



RED HAT ENTERPRISE LINUX:

THE CLEAR LEADER FOR ENTERPRISE WEB APPLICATIONS

Industry standard benchmarks illustrate that when you need performance, scalability, and reliability for your web applications, Red Hat Enterprise Linux should be your first choice.

As the fastest-growing server operating system in the world¹, Red Hat Enterprise Linux is being deployed across a broad range of applications.

The reason is obvious when you consider the increasing dependency on web technologies in all facets of company operations. Everything from customer sales to Human Resources is being moved to the web browser as a client. However, as the end-client becomes mobile and easier to manage, the burden on the server architecture increases. Whether it is a web server, an application server, or a database, the superior performance and scalability of Red Hat Enterprise Linux has been demonstrated in physical and virtual deployments.

Therefore, best practices for performance and scalability include deploying Red Hat Enterprise Linux throughout your enterprise web applications.

Independent tests performed under the guidelines imposed by industry-standard benchmark standards² found that Red Hat Enterprise Linux is the leading platform for running the following workloads and applications under a three-tiered web application architecture:

- Web servers³
- Java applications on x86_64 hardware⁴
- Large-scale online transaction processing (OLTP) and database applications on x86_64 hardware⁵

- Java Enterprise Edition (EE) application servers for enterprise portals, service oriented architecture (SOA), and business process management (BPM)⁶
- Large-scale SAP applications on x86_64 hardware⁷
- Large guests on virtualized x86_64 hardware⁸

YOUR DUAL CHALLENGE: SIMULTANEOUSLY ACHIEVING COST SAVINGS AND HIGH PERFORMANCE

Amidst today's turbulent economic conditions, the value proposition of getting the most from your IT environment resonates more than ever. You face two key challenges today when deploying enterprise applications: finding ways to continually enhance performance and cutting costs. Red Hat delivers on both.

First, performance. Both internal and external users expect rapid response times. For internal users, productivity suffers if your web applications are slow to respond. And when applications are externally focused – to be used by customers or partners – poor performance can drive users away, often to competitors. So, first and foremost, your web applications must be fast.

And as you add users, performance can't suffer: enterprise web applications must be able to accommodate hundreds of thousands of users without performance degradation. After all, people expect a responsive, well-designed, and highly functional webpage. So your web applications must scale.

But you also need to contain costs. This means taking advantage of the latest multi-core hardware as well as leveraging virtualization for even greater cost savings.

1 Analysis based upon IDC Doc #218938/June 2009

2 TPC, SPEC, and SAP enforce strict policies on publishing benchmark results for competitive comparison purposes. All Red Hat reference architecture documents comply with these policies.

3 SPECweb2005 score = 71,045

4 SPECjbb2005 = 2,150,260 BOPS.

5 1,200,000 tpmC, \$1.99/tpmC.

6 SPECjAppServer2004 = 22,634 JOPS

7 5,156 - 2 Tier SAP SD users

8 85 percent virtualization efficiency for 24vCPU guests running SAP SD

In the past, you might have hesitated to deploy Linux – unsure if it was powerful or scalable enough to support your enterprise web applications. Due to the depth and breadth of Red Hat's relationship with industry leaders, the proof has emerged and Red Hat Enterprise Linux has presented itself as a mature, mission-critical platform. As more IT managers are discovering, Red Hat Enterprise Linux offers significant price/performance advantages over Microsoft Windows as well as other legacy operating systems.

Over the past year, a number of leading technology firms – including IBM, HP, and SAP – invited Red Hat to participate in industry-standard benchmarks that compared Red Hat Enterprise Linux to Microsoft Windows and other operating systems under scenarios comparable to those you deal with every day. The benchmarks show Red Hat Enterprise Linux is the leader in web-based performance.

RED HAT ENTERPRISE LINUX AT THE DATABASE TIER

Databases are the heart of your secure, scalable, and reliable web application. As you add users and increase application complexity, you must be careful that performance doesn't suffer – both on bare metal and in virtualized environments.

RED HAT ENTERPRISE LINUX PROVEN BEST PLATFORM FOR ONLINE TRANSACTION PROCESSING

As the class of systems that manages mission-critical online applications for enterprises in industries ranging from banking, to manufacturing, to retail, online transaction processing (OLTP) is increasingly performed on clusters of x86 machines. OLTP can refer to transactions that are either executed online, as in ATM transactions, or placed in a queue to be executed later, as in many order processing systems.

