SPECweb2005 Performance

ESX Server 3.5

Virtualization is revolutionizing data center computing by making it easy for people to run multiple operating systems and multiple applications seamlessly on the same computer. More and more organizations are adopting VMware® Infrastructure 3 for server consolidation and to reduce the total cost of ownership.

VMware ESX Server 3.5 is designed for high performance. With a number of optimizations for superior performance, even the most I/O-intensive applications perform well when deployed on VMware Infrastructure 3. In this paper we compare the performance of a virtual machine to that of a similarly configured native machine using the industry standard SPECweb2005 workload. In our virtualized tests we achieved close to 85 percent of native throughput performance using the highly network-intensive SPECweb2005 workload. In the tests focused on measuring latency, we did not observe any noticeable difference in application latency between the native and virtual environments. These results demonstrate that users need not sacrifice performance in order to embrace the benefits of virtualization technology.

This paper covers the following topics:

Who Should Read This Paper

This paper is intended for VMware customers who are interested in deploying their network-intensive applications in a virtual environment using VMware Infrastructure 3 and would like to understand the performance implications as well as tunings and considerations for better network performance in a virtualized environment.

About VMware Infrastructure 3

VMware Infrastructure 3 is the next generation of the industry-leading infrastructure software suite that virtualizes servers, storage, and networking, allowing multiple unmodified operating systems and their applications to run independently in virtual machines while sharing physical resources. The software suite consists of ESX Server (hypervisor) and several other products that work together to not only provide the benefits of consolidation but also foster flexibility. The suite features unique technologies such as VMware VMotion that enables moving an entire running virtual machine from one physical server to another, VMware HA that provides cost-effective failover protection by eliminating the need for dedicated stand-by servers or

additional software, and VMware DRS that dynamically allocates and balances available computing resources among virtual machines.

In essence, VMware Infrastructure 3 enables organizations to decouple the entire software environment from their underlying hardware infrastructure. This virtualization approach helps organizations build computing infrastructure with high levels of utilization and flexibility.

About the SPECweb2005 Workload

SPECweb2005 is the SPEC benchmark for measuring a system's ability to act as a Web server. In response to rapidly advancing Web technology, the SPECweb2005 benchmark includes many sophisticated and state-of-the-art enhancements to meet the demands of modern Web users.

SPECweb2005 is designed with three workloads: banking, e-commerce, and support. The banking component emulates a banking site that transfers encrypted information using HTTPS. The e-commerce component emulates an e-commerce site that uses unencrypted HTTP when browsing and secure HTTPS when the user enters the shopping cart. The support component emulates a vendor support site that provides downloads—such as driver updates and documentation—over HTTP.

The SPECweb2005 architecture represents a typical Web architecture that consists of the clients, Web server software and back-end application or database server. The benchmark drivers that generate the HTTP requests run on one or more client machines. The back-end simulator (BeSim) emulates a back-end application or database server. To process the SPECweb2005 requests, the Web server software needs to communicate with the BeSim in order to retrieve specific information that needs to be included in the HTTP response. Because the HTTP response is dynamically constructed, the Web server software should include PHP or JSP support that is needed to generate the dynamic Web content.

The performance score of each of the three workloads (banking, e-commerce, and support) is measured in terms of the number of simultaneous user sessions the system under test is able to support while meeting the quality of service requirements of the respective benchmark workload. The aggregate metric reported by the SPECweb2005 benchmark is a normalized metric based on performance scores obtained on all the three workloads. For more information about the benchmark, see http://www.spec.org/web2005/.

Test Configuration and Methodology

In this section, we describe in detail how we configured both the native and the virtual environments for all our tests. In order to draw fair comparisons, we attempted as much as possible to configure both testbeds identically. The physical network and storage infrastructure were never changed as we switched between native and virtual machine tests. Neither storage configuration nor network configuration in the virtual environment requires any additional hardware.

CPU and Memory

In our test configuration, the system under test was an HP ProLiant DL385 G1 server. The server was configured with two 2.2GHz dual-core AMD Opteron 275 processors and 8GB of RAM.

In the native environment, the system was booted with one CPU and 6GB of memory and ran Red Hat Enterprise Linux 4 64-bit. In the virtualized environment, we used a one-VCPU virtual machine configured with 6GB of memory, running Red Hat Enterprise Linux 4 64-bit and hosted on ESX Server 3.5. We used the same versions of the operating system and Web server software (Rock Web Server, Rock JSP/Servlet container) in both the native and the virtualized tests.

Network

The SPECweb2005 workload is quite network intensive. Even on a single-CPU test, we exceeded the capacity of a single 1Gbps network link. The system was therefore configured with two 1Gbps Ethernet adapters, each associated with a unique subnet. We used two clients, each of which was connected directly to the server over a separate private subnet using crossover cables. These two networks carry the client traffic. In addition, we used one more 1Gbps Ethernet adapter on the server for the BeSim (back-end database simulator) traffic. The BeSim was also connected to the server on a separate private subnet using a cross-over cable.

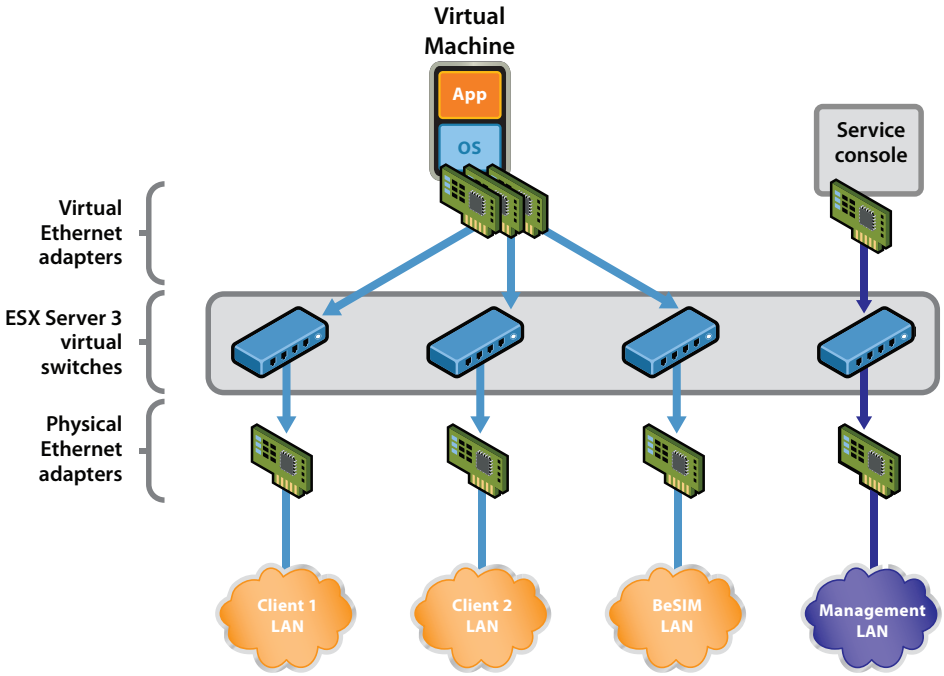
VMware Infrastructure 3 provides a rich set of network capabilities for configuring the virtual machines. We briefly discuss a few network virtualization terms that will help the reader better understand how we configured the network on a virtual machine.

