depend on the workload and hardware information you have already gathered, and also on your planned deployment scenario (aggregation, dispersion, consolidation, or cloud computing). Putting all this together, you can create a reasonable approximation of your migration costs. In tandem with your business goals, you can use these estimates to identify the migration projects that will deliver the highest value to your business.

3. Readiness and Risk Analysis

Once you have a reasonable approximation of the cost and complexity of migration, it is important to consider the potential risks associated with the transition.

- **Workloads.** How will the migration impact SLAs, performance, security, and maintenance windows? How will you transition to the new solution with minimal disruption to your production environment? Do you have sufficient budget, staff, and other resources to keep the project on schedule?
- **Cost.** How portable is your software code, and how will migration impact software licensing, hardware requirements, and operating expenses (including datacenter floor space, power, and cooling)? Will you need training or new staff to address any skill gaps?
- **Acceptance.** Are there political, technical, or governance-related barriers to migration in your organization? Are business or IT personnel strongly attached to existing solutions because of historical experiences or personal familiarity?

For organizations with experience in deploying and managing Linux solutions, many of these risks may be negligible or irrelevant because existing staff already have the knowledge and expertise required to mitigate them. Organizations that are new to Linux, on the other hand, are likely to experience greater internal resistance to migration, along with a skill gap that can add to overall risk. However, this is by no means an insurmountable issue. Red Hat Enterprise Linux solutions can be purchased pre-configured from most server vendors, who have a detailed understanding of peripherals and integration requirements. In addition, Red Hat offers world-class training and support (including online courses and on-site workshops). UNIX professionals will find that a great deal of their existing knowledge is readily transferable. They will also find that Red Hat Enterprise Linux running on Intel processor-based systems offers a level of functionality and robustness capable of meeting virtually all requirements. Nevertheless, overcoming initial resistance can require a coordinated effort. Once you have determined that migration makes sense for your organization:

- Build a business case to enlist executive-level support. The steps described above will provide the information you need.
- Invest the time and resources to enlist broader support among business and IT decision makers so they understand the value of migration and you have a chance to respond to any reservations they might have. (This can also be a valuable exercise in exposing potential risks you may not have considered.)
- Create and share your plan for training and transitioning IT personnel. Once people know their jobs are safe, their reservations will often subside, especially when they realize they will be learning skills that will open new career opportunities by extending their expertise across one of the world's fastest-growing operating environments. With appropriate training, you are likely to gain enthusiastic supporters.

- Select low-risk applications for your first migration projects. Ultimately, your migration priorities should depend on a comprehensive look at cost, risk, and value, but choosing a low-risk target for initial migration can be instrumental in building support and developing skill sets that will serve you well during future migrations.

4. Strategic Migration Roadmap

At this point, you are ready to bring all the elements together to create a comprehensive migration roadmap. There are seven major steps in this process, and you will have already gathered much of the required information.

STEP 1: Detailed analysis of existing hardware. Perform a detailed analysis of the hardware that is currently supporting the applications you will be migrating. For each application, include the following data for development, testing, staging, and deployment environments:

- Number of servers and processors per server
- Memory requirements
- Storage and file system requirements
- Network requirements (bandwidth and latency)
- Other I/O requirements (accelerators, management subsystems, and so on)

STEP 2: Consolidated deployment scenario and virtualization analysis. Assess your new hardware requirements based on your chosen deployment scenario: consolidation, dispersion, aggregation, or cloud computing. Be aware that today's multicore Intel processor-based servers are far more powerful than older systems of similar size, so you may be able to significantly drive down costs by consolidating multiple applications per server using Red Hat Enterprise Virtualization. When assessing the consolidation potential, consider the following for each application:

- Application SLAs
- Average and peak hardware utilization rates (processor, memory, disk, bandwidth, etc.)
- Physical location of applications (if you have multiple datacenters)
- Virtualization limitations (ISV support, regulatory, and compliance issues, etc.)
- Operational type (development, testing, production, etc.)
- Security and network segmentation
- High availability and disaster recovery requirements
- Clustering requirements and limitations
- Specialized hardware requirements (storage area networks, tape drives, InfiniBand, etc.)
- Power and cooling requirements
- Integration into server management infrastructure

STEP 3: High-level hardware redeployment analysis. A key benefit of migration is the elimination of expensive RISC servers to reduce your total costs. However, most organizations do not migrate all their applications at once. As you migrate off one RISC server, consider using it to add capacity for an existing UNIX/RISC application that you are not yet ready to migrate. The savings can be appreciable.