In the x86 world, enterprises have the choice of x86 and Windows platforms for their OLTP applications. Recently, IBM and Red Hat ran the TPC Benchmark™C (TPC-C) on IBM's latest x86 systems, testing a mix of five concurrent

transactions of different types and complexity. The underlying database contained nine types of tables of varying record and data population sizes. Because TPC-C is an industry-standard benchmark, we can compare our results to those on Windows and legacy UNIX platforms.⁹

Red Hat Enterprise Linux surpassed the Windows Server results in both overall throughput and in price/performance. The Red Hat Enterprise Linux and IBM results represented the first time that a technology combination exceeded one million transactions per minute (tpmC) on an x86-based system. Red Hat Enterprise Linux achieved 1.2 million tpmC at \$1.99 on an 8 processor x86_64 server. The nearest Windows Server result on similar hardware was .84 million tpmC at \$3.46 (see Figure 1 and Figure 2).

Conclusion: From both a performance and a cost perspective, Red Hat Enterprise Linux is the superior platform for OLTP on x86_64 systems when compared to Windows.

BEST TPC-C PRICE/ PERFORMANCE FOR 8 PROCESSOR X86_64 SERVERS (DEC 2008)

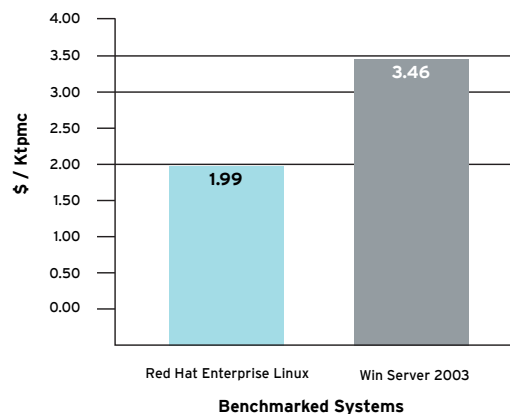


Figure 1: Red Hat Enterprise Linux had the best OLTP system price/performance when compared to Windows.

⁹ The TPC-C Benchmark was performed with DB2 on IBM Systems x3960 M2 using Red Hat Enterprise Linux operating at more than one million transactions per minute (tpmC).



BEST TPC-C THROUGHPUT FOR X86_64 SERVERS (OCT 2008)

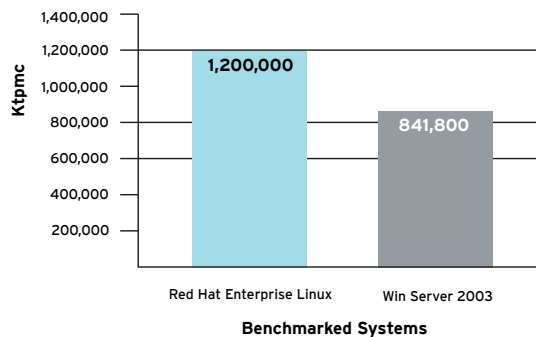


Figure 2: Red Hat Enterprise Linux delivered the best throughput when compared to Windows.

ORACLE OLTP PERFORMANCE SCALING ON RED HAT ENTERPRISE LINUX

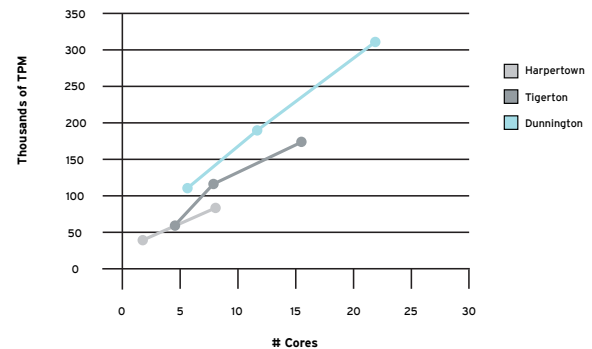


Figure 3

RED HAT ENTERPRISE LINUX SCALES TO HANDLE MISSION-CRITICAL ORACLE 10G DATABASES

Driven by cost savings, more and more enterprises are migrating applications from UNIX on proprietary RISC hardware to Red Hat Enterprise Linux running on commodity x86 machines. To manage the demands of their largest mission-critical databases, such businesses need the option to scale up the number of processors in each system.

Red Hat recently ran benchmarks that tested the vertical scaling for Oracle database performance on Red Hat Enterprise Linux on servers with increasingly larger numbers of x86_64 cores.¹⁰ Previous benchmarks demonstrated excellent scalability up to eight cores. But in March 2009, Red Hat performed a test dramatizing that Oracle OLTP applications could scale vertically up to 24 cores (see Figure 3).