Network configuration in VMware Infrastructure 3 is centered around the concept of a virtual switch, which is a software representation of a modern Ethernet switch. It acts as a conduit between the virtual network interface on a virtual machine and the actual physical network adapter. In our virtualized tests we configured the virtual machine with three virtual Ethernet adapters. Each virtual network adapter was connected to a unique physical network adapter through a virtual switch interface. By not connecting any other virtual machines to the virtual switches, we essentially dedicated the three physical network adapters to the test virtual machine. Just as in native system tests, we separated the client network traffic from the BeSim traffic in the virtualized tests.

The physical network configuration is exactly the same in both the virtualized tests and the native tests. The virtual networking does not require additional networking hardware. Each of the three virtual network adapters has a unique IP address and a unique MAC address. Thus from the client's networking standpoint, the virtual network adapters of a virtual machine appear the same as the physical network adapters of a native system.

Figure 1 shows the networking configuration in the virtual environment.

Figure 1. Network configuration in the virtual environment



VMware Infrastructure 3 provides various choices for virtual network adapters, including vlance (which emulates an AMD Lance PCNet32 Ethernet adapter; vlance is not an available option for 64-bit guest operating systems) and e1000 (which emulates an Intel e1000 82545EM Ethernet adapter). In our tests, we used vmxnet, a virtual network adapter that is designed for high performance. This is a paravirtualized device that works only if VMware Tools is installed in the virtual machine.

Storage

VMware Infrastructure 3 storage configuration completely hides the physical storage infrastructure from the virtual machines. The virtual machines access the underlying physical storage as though it were JBOD ("just a bunch of disks," in which disks are merely concatenated together so they appear to be a single large disk) SCSI within the virtual machine. VMware Infrastructure 3 provides the choice of two virtual SCSI controllers, BusLogic and LSI Logic. The default controller for a virtual machine depends on the guest operating system. In our virtualized environment we used the default LSI Logic SCSI adapter.

On the physical host the administrator is free to choose either a locally-attached RAID controller or a remote storage area network (SAN) device. Apart from the choice of the controller, the storage configuration for a virtual machine also provides choices on ways to make blocks of storage accessible to the virtual machine:

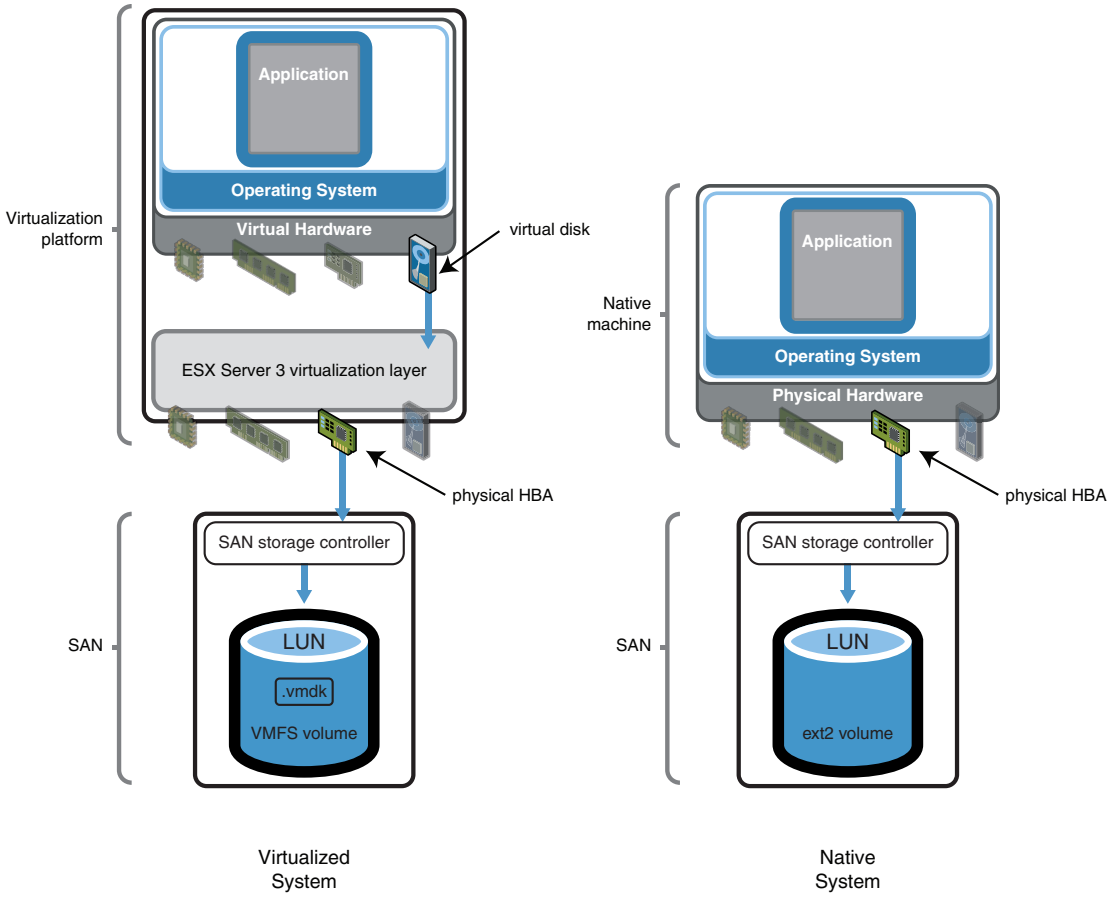
- Using an encapsulated disk file hosted on a VMware Virtual Machine File System (VMFS)
- Using a raw LUN

The vast majority of virtual machines use encapsulated disk files (`.vmdk`) on a VMFS volume hosted on a remote SAN device. This configuration enables customers to take advantage of some of the advanced features of VMware Infrastructure 3, such as VMotion. Accordingly, we configured the virtual machine to use a `.vmdk` file hosted on a 12-disk RAID-0 LUN on a remote SAN.

For the native tests, we configured a 12-disk RAID-0 LUN formatted with the ext2 file system on the same Fibre Channel SAN. As with the network configuration, the physical storage configuration is exactly the same in both the virtualized tests and the native tests. The storage configuration, like the virtual networking, does not require any additional hardware.