STEP 4: Consolidated risk analysis and risk mitigation plan update. Revisit and update your risk analysis based on the more detailed information you have now gathered. If risk factors have changed significantly, you may want to reconsider or re-prioritize your application migration list.

STEP 5: Training plan. Determine which staff members will need training and identify appropriate resources. Red Hat offers comprehensive training for Red Hat Enterprise Linux, including online, classroom, and on-site workshops. You may need to identify additional training resources for new hardware or ISV applications.

STEP 6: Detailed cost estimate. Based on the information you have gathered, create a detailed estimate of direct costs and savings. Include each of the following:

Costs for:

- New ISV applications (infrastructure and functional)
- New hardware
- Application migration
- Training

Savings from:

- Replacing proprietary ISV applications with open source alternatives
- Redeployed hardware

Note that this is not a complete return on investment or TCO analysis because it does not include indirect savings, such as operational cost savings or the savings from not having to upgrade the existing UNIX/RISC environment.

STEP 7: Master migration roadmap. Use all the information you have gathered so far to create a project plan that details when, where, and how your migration will occur. The first step is to prioritize specific system and application migrations based on factors such as capital budget allocation timing, specific business priorities, and datacenter constraints. You can then create actual project timelines that include tasks and dates and match specific capital and operational expenditures to quarterly IT budgets.

5. Implementation

By carefully following the methodology described above, you should be well positioned to make the transition smoothly and with few if any unforeseen complications. An enormous variety of companies have successfully migrated mission-critical applications to Red Hat Enterprise Linux on Intel processor-based servers, and the relative ease and value of the migration has led them to standardize on the combined platform for future deployments and upgrades.

See Appendix A for additional resources.

CONCLUSION

With scalable and highly reliable servers based on the Intel Xeon processor 7500 series, Red Hat Enterprise Linux running on Intel processor-based servers now offer exceptional value across the full range of enterprise workloads, all the way from the edge of the datacenter to the most mission-critical back-end applications. The combined platform provides a foundation for complete enterprise solutions that rival the scalability and availability of proprietary UNIX/RISC architectures, but at a fraction of the cost and with far greater choice and flexibility. Enterprise-class service and support are also available from Red Hat and Intel, and from many other hardware, software, and service vendors around the world.

Migration to this high-value computing platform can deliver substantial business and IT benefits, but requires careful planning to clearly understand the costs, risks, and benefits, and to create a strategic migration plan for your business. More detailed migration guides are available, along with comprehensive services to support your assessment, planning, and implementation. See Appendix A for more information, or contact your Red Hat or Intel representative.

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, Sabre Holdings

The computing challenges faced by Sabre Holdings are perhaps best described by Robert Wiseman, the global company's chief technology officer: "While operating the largest travel distribution service in the world, we develop solutions that must withstand what is perhaps the highest sustainable volumes anywhere, peaking at 32,000 transactions per second, available 24x7, with five-nines uptime."

To capitalize on business growth opportunities while containing infrastructure costs and meeting those rigorous requirements, Sabre Holdings has migrated numerous mission-critical applications from its previous UNIX/RISC architecture to Intel processor-based servers and has chosen Red Hat Enterprise Linux for its corporate-standard OS. The company is 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

APPENDIX A: ADDITIONAL RESOURCES

Red Hat and Intel: The Intelligent Server Choice web site—Access information and resources, including success stories, whitepapers, migration guides, webinars, and more.
www.redhat.com/intelligence/

Intel Software Network—Get more information on Intel and Red Hat solutions, including marketing and technical collateral, news, links, multimedia, and success stories.
http://software.intel.com/sites/oss/ecosystem_daughter/redhat/isv_redhat_collateral.htm

Red Hat Enterprise Linux 5—
Get detailed product information.
www.redhat.com/rhel

Intel processor-based servers—
Get detailed information, including performance benchmarks.
www.intel.com/p/en_US/products/server/processor