¹⁰ The scaling of Oracle 10g as tested using Red Hat Enterprise Linux 5 on Intel Xeon-based servers

ORACLE 10G PERFORMANCE ON RED HAT ENTERPRISE LINUX 5 VIRTUALIZATION SCALES BOTH HORIZONTALLY AND VERTICALLY

No matter whether an enterprise wants to scale its Oracle 10g databases vertically or horizontally, Red Hat Enterprise Linux with integrated virtualization allows the customer to achieve its performance goals. Almost every virtualization solution supports increased utilization of your system by adding multiple smaller guests. Red Hat's virtualization technology also allows you to scale up and add up to 32 virtual CPUs to a single guest. As internal benchmarking shows, scaling up virtual CPU systems provides you the same benefits that you would expect from adding physical CPUs. (Figure 4). This allows them to accommodate ever-larger mission-critical workloads.

RELATIVE PERFORMANCE OF DATABASE WORKLOAD IN A VIRTUAL GUEST

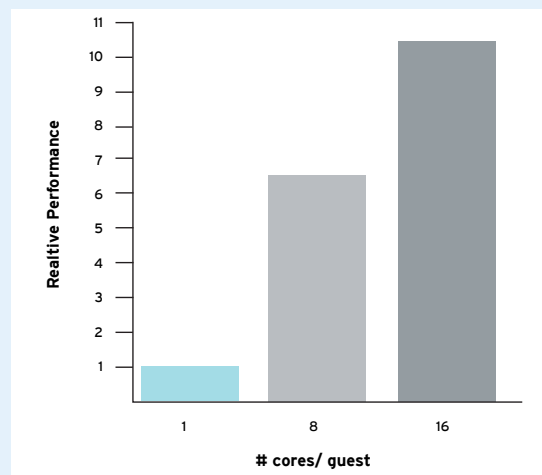


Figure 4: Enterprises can use Red Hat Enterprise Linux with Oracle 10g to scale up by assigning more CPUs to a single guest.

SAP ACHIEVES TOP VIRTUALIZATION EFFICIENCY WITH RED HAT ENTERPRISE LINUX VIRTUALIZATION

It is the common wisdom that server efficiency can drop – often precipitously – in virtualized environments. This has discouraged many enterprises from deploying virtualization for their largest and most mission-critical database applications. But in November 2008, when Red Hat tested the performance hit that a very large-scale SAP SD application took in a virtualized environment under Red Hat Enterprise Linux,¹¹ it proved to be minimal. With an efficiency rate of 85 percent, the virtualized SAP application was able to accommodate 4,400 users when compared to the 5,156 users supported on bare metal (see Figure 6).

Moreover, because of the higher virtual CPU limit per guest made possible by Red Hat Enterprise Linux 5 virtualization, Red Hat Enterprise Linux outperformed other leading virtualization solutions that were also tested at SAP's Linux Labs (see Figure 5).

COMPARISON OF BARE-METAL VERSUS PARA-VIRTUALIZED GUEST PERFORMANCE USING SAP-SD BENCHMARK ON RED HAT ENTERPRISE LINUX 5.2

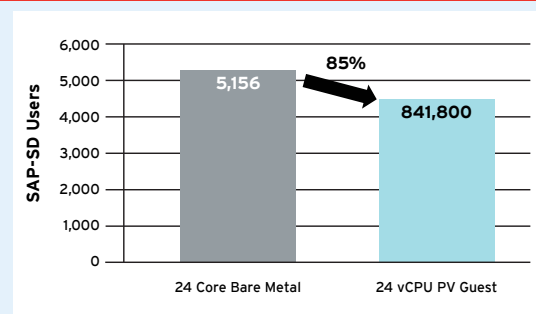


Figure 5: Red Hat Enterprise Linux virtualization is the best platform for running large web applications such as SAP as guests on x86_64 hardware.

¹¹ Under the SAP SD Benchmark using DB2 running Red Hat Enterprise Linux 5 Virtualization on IBM System x3850 M2



THE BUSINESS LOGIC TIER

Users simply won't tolerate a slow-moving web application that performs more sluggishly than the other applications they use. And you have to continue keeping your eye on costs. After all, the lower the throughput, the more hardware you need to run your application. That adds up.

Further benchmarks that compared Red Hat Enterprise Linux to other operating environments found that Red Hat Enterprise Linux achieves more business processes per minute and enables more processing with less hardware.