Figure 2 depicts how we configured our storage in both the virtual and native environments.

Figure 2. Storage configuration in virtual and native environments



System Tuning

We applied the same tunings in both the virtualized and native tests for both the operating system (Red Hat Enterprise Linux 4 64-bit) and the Web server software (Rock Web Server and JRock Servlet container). The tunings are listed in the full disclosure report in "Appendix: Detailed SPECweb2005 Results" on page 11.

In our virtualized tests we increased the transmit coalescing size in the vmxnet virtual NIC to meet the high network throughput demands of the support workload. Most virtual machine workloads are latency sensitive, so the default dynamic tuning works fine. However, if the network throughput demands of the workload are very high (close to or exceeding 1Gbps), this parameter can be tuned to favor throughput over latency. We also

used the manual processor affinity feature to assign the virtual machine to a physical core on the system under test. This was done to better understand and track the CPU usage of the virtual machine. In our tests, affinity yielded less than 5 percent improvement in performance.

NOTE Manual affinity is not recommended in production environments because it may interfere with the CPU scheduler's ability to load balance effectively across multiple CPUs.

To increase the transmit coalescing size, perform the tasks below:

1 Using VMware Infrastructure Client (VI Client), choose the ESX Server host on which the virtual machine is deployed.

2 Click the **Configuration** tab.

3 Click **Advanced Settings** in the Software panel.

4 Click the **Net** tab.

5 Edit the `Net.vmxnetThroughputWeight` value to `128`, then click **OK**.

6 Reboot the virtual machine.

To set the processor affinity, perform the following tasks:

1 Using VI Client, right-click a virtual machine and choose **Edit Settings**.

2 In the Virtual Machine Properties dialog box, click the **Resources** tab and choose **Advanced CPU**.

3 In the Scheduling Affinity panel, set the processor affinity.

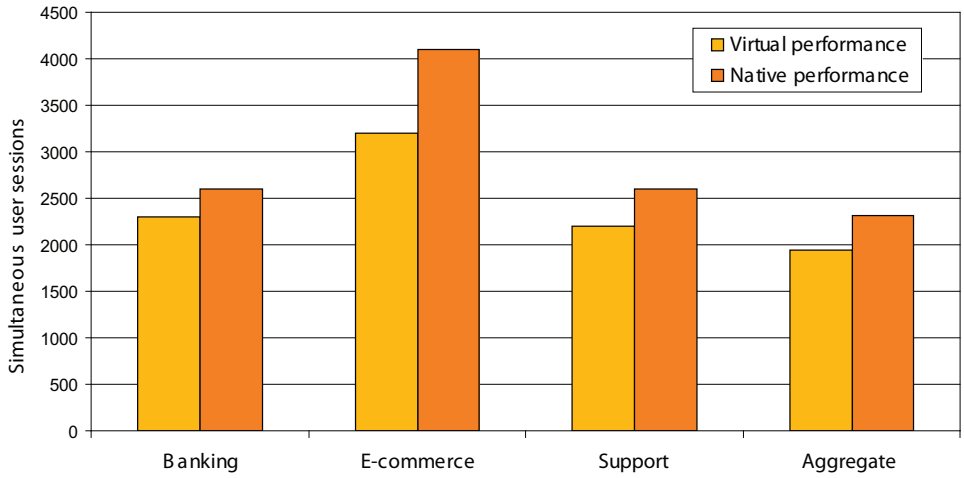
Performance

ESX Server is designed for high performance. However, as with any additional software layer, the virtualization adds some overhead. Each of the system resources—such as CPU, memory, network, and storage—experiences different levels of virtualization overhead. In general, applications that consist primarily of unprivileged user-level application code show near-native performance in a virtual environment because the user-level code is run directly on the underlying processor. A compute-intensive application, for instance, falls in this category. Applications that include a heavy system (privileged) component can incur some extra processing to virtualize. An application that is very network- or disk I/O-intensive, for instance, falls in this category. The results in this section demonstrate that a network-intensive application such as the SPECweb2005 benchmark running inside a virtual machine achieves performance that is close to native while consuming only a modest amount of additional CPU.

There are various dimensions to performance. The most significant of these that pertain to real world applications are overall latency (execution time) of an application and system throughput (maximum operations per second). We are also concerned with the amount of physical resource required, per request or response. Our tests focused on measuring all these aspects of performance.

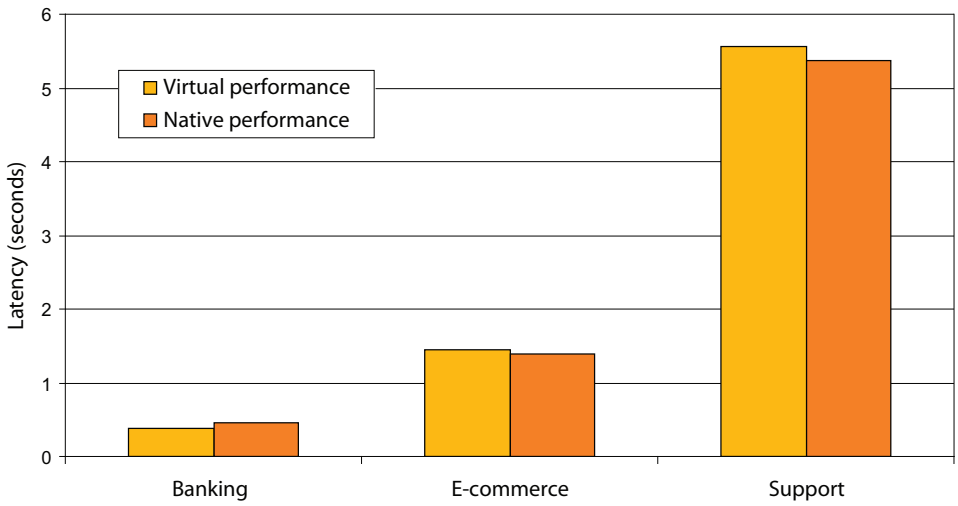
Our first set of tests focused on measuring the peak throughput that can be sustained by both native machines and virtual machines. In the context of the SPECweb2005 workload, the appropriate metric to measure throughput is the maximum connections a system can sustain while meeting the benchmark latency requirements. In our throughput tests, as you can see from Figure 3, we obtained close to 85 percent of native performance using the SPECweb2005 workload. The aggregate metric reported by the SPECweb2005 benchmark is a normalized metric based on the performance scores obtained on all three workloads. At the individual workload level, we obtained close to 90 percent of native performance on the SPECweb2005 banking workload, close to 80 percent of native performance on the e-commerce workload, and 85 percent of native performance on the support workload.