Advanced Mission-Critical Program—
Learn how Red Hat and Intel are teaming up with leading hardware vendors to deliver a new level of mission-critical service and support.
www.redhat.com/promo/mc_program/

Red Hat Training—
Learn more about the comprehensive, award-winning training programs available from Red Hat.
www.redhat.com/training/

Red Hat Consulting Services—
Learn about the complete set of services for migration planning and implementation available from Red Hat.
www.redhat.com/consulting

APPENDIX B: THE OPEN SOURCE SOLUTION STACK

Red Hat offers and supports a complete open source solution stack for enterprise customers. All components are available on a subscription basis that includes software, support, updates, and upgrades—all delivered online through Red Hat Network.

Components include:

- **JBoss Application Server—**the leading Java-based runtime for web and enterprise applications (includes Apache Tomcat).
- **JBoss Hibernate—**the leading technology for object and relational mapping and persistence.
- **Red Hat Enterprise Linux—**the leading open source Linux platform for enterprise computing.
- **Open source databases—**the world's most popular open source databases, including MySQL and PostgreSQL.
- **Web server—**Apache HTTP server, the most popular web server on the Internet, and standard programming languages PHP and Perl.

APPENDIX C: SAMPLE STANDARD BUILD

The following provides an example of software components that can be used in a standard build. Many alternatives are available, including both open source and vendor products.

Infrastructure Component	Red Hat Enterprise Linux Environment
Provisioning	Kickstart, Red Hat Network/Satellite
Network File Systems	NFS/NFSv4
Drive/Directory mounting	Autofs
Package management	RPM/YUM
Systems management	Red Hat Network/Satellite
Monitoring	Red Hat Network/Satellite
Troubleshooting	SystemTap
Packet filtering firewall	Netfilter/IPtables
Intrusion detection	Advanced Intrusion Detection Environment (AIDE)
Identity management	Red Hat Directory Server, Red Hat Certificate System
File Systems	Ext3/4, LVM, GFS, XFS
Virtualization	Red Hat Enterprise Virtualization, Xen, Kernel-based Virtual Machine (KVM), VMware support
Storage multipath	device-mapper-multipath
Job scheduling	Red Hat Enterprise MRG Grid
Clustering	Red Hat Cluster Suite
Bare-metal recovery	Kickstart, Red Hat Network/Satellite

APPENDIX D: ADVANCED RAS CAPABILITIES IN THE INTEL XEON PROCESSOR 7500 SERIES

As shown in the table below, the Intel Xeon processor 7500 series includes more than 20 new reliability, availability, and serviceability (RAS) features. Red Hat is integrating extensive support into Red Hat Enterprise Linux to support these features and deliver breakthrough support for hosting mission-critical applications.

Benefits for IT	Intel Silicon Features	Red Hat Support[a]
Protects data		
• Reduces circuit-level errors • Detects data errors across the system • Limits the impact of errors	Parity checking and Error Correction Code (ECC)	No support required (fully implemented in silicon)
	Memory thermal throttling	
	Intel® QuickPath Interconnect (Intel® QPI) protocol protection via Cyclic Redundancy Checking (CRC): 8-bit or 16-bit rolling	
	Memory demand and patrol scrubbing	Support planned for Red Hat Enterprise Linux 6
	Corrupt data containment mode	
	Viral mode	
Increases availability		
• Heals failing data connections • Supports redundancy and failover for key system components • Recovers from uncorrected data errors	Intel® Scalable Memory Interconnect (Intel® SMI) Lane failover	No support required (fully implemented in silicon)
	Intel SMI clock failover	
	Intel SMI and Intel QPI packet retry	
	Intel QPI clock failover	
	Intel QPI self-healing	
	Single Device DRAM Correction (SDDC) plus random bit error recovery	
	Machine Check Architecture Recovery (MCA Recovery)	Support planned for Red Hat Enterprise Linux 6
	Memory mirroring	
	Memory DIMM and rank sparing	
Minimizes planned downtime		
Helps IT: • Predict failures before they happen • Maintain partitions instead of systems • Proactively replace failing components	Electronically isolated (static) partitioning	No support required (fully implemented in silicon)
	MCA Recovery error logging (CMCI) with operating system predictive failure analysis	Support planned for Red Hat Enterprise Linux 6
	Memory board hot add/remove	
	Memory on-lining	
	CPU board hot add at Intel QPI	
	CPU on-lining	

[a] Some of the listed RAS features require physical support at the platform level and support may vary depending on your chosen server vendor.