RED HAT ENTERPRISE LINUX BEATS WINDOWS AND SOLARIS RUNNING JAVA ON X86_64 HARDWARE

Enterprises need their business-critical Java applications – both internal and customer-facing – to perform at top speed or risk having employee productivity and customer satisfaction deteriorate. In February 2009, Red Hat simulated an order processing application scenario for a wholesale supplier to test the performance capabilities of various operating systems running on Intel Xeon-based hardware.¹² Red Hat Enterprise Linux beat both Windows and Solaris in benchmarks that measured business operations per second (BOPS) as well as the BOPS per each Java virtual machine (JVM) instance (see Figure 6).

¹² Test was run using the SPECjbb 2005 Benchmark using Red Hat Enterprise Linux 5.3 on an 96-core Intel Xeon-based NEC server.

BEST SPECJBB2005 BOPS FOR X86_64 SERVERS (MAR 2009)

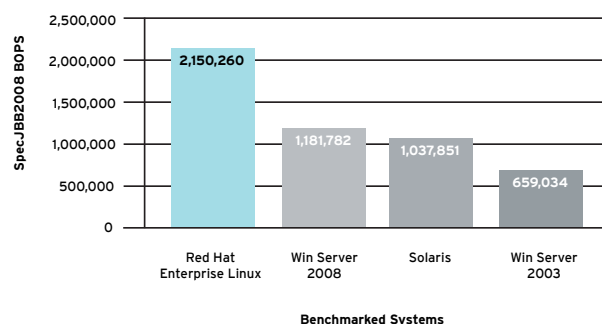


Figure 6: Red Hat Enterprise Linux was by far the best-performing operating system for running Java applications.

RED HAT ENTERPRISE LINUX IS THE BEST OPERATING SYSTEM FOR WEB SERVERS

In the online world, responsiveness is everything. It is the responsibility of the web server to manage the connections and deliver the content. Not only is this an I/O-intensive function, but in secure SSL environments, it is also computationally intensive. Even a few seconds delay can lose customers, slow down worker productivity, and hurt the bottom line. Small wonder that businesses are constantly seeking the most robust and high-performing operating system for the web servers running their mission-critical online applications.

After testing the performance of Red Hat Enterprise Linux using three common enterprise workloads – banking, e-commerce, and support – Red Hat Enterprise Linux emerged the clear winner.¹³

¹³ The tests were conducted in accordance with SPECweb2005, the next-generation SPEC benchmark for evaluating the performance of World Wide Web servers.

Red Hat Enterprise Linux achieved the highest SPECweb2005 score on benchmarks completed in January 2009. Of the top 20 published SPECweb2005 results, 19 were achieved using Red Hat Enterprise Linux. There are numerous results for SpecWeb2005 that document the increase in performance from generation to generation. However, none of them have been run on a Windows Server platform.

BEST SPECWEB2005 (2-SOCKET X86_64 SERVERS)

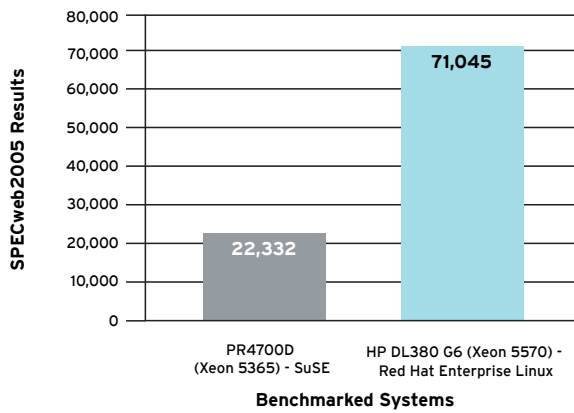


Figure 7: Red Hat Enterprise Linux achieved the best score on two-socket x86_64 hardware.

BEST SPECWEB2005 (4-SOCKET X86_64 SERVERS)

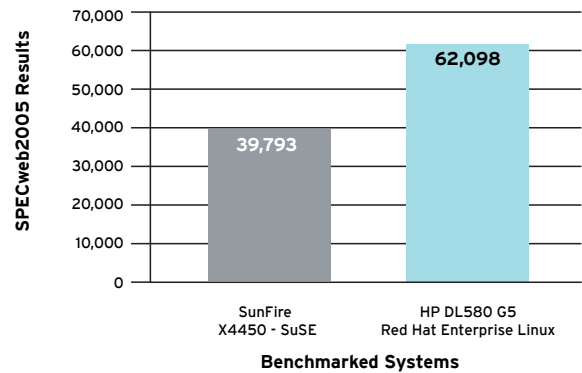


Figure 8: Red Hat Enterprise Linux achieved the best results on web server benchmarks conducted on four-socket x86_64 machines.