Figure 3. SPECweb2005 throughput performance in virtual and native environments



In our second set of tests, we focused on latency measurements. In the SPECweb2005 benchmark, a Web page request constitutes multiple HTTP requests. A client records the response time only after all of the HTTP requests that constitute a Web page request have been sent and all the responses are received (typically, this is a dynamic response plus any embedded image files). This latency is reported as average response time in the benchmark disclosure report. In our latency tests, we have chosen the load that is approximately 80 percent of the peak throughput obtained on a native machine. We did this to ensure the system was not saturated but was sufficiently loaded (with the utilization levels of 70 to 80 percent) during our latency measurements. As you can see from Figure 4, in the latency tests, we did not observe any difference in application latency between the native and virtual environments. We also did not any observe any difference in the network or storage utilizations between the two tests. These results show that in customer environments in which CPU resources are not saturated, users may not perceive the minimal virtualization latency added by the ESX Server hypervisor. In the banking tests, we in fact observed lower latency in the virtual environment compared to the latency observed in the native environment. This may be because ESX Server intelligently offloads some functionality to the available idle cores, and in certain cases users may even experience slightly better latency in a virtual environment.

Figure 4. SPECweb2005 latency performance in virtual and native environments



We collected the performance data for CPU, memory, disk, and network usage in both native and virtualized tests. In native tests, we used performance monitoring tools available on RHEL4 including the `vmstat`, `mpstat`, `iostat`, and `sar` utilities. In the virtual machine tests, we used `esxtop` to collect both the ESX Server and virtual machine performance data. In the virtual environment, the statistics obtained by running performance monitoring tools inside a virtual machine may not accurately reflect the physical resource usage.

In the following subsections we discuss the performance statistics we gathered in each of the three benchmark component tests.

Banking Performance

Of the three workloads that comprise SPECweb2005, the banking workload has the largest user (unprivileged) component. The workload is characterized by 100 percent SSL encrypted traffic that typifies an Internet personal banking workload. SSL is very compute intensive and is completely implemented in user space. Thus you can expect to observe very little virtualization overhead and close to native performance.

Tables 1 and 2 show a detailed analysis of the performance statistics collected during both 1-CPU native and 1-VCPU virtualized throughput tests using the banking workload.

Table 1. Banking workload native throughput performance statistics

Sessions	CPU Usage (user/sys/idle/wait)	Memory (Inactive/si/so)	Disk I/O (latency)	Network I/O (transmit)
2600	80/19/01/00	3.5GB/0/0	3 ms	110 Mbps (approx.)

Table 2. Banking workload ESX Server throughput performance statistics

Sessions	CPU Usage (%PCPU/%USED)	Memory (%ACTV/SWAP)	Disk I/O (latency)	Network I/O (transmit)
2300	100/104	48/0	4 ms	90 Mbps (approx.)

We observed 2600 and 2300 banking user sessions in the native and virtualized environments, respectively.

In the native tests, as indicated by the CPU Usage column, the processor was fully saturated. Data from `/proc/meminfo` showed that the amount of inactive memory that could be reclaimed was about 3.5GB, indicating no memory shortage. There was no swap activity (indicated by the si and so columns in `vmstat`) during the tests. The disk I/O service time is quite small, indicating the absence of any storage bottleneck. On the network front, these tests used about 6 percent of the network bandwidth provided by the two 1Gbps links, clearly indicating the absence of network bottlenecks.

In the ESX Server tests, the virtual machine consumed 100 percent of CPU resources (indicated by the %PCPU column in `esxtop`) on the CPU to which it was pinned. The actual total physical CPU resources used by the virtual machine are 104 percent (which amounts to 1.04 cores on a four-core server), which includes additional work done in ESX Server, such as network interrupt processing. There was no swap activity (indicated by the SWAP column in `esxtop`) during the tests. The active memory referenced by the virtual machine (as indicated by the %ACTV column in `esxtop`) was about 48 percent (which amounts to less than 3GB) with no indication of memory shortage. The average disk latency observed by the virtual machine (as indicated by the DAVG/cmd column in `esxtop`) was about 4ms. The transmit network traffic was about 90 Mbps.

In both the native and virtualized throughput tests the performance was limited by the amount of CPU resources available. With nearly the same amount of physical CPU resources, we achieved close to 90 percent of native throughput performance using the banking workload.

Table 3 compares the performance statistics collected during the one-CPU native and one-VCPU virtualized latency tests using the banking workload. We used the same load of 2100 banking connections in both the tests. We made sure the load on the system was sufficiently heavy to ensure the latency metrics have maximum relevance.

Table 3. Banking workload latency performance statistics

Environment	Sessions	Latency (in seconds)	CPU Utilization (in cores)	Network I/O (transmit)	Disk I/O (latency)
Native	2100	0.464	0.76	85 Mbps	3 ms
Virtual	2100	0.384	0.94	85 Mbps	3 ms

As you can see in Table 3, we observed very minimal difference in the application latency between the tests. In fact, in the ESX Server tests we observed slightly lower application latency compared to the latency observed

in the native tests. This may be because ESX Server intelligently offloads some CPU functionality onto the other available idle cores and hides the virtualization overhead. These tests show that if the CPU in the server is not saturated, users may not pay any penalty in application latency in the virtual environment.

E-Commerce Performance

In the e-commerce workload, unlike the banking workload, only a fraction of the user sessions enter the SSL stage. This typifies an Internet e-commerce site, where most of the browsing and viewing activity does not use encryption, and SSL is used only during the checkout or buy stage. The I/O needs for this workload are higher than those for banking, so you could expect more virtualization overhead compared to the banking workload.

Tables 4 and 5 show a detailed analysis of the performance statistics collected during both one-CPU native and one-VCPU virtualized throughput tests using the e-commerce workload.

Table 4. E-commerce workload native throughput performance statistics

Sessions	CPU Usage (user/sys/idle/wait)	Memory (Inactive/si/so)	Disk I/O (latency)	Network I/O (transmit)
4100	57/40/02/01	2.1GB/0/0	3 ms	430 Mbps (approx)

Table 5. E-commerce workload ESX Server throughput performance statistics

Sessions	CPU Usage (%PCPU/%USED)	Memory (%ACTV/SWAP)	Disk I/O (latency)	Network I/O (transmit)
3200	100/109	41/0	3 ms	330 Mbps (approx)

We observed 4100 and 3200 e-commerce users in the native and virtualized environments, respectively.

In the native tests, you can see that the processor was fully saturated. There were no indications of any memory shortage or disk I/O bottleneck. Data from `/proc/meminfo` showed that the amount of inactive memory that can be reclaimed was about 2.1GB. On the network front, these tests used about 20 percent of the network bandwidth provided by the two 1Gbps links, again indicating the absence of network bottlenecks.