ABOUT THE AUTHORS

Jeff Bernard is a senior director at Red Hat, Inc. and heads up the ISV Partners group in the Platform Business Unit. He owns the marketing initiative to help customers migrate to Red Hat. With over 25 years of experience in the high technology arena, Jeff most recently worked at EMC Corporate where he led the marketing for the midrange CLARiiON software group and helped align VMware and their virtualization offerings with EMC's business. Previous to this, Jeff led several different marketing teams at Sun Microsystems, including the Solaris Marketing organization where he rolled out Solaris 8 on a worldwide basis. Earlier in his career, Jeff held several positions in hardware and software companies with a focus on enterprise systems.

Robert Shiveley is a product manager for Intel's Mission Critical Server Platforms (Intel Xeon processor and Intel® Itanium processor-based platforms). During his 12 years at Intel, Robert has worked in enterprise product and solutions marketing involving enterprise manageability, security, IT infrastructure optimization, IT business value, and enterprise regulatory compliance. Prior to Intel, he worked in strategic and product marketing, solution sales, and business development at enterprise independent software vendors. His experience also includes work in the fields of accounting, audit and regulatory compliance, IT operations, and international finance in several industries, including healthcare, financial services, pharmaceutical, and biomedical systems companies. He has degrees in accounting, business, and information systems and is a licensed CPA.

Performance Benchmark Details (Figure 3):

SPECjbb2005

Sun SPARC Enterprise T5440 server with four Sun UltraSPARC T2 Plus processors, 1.60 GHz, 64 x 4GB DDR2 memory, 1 x 146GB SCSI hard disks, OpenSolaris 2009.06 versus Dell PowerEdge R910 server with four Intel Xeon processors X7560, 2.27 GHz, 32 x 4GB PC3-8500 DDR3 memory, 2 x 73GB, SAS 6.0 GB/s hard disks, Red Hat Enterprise Linux 5.4 (2.6.18-164.9.1.el5). For more information, read the full Principled Technologies Report at: http://www.principledtechnologies.com/clients/reports/Dell/R910_TCO.pdf. The Sun SPARC Enterprise T5440 server result of 841,380 is published on the SPEC Web site at: http://www.spec.org/jbb2005/results/res2009q3/jbb2005-20090720-00753.html

SPECint_rate_base2006

Fujitsu SPARC Enterprise T5440 server with four Sun UltraSPARC T2 Plus processors, 1.60 GHz, 256 GB (64 x 4GB) memory, 536 GB (24 x 73GB 15000RPM FC-AL hard disks, Solaris 10 versus Bull SAS NovaScale R480 F2 server with four Intel Xeon processors X7560, 2.27 GHz, 256 GB (64 x 4GB DDR3-1067 QR RDIMM), 1 x 300 GB 10000 RPM SAS 6 Gb hard disks, Red Hat Enterprise Linux 5 (2.6.18-164.9.1.el5). For more information, see the published results on the SPEC Web site at: http://www.spec.org/cpu2006/results/res2009q3/cpu2006-20090721-08258.html and http://www.spec.org/cpu2006/results/res2010q1/cpu2006-20100315-09869.html

SPECfp_rate_base2006

Fujitsu SPARC Enterprise T5440 server with four Sun UltraSPARC T2 Plus processors, 1.60 GHz, 256 GB (64 x 4GB) memory, 536 GB (24 x 15K SUN72G FC hard disks, Solaris 10 versus Bull SAS NovaScale R480 F2 server with four Intel Xeon processors X7560, 2.27 GHz, 256 GB (64 x 4GB DDR3-1067 QR RDIMM), 1 x 300 GB 10000 RPM SAS 6 GB hard disks, Red Hat Enterprise Linux 5 (2.6.18-164.9.1.el5). For more information, see the published results on the SPEC Web site at: http://www.spec.org/cpu2006/results/res2009q3/cpu2006-20090721-08257.html and http://www.spec.org/cpu2006/results/res2010q2/cpu2006-20100331-10342.html

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