RED HAT ENTERPRISE LINUX BEST PLATFORM FOR RUNNING JAVA ENTERPRISE EDITION APPLICATION SERVERS

Whether needing a platform to support their SOA or business process management (BPM) efforts, enterprises require a robust, scalable, and high-performing platform for Java Enterprise Edition (EE) application servers. Through benchmarks performed in February 2009, Red Hat Enterprise Linux beat out HP-UX, AIX, and Solaris by comparing jAppServer operations per second (JOPS) achieved.¹⁴ (See Figure 9.)

¹⁴ SPECjAppServer2004 Benchmark using Red Hat Enterprise Linux 5.2 on an IBM BladeCenter HS21.



BEST SPECJAPPSERVER2004

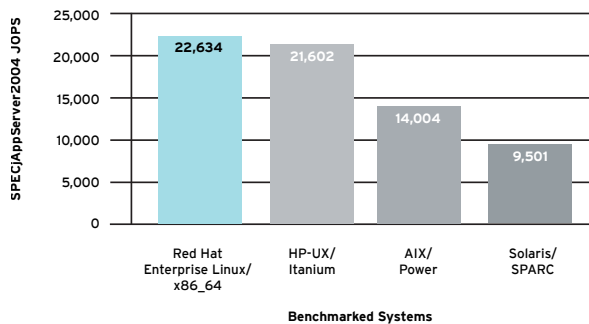


Figure 9: Red Hat Enterprise Linux beat out HP-UX, AIX, and Solaris when benchmarking the performance of Java EE application servers.

PUTTING IT ALL TOGETHER: RED HAT ENTERPRISE LINUX SCALES BETTER THAN WINDOWS FOR LARGE SAP APPLICATIONS

To determine whether Red Hat Enterprise Linux can scale sufficiently to support the large number of users of the SAP Sales and Distribution (SD) applications that global retailers depend on to run their businesses, Red Hat ran the SAP SD Benchmark.¹⁵ This benchmark has become a de facto standard for evaluating the performance of many ERP solutions, and tests a scenario in which a customer places an order for five separate products, and encompasses all processes and processing involved in moving those products from inventory through delivery and customer invoicing.

Conventional wisdom in the marketplace has been that Red Hat Enterprise Linux cannot scale to accommodate a large number of customers under a scenario of this sort. This test proved otherwise.

¹⁵ The benchmark used DB2 and Red Hat Enterprise Linux 5 on IBM System x3850 M2

In November 2008, Red Hat Enterprise Linux achieved the best 24-core performance to date – beating both Solaris and Windows – on x86_64 servers by scaling to support simultaneous transactions by 5,156 SAP SD users (see Figure 10).

2-TIER SAP SD BENCHMARK RESULTS (NOV 2008)

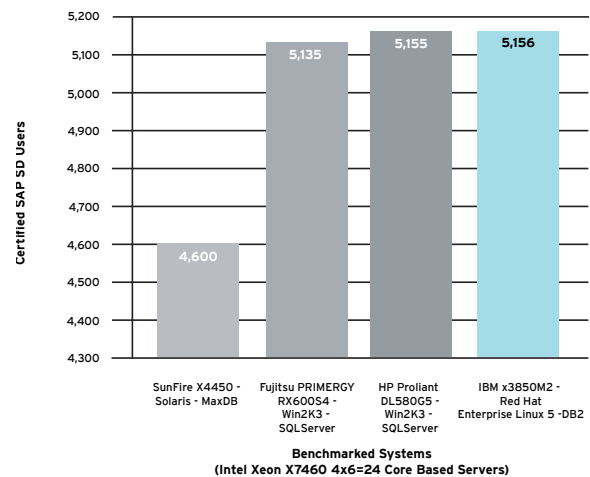


Figure 10: Red Hat Enterprise Linux outperformed Windows and Solaris on SAP SD benchmark in November 2008.



CONCLUSION: NO COMPROMISES WITH RED HAT ENTERPRISE LINUX

These rigorous tests, run in conformance with accepted industry-standard benchmarks, illustrate how Red Hat Enterprise Linux beats Microsoft Windows as the best platform for enterprise web applications. This superior performance, coupled with significant cost savings derived from the ability to leverage the latest multicore x86 hardware as well as virtualization, adds up to competitive advantage for you.

Whether it's migration, consolidation, expansion, or just plain good architectural capacity planning, Red Hat Enterprise Linux is your best choice for an enterprise operating system that will enable all of those efforts.

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