In the ESX Server tests, the virtual machine used 100 percent of CPU resources (indicated by the %PCPU column in `esxtop`) on the CPU to which it was pinned. The total physical CPU resources used by the virtual machine are 109 percent (which amounts to 1.09 cores on a four-core server) which includes additional work done in ESX Server, such as network interrupt processing. The active memory referenced by the guest virtual machine (as indicated by the %ACTV column in `esxtop`) was about 41 percent, which amounts to roughly 2.5GB of memory. There was no swap activity during the tests. The average disk latency observed in the virtual machine was about 3ms. The transmit network traffic was about 330 Mbps.

We achieved close to 80 percent of native performance on the e-commerce workload by using slightly more physical CPU resources than were used in the native tests.

Table 6 compares the performance statistics collected during one-CPU native and one-VCPU virtualized latency tests using the e-commerce workload. We used the same load of 3200 e-commerce connections in both tests. We made sure the load on the system was sufficiently heavy to ensure the latency metrics have maximum relevance.

Table 6. E-commerce workload latency performance statistics

Environment	Sessions	Latency (in seconds)	CPU Utilization (in cores)	Network I/O (transmit)	Disk I/O (latency)
Native	3200	1.398	0.70	330 Mbps	3 ms
Virtual	3200	1.445	1.09	330 Mbps	3 ms

As you can see in Table 6, although ESX Server used more CPU resources, there was no appreciable difference in the application latency. Just as we saw in the banking tests, these tests confirm that in environments in which the CPU resources are not saturated, users may not notice any difference in application latency in the virtual environment.

Support Performance

The support workload has characteristics observed in Web sites used for downloading patches related to upgrades and fixes. The workload is designed to stress network I/O and disk I/O. The response size of an HTTP request can be as large as 35MB. This workload has no SSL traffic. Of the three workloads, the support workload is the most I/O intensive and has the largest system (privileged) component. Thus you can expect more virtualization overhead compared to the other two workloads.

Tables 7 and 8 show a detailed analysis of the performance statistics collected during both one-CPU native and one-VCPU virtualized throughput tests using the support workload.

Table 7. Support workload native throughput performance statistics

Sessions	CPU Usage (user/sys/idle/wait)	Memory (Inactive/s/so)	Disk I/O (latency)	Network I/O (transmit)
2600	13/85/01/01	2.0GB/0/0	2 ms	1200 Mbps (approx)

Table 8. Support workload ESX Server throughput performance statistics

Sessions	CPU Usage (%PCPU/%USED)	Memory (%ACTV/SWAP)	Disk I/O (latency)	Network I/O (transmit)
2200	100/128	80/0	2 ms	1050 Mbps (approx)

We observed 2600 and 2200 support users in the native and virtual environments, respectively.

When compared to the banking and e-commerce tests, these tests show a high amount of system component (more than 80 percent). In both the native and virtualized tests the processor was fully saturated. In the virtualized tests, the virtual machine consumed 100 percent of CPU resources (indicated by the %PCPU column in `esxtop`) on the CPU to which it was pinned. The actual physical CPU resources used by the virtual machine are 128 percent (which amounts to 1.28 cores on a four-core server) which includes additional work done in ESX Server, such as network interrupt processing. As expected, due to the high system component in the support workload, we observed more CPU resource usage in support tests compared to banking and e-commerce. There were no indications of any memory shortage or disk I/O bottlenecks in either test.

The support workload is very demanding on network I/O. As indicated by the performance statistics, in both the native and virtualized environments we observed 1.2Gbps and a little more than 1Gbps client network traffic, respectively, surpassing the capacity of a single 1Gbps link. Using the vmxnet driver in the virtualized tests we took advantage of VMware ESX Server 3.5 features such as support for TCP segment offloading and transmit coalescing, which helped us get close to 85 percent of native throughput performance even with the support workload.

Table 9 shows comparison of the performance statistics collected during both one-CPU native and one-VCPU virtualized latency tests using the support workload. We used the same load of 2200 support connections in both the tests. We made sure the load on the system was sufficiently heavy to ensure the latency metrics have maximum relevance.

Table 9. Support workload latency performance statistics

Environment	Sessions	Latency (in seconds)	CPU Utilization (in cores)	Network I/O (transmit)	Disk I/O (latency)
Native	2200	5.362	0.85	1050 Mbps	2 ms
Virtual	2200	5.558	1.28	1050 Mbps	2 ms

As you can see in Table 9, although ESX Server used more CPU resources, there was no appreciable difference in the application latency. These tests confirm that irrespective of the workload characteristics, in general, if the CPU in the server is not fully saturated, users may not notice any difference in application latency in the virtual environment.

Conclusions and Future Work

Virtualization has become a mainstream technology. With the advancements in technology, performance is no longer a barrier to virtualization.

In this paper we used the highly network-intensive SPECweb2005 workload to compare the native and virtualized environments. Our tests demonstrate that performance in a virtualized environment can be close to that of a native environment even when using the most I/O-intensive applications. Given the underutilized CPU resources in many IT environments, the moderately higher processor requirements for virtualization overheads may be quite manageable. With added benefits such as server consolidation, lower maintenance costs, higher availability, and fault tolerance, a very compelling case can be made to virtualize any application, irrespective of its workload characteristics.

Our testing was limited to a platform that does not support hardware virtualization. Some of our observations and analysis may not apply on the emerging hardware platforms that support hardware virtualization. Our future work will focus on evaluating the performance of network intensive workloads on these new platforms.

Our future work will also focus on investigating the scale-out performance (by increasing the number of virtual machines) as well as scale-up performance (by increasing the number of virtual CPUs configured for each virtual machine) using the SPECweb2005 workload.

Appendix: Detailed SPECweb2005 Results

This appendix presents the full results of the SPECweb2005 tests in the virtual environment and in the native environment.

SPECweb2005 Results in Virtual Environment

SPECweb2005 Result

Hewlett-Packard: HP ProLiant DL 385 G1 (with VMware ESX Server 3.5)
Accoria: Rock Web Server v1.4.2 (x86_64)
Accoria: Rock JSP Container (1.2.1)

SPECweb2005 = 1940

SPECweb2005_Banking = 2300
SPECweb2005_Ecommerce = 3200
SPECweb2005_Support = 2200

Tested By: VMware Inc., USA SPEC License #: 2933 Test Date: Oct-2007

Performance

Banking

Simultaneous User Sessions	Test Iteration	Aggregate QOS Compliance			Validation Errors
		Good	Tolerable	Fail	
2300	1	97.4%	100.0%	0.0%	0
	2	97.0%	100.0%	0.0%	0
	3	96.9%	100.0%	0.0%	0

Ecommerce

Simultaneous User Sessions	Test Iteration	Aggregate QOS Compliance			Validation Errors
		Good	Tolerable	Fail	
3200	1	99.9%	100.0%	0.0%	0
	2	99.8%	100.0%	0.0%	0
	3	99.8%	100.0%	0.0%	0

Support

Simultaneous User Sessions	Test Iteration	Aggregate QOS Compliance			Validation Errors
		Good	Tolerable	Fail	
2200	1	98.3%	99.9%	0.1%	0
	2	98.0%	99.6%	0.4%	0
	3	98.1%	99.8%	0.2%	0

Configuration

Availability Dates

SUT Hardware	Nov-2006
Backend Simulator	Aug-2006
Web Server Software	Apr-2007 (Rock Web Server) Dec-2006 (Rock JSP Container)
Operating System	Aug-2006 (for RHEL4) and Jan 2008 (ESX Server 3.5)
Other Components	N/A

System Under Test (SUT)

# of SUTs	1
Vendor	Hewlett-Packard
Model	HP ProLiant DL 385 G1 (with VMware ESX Server 3.5)
Processor	AMD Opteron 275
Processor Speed	(MHz) 2205
# Processors	1 core Virtual Machine (4 cores, 2 chips, 2 cores/chip)
Primary Cache	64KB(I) + 64KB(D)
Secondary Cache	1024 KB (per core)
Other Cache	N/A
Memory	6 GB SDRAM
Disk Subsystem	1 x 146.80GB SCSI (ESX Server 3.5), 12*133.68GB SCSI (RHEL4, and fileset data)
Disk Controllers	HP Smart Array 6i Controller, QLogic Corp. QLA2340 Fibre Channel Adapter
Operating System	RedHat Enterprise Linux 4 Update 4 (2.6.9-42.ELsmp) x86_64 as Guest OS on VMware ESX Server 3.5 (hypervisor)
File System	ext2
Other Hardware	Network and Storage virtualization do not require additional hardware
Other Software	JDK-1.6.0_01-linux-amd64

SUT Network

# of Controllers	3
Network Controllers	Intel 8254NXX Gigabit dual-port Adapter, HP NC7782 Gigabit Adapter
# of Networks	3
Network Type	Fast Ethernet
Network Speed	1 Gb/s
MSL (sec)	30 (Non RFC1122)
Time-Wait (sec)	60 (Non RFC1122)
MTU Size	1500

Web Server Software

Vendor	Accoria
Name/Version	Rock Web Server v1.4.2 (x86_64)
Dynamic Scripts	JSP

Server Cache	N/A
Log Mode	Rock Binary CLF

Script Engine

Vendor	Accoria
Name/Version	Rock JSP Container (1.2.1)
Dynamic Scripts	JSP
Server Cache	N/A
Log Mode	Rock Binary CLF

Clients

# of Clients	11
Model	Dell Poweredge 1850 HP ProLiant DL360 G5
Processor	Intel Xeon Intel Xeon
Processor Speed (MHz)	3200 3000
# Processors	2 4 (4 cores, 2 chips, 2 cores/chip)
Memory	4096 MB SDRAM 8192 MB SDRAM
Network Controller	Intel Corporation 82541GI/PI Gigabit Ethernet Controller Broadcom Corporation NetXtreme II BCM5708 Gigabit Ethernet
Operating System	RedHat Enterprise Linux update4 (2.6.9-42.ELsmp) RedHat Enterprise Linux update4 (2.6.9-42.ELsmp x86_64)
JVM Version	Java(TM) SE Runtime Environment (build 1.6.0_01-b06) Java(TM) SE Runtime Environment (build 1.6.0_01-b06)
JIT Version	Java HotSpot(TM) Server VM (build 1.6.0_01-b06, mixed mode) Java HotSpot(TM) Server VM (build 1.6.0_01-b06, mixed mode)
Other Hardware	N/A N/A
Other Software	N/A N/A

Backend Simulator (BESIM)

# of Simulators	1
Model	Dell Poweredge 1850
Processor	Intel Xeon
Processor Speed	(MHz) 3200
# of Processors	2
Memory	4096 MB SDRAM
Network Controller	Intel Corporation 82541GI/PI Gigabit Ethernet Controller
Operating System	RedHat Enterprise Linux (2.4.21-47.ELsmp)
File System	ext2
Web Server	Rock Web Server v1.4.2
Server Scripts	ISAPI
Other Hardware	N/A
Other Software	N/A

Common Workload Notes

SUT Notes

- ESX Server 3.5 used as the hypervisor. The Virtual Machine (VM) used one vCPU configured with 6GB memory running RHEL 4 64bit.
- Both OS and the fileset data are located on the same VMFS volume, hosted on a 12-disk RAID-0 stripe LUN on Dell/EMC CX3-40 SAN Array
- The VM is pinned to one of the 4 cores (core 3) on the system.
- ESX had all four cores to its disposal, but the VM was configured with one vCPU only
- The VM was configured with three virtual network adapters, each of which was connected to a unique physical network adapter through a virtual switch interface
- 2 of the networks were used for client traffic, and the third was used for Besim traffic
- vmxnet is used as the virtual network adapter (available as part of VMware Tools)
- The Net.vmxnetThroughputWeight was increased from the default 0 to 128, to favor the throughput in the vmxnet behaviour

Operating System Notes

- Operating System Notes:
- net.ipv4.ip_forward = 0 # Controls IP packet forwarding
- net.ipv4.tcp_timestamps = 0 # default 1
- net.ipv4.tcp_max_tw_buckets = 1500000 # sets TCP time-wait buckets pool size, default 180000
- net.ipv4.tcp_rmem = 5000000 5000000 5000000 # maximum receive socket buffer size, default 131071
- net.ipv4.tcp_wmem = 5000000 5000000 5000000 # maximum TCP write-buffer space allocatable, default 4096 16384 131072
- net.ipv4.tcp_mem = 5000000 5000000 5000000 # maximum TCP buffer space allocatable, default 392192 392704 393216
- net.ipv4.tcp_window_scaling = 0 # turns TCP window scaling support off, default on
- net.ipv4.tcp_tso_win_divisor = 8

- net.core.rmem_max = 1048576 # maximum receive socket buffer size, default 131071
- net.core.wmem_max = 1048576 # maximum send socket buffer size, default 131071
- net.core.rmem_default = 1048576 # default receive socket buffer size, default 135168
- net.core.wmem_default = 1048576 # default send socket buffer size, default 135168
- net.core.optmem_max = 5000000 # default 10240, maximum amount of option memory buffers, default 20480
- net.core.netdev_max_backlog = 81920 # maximum length of the input queues for the processors, default 300
- net.ipv4.tcp_max_syn_backlog = 8192
- net.ipv4.conf.all.arp_filter=1 # enables source route verification, default 0
- net.ipv4.ip_local_port_range = 4096 63000 # enables more local ports
- ulimit -n 102400, increases the number of open file descriptors, default 1024

Web Server Software Notes

- The following tunes were used for Web Server
- HTTP Script Notes
- SPEC-provided JSP scripts used without modification

Client Notes

- Following tunings were used on the client system
- ulimit -n 102400, increase the file descriptors
- net.ipv4.ip_local_port_range = 1024 65535, increase the local TCP/IP ports
- net.ipv4.tcp_max_tw_buckets = 1500000
- net.ipv4.tcp_timestamps = 0
- java -Xms1024m -Xmx1024m -XX:+UseParNewGC -XX:+UseConcMarkSweepGC, options used for client driver processes

BESIM Notes

- Operating System Notes:
- net.ipv4.ip_forward = 0 # Controls IP packet forwarding
- net.ipv4.tcp_timestamps = 0 # default 1
- net.ipv4.tcp_max_tw_buckets = 1500000 # sets TCP time-wait buckets pool size, default 180000
- net.ipv4.tcp_rmem = 5000000 5000000 5000000 # maximum receive socket buffer size, default 131071
- net.ipv4.tcp_wmem = 5000000 5000000 5000000 # maximum TCP write-buffer space allocatable, default 4096 16384 131072
- net.ipv4.tcp_mem = 5000000 5000000 5000000 # maximum TCP buffer space allocatable, default 392192 392704 393216
- net.ipv4.tcp_window_scaling = 0 # turns TCP window scaling support off, default on
- net.ipv4.tcp_tso_win_divisor = 8
- net.core.rmem_max = 1048576 # maximum receive socket buffer size, default 131071
- net.core.wmem_max = 1048576 # maximum send socket buffer size, default 131071
- net.core.rmem_default = 1048576 # default receive socket buffer size, default 135168

- net.core.wmem_default = 1048576 # default send socket buffer size, default 135168
- net.core.optmem_max = 5000000 # default 10240, maximum amount of option memory buffers, default 20480
- net.core.netdev_max_backlog = 81920 # maximum length of the input queues for the processors, default 300
- net.ipv4.tcp_max_syn_backlog = 8192
- net.ipv4.conf.all.arp_filter=1 # enables source route verification, default 0
- net.ipv4.ip_local_port_range = 4096 63000 # enables more local ports
- ulimit -n 25000 # increase the descriptors
- validate_static -1
- validate_httpmod -1
- header_etag_on 0
- header_server_on 0
- log_buf_size 1048576
- tcp_send_buf_size 102400
- keepalive_max 10000000
- connection_timeout 36000
- host:81
- document_root /usr/httpd/etc/specweb05
- access_log access.log
- error_log error.log
- cgi_type isapi
- cgi_where internal

Other Notes

- Result prepared by Sreekanth Setty

Banking Run Details

Test results for each iteration

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
1	login	130685	124992	5679	14	12,428.7	0.884	34825
	account_summary	92198	90062	2129	7	7,102.5	0.538	28208
	check_detail_html	51828	49916	1911	1	3,506.2	0.565	24772
	bill_pay	84643	82694	1946	3	6,040.4	0.525	26131
	add_payee	6921	6749	172	0	510.6	0.529	27013
	payee_info	4907	4754	153	0	597.2	0.712	44567
	quick_pay	40696	39048	1647	1	3,776.3	0.660	33978
	billpay_status	13435	13151	284	0	1,239.2	0.587	33775
	chg_profile	7483	7323	160	0	896.6	0.665	43876
	post_profile	5460	5407	53	0	555.8	0.589	37275
	req_checks	7312	6780	532	0	1,775.1	1.228	88894
	post_chk_order	5255	5145	110	0	485.8	0.579	33848
	req_xfer_form	10551	10332	219	0	654.1	0.491	22700
	post_fund_xfer	7643	7448	195	0	525.5	0.514	25177
	logout	37057	36654	402	1	7,654.3	1.068	75635
	check_image	103693	103682	4	7	2,990.6	0.157	10560
	Total	**609767**	**594137**	**15596**	**34**	**50,738.9**	**0.600**	**30,469**
2	login	131093	125074	6017	2	12,204.8	0.891	34846
	account_summary	92513	89988	2525	0	6,979.3	0.556	28236
	check_detail_html	52036	49585	2451	0	3,444.5	0.592	24775
	bill_pay	84710	82386	2324	0	5,914.5	0.538	26132
	add_payee	6911	6723	188	0	498.4	0.547	26994
	payee_info	5013	4819	194	0	597.3	0.730	44597
	quick_pay	40608	38647	1961	0	3,687.0	0.675	33983
	billpay_status	13494	13125	369	0	1,218.0	0.594	33785
	chg_profile	7402	7216	186	0	868.3	0.678	43905
	post_profile	5332	5257	75	0	531.3	0.597	37295
	req_checks	7337	6746	591	0	1,742.8	1.237	88907
	post_chk_order	5320	5154	166	0	481.4	0.600	33867
	req_xfer_form	10589	10333	256	0	642.7	0.504	22716
	post_fund_xfer	7599	7403	196	0	510.7	0.528	25155
	logout	37072	36501	571	0	7,481.2	1.074	75531
	check_image	104090	104090	0	0	2,936.6	0.163	10559
	Total	**611119**	**593047**	**18070**	**2**	**49,739.0**	**0.612**	**30,462**

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
3	login	130606	123989	6559	58	12,200.6	0.894	34821
	account_summary	92088	89432	2645	11	6,969.0	0.551	28209
	check_detail_html	51728	49332	2337	59	3,437.9	0.587	24774
	bill_pay	84548	82097	2449	2	5,927.8	0.536	26134
	add_payee	6869	6656	213	0	497.5	0.548	26999
	payee_info	4970	4759	209	2	594.5	0.741	44590
	quick_pay	40541	38606	1901	34	3,695.7	0.673	33981
	billpay_status	13478	13080	398	0	1,221.3	0.603	33776
	chg_profile	7399	7163	236	0	871.5	0.681	43905
	post_profile	5337	5258	79	0	533.9	0.602	37292
	req_checks	7284	6702	574	8	1,736.8	1.243	88883
	post_chk_order	5314	5186	128	0	482.8	0.597	33869
	req_xfer_form	10557	10253	304	0	642.6	0.509	22690
	post_fund_xfer	7586	7365	221	0	512.1	0.534	25163
	logout	37073	36380	693	0	7,516.3	1.078	75575
	check_image	103464	103464	0	0	2,931.4	0.159	10561
	Total	**608842**	**589722**	**18946**	**174**	**49,771.7**	**0.612**	**30,472**

Notes for Banking Workload

Web Server Software Notes

- Rock tunes (httpd/conf/bank.conf):
- connection_timeout 9200
- cache_memory_size 8192
- gateway_connection_max 2000
- port_getn 256
- host tengger01.eng.vmware.com:443
- ssl_key_file /export/home/httpd/ssl.key
- cgi_listener localhost/8080
- access_log access_port443.log
- access_log_format commonlog_binary
- error_log error_port443.log
- default_mime_type text/html
- ssl_session_count 37917
- ssl_session_timeout 900
- file /bankjsp
- cgi_type gateway
- cgi_regex .*jsp

Script Engine Notes

- Following tunings used for JRock JSP container (in jrock/conf/specweb2005_bank.xml)
- session_timeout 600
- docroot /www/sw2005/bank/bankjsp
- context_path /bankjsp
- session_timeout 600

Errors for Banking Workload

Quality of Service Errors

- No QOS Errors Found

Validation Errors

- No Validation Errors Found

Ecommerce Run Details

Test results for each iteration

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
1	index	70835	70768	67	0	12,615.1	1.528	139128
	search	35563	35561	2	0	8,325.7	1.863	182892
	browse	63247	63146	101	0	12,553.1	1.672	155054
	browse_productline	54186	54184	2	0	12,559.1	1.885	181068
	productdetail	43445	43412	32	1	3,000.2	0.986	53948
	customize1	91443	91439	4	0	19,342.9	1.691	165251
	customize2	48184	48183	1	0	10,151.2	1.683	164583
	customize3	33204	33010	183	11	7,528.9	1.847	177138
	cart	28630	28580	47	3	2,700.7	0.877	73693
	login	20433	20333	98	2	1,271.2	0.567	48603
	shipping	19251	19251	0	0	1,062.9	0.484	43134
	billing	18269	18269	0	0	781.5	0.413	33416
	confirm	13745	13745	0	0	566.0	0.374	32169
	Total	**540435**	**539881**	**537**	**17**	**92,458.3**	**1.445**	**133,651**

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
2	index	70406	70234	172	0	12,524.0	1.534	139105
	search	35962	35960	2	0	8,410.6	1.866	182892
	browse	63006	62769	237	0	12,484.1	1.680	154949
	browse_productline	54052	54045	7	0	12,514.0	1.889	181050
	productdetail	43241	43198	42	1	2,962.4	0.989	53574
	customize1	91000	90981	19	0	19,229.4	1.695	165248
	customize2	47990	47983	7	0	10,099.8	1.689	164580
	customize3	33121	32832	278	11	7,502.5	1.857	177139
	cart	28484	28392	89	3	2,682.6	0.887	73648
	login	20315	20215	100	0	1,272.3	0.575	48977
	shipping	19094	19094	0	0	1,053.2	0.488	43134
	billing	18154	18154	0	0	775.8	0.417	33416
	confirm	13635	13635	0	0	560.9	0.381	32169
	Total	**538460**	**537492**	**953**	**15**	**92,071.5**	**1.452**	**133,716**
3	index	70578	70403	175	0	12,417.8	1.545	139073
	search	35975	35958	17	0	8,324.1	1.873	182897
	browse	63249	63008	241	0	12,401.4	1.693	154983
	browse_productline	54225	54208	17	0	12,420.7	1.896	181057
	productdetail	43389	43313	75	1	2,953.7	1.003	53810
	customize1	91085	91062	23	0	19,041.5	1.702	165243
	customize2	48069	48049	20	0	10,008.6	1.697	164580
	customize3	33173	32809	347	17	7,434.5	1.877	177149
	cart	28633	28477	156	0	2,673.3	0.920	73799
	login	20342	20187	148	7	1,256.6	0.592	48828
	shipping	19155	19155	0	0	1,045.3	0.500	43134
	billing	18209	18208	1	0	769.8	0.439	33416
	confirm	13690	13690	0	0	557.2	0.400	32169
	Total	**539772**	**538527**	**1220**	**25**	**91,304.5**	**1.464**	**133,705**

Notes for Ecommerce Workload

Web Server Software Notes

- Rock tunes (httpd/conf/ecommerce.conf):
- connection_timeout 9200
- cache_memory_size 8192
- gateway_connection_max 2000
- port_getn 256
- host host:80
- access_log access_port80.log
- access_log_format commonlog_binary

- error_log error_port80.log
- index_directory yes
- content_negotiation yes
- cgi_type gateway
- cgi_regex .*jsp
- cgi_listener localhost/8080
- host host:443
- document_root /www
- ssl_key_file /export/home/httpd/ssl.key
- ssl_cert_file /export/home/httpd/ssl.cer
- access_log access_port443.log
- access_log_format commonlog_binary
- error_log error_port443.log
- default_mime_type text/html
- ssl_session_count 37917
- ssl_session_timeout 900
- file /ecommjsp
- cgi_type gateway
- cgi_regex .*jsp
- cgi_listener localhost/8080

Script Engine Notes

- Following tunings used for JRock JSP container (in jrock/conf/specweb2005_ecommerce.xml)
- session_timeout 600
- docroot /www/sw2005/ecommerce/ecommjsp
- context_path /ecommjsp

Errors for Ecommerce Workload

Quality of Service Errors

- No QOS Errors Found

Validation Errors

- No Validation Errors Found

Support Run Details

Test results for each iteration

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
1	home	31399	31237	162	0	881.6	0.761	60262
	search	48811	48711	100	0	617.4	0.411	27149
	catalog	45240	45190	50	0	712.9	0.465	33820
	product	95300	93220	1969	111	3,023.3	0.926	68089
	fileCatalog	86748	84311	2300	137	4,277.1	1.292	105823
	file	52375	50596	1674	105	3,058.7	1.485	125343
	download	26222	26177	3	42	84,002.7	68.758	6875738
	Total	**386095**	**379442**	**6258**	**395**	**96,573.7**	**5.558**	**536,853**
2	home	31460	31148	250	62	876.7	0.784	60262
	search	48844	48560	254	30	613.4	0.431	27159
	catalog	45081	44912	166	3	704.7	0.479	33806
	product	95146	92971	1686	489	2,996.8	0.956	68112
	fileCatalog	86839	84270	2108	461	4,249.7	1.320	105828
	file	52489	50493	1640	356	3,042.8	1.519	125360
	download	26233	26190	4	39	83,681.3	68.983	6898252
	Total	**386092**	**378544**	**6108**	**1440**	**96,165.5**	**5.600**	**538,625**
3	home	31437	31232	179	26	875.0	0.776	60259
	search	48758	48573	176	9	611.8	0.431	27165
	catalog	45101	44970	127	4	704.3	0.478	33807
	product	95155	93097	1796	262	2,993.4	0.951	68106
	fileCatalog	86797	84204	2317	276	4,242.6	1.323	105822
	file	52393	50439	1756	198	3,033.7	1.518	125355
	download	26216	26172	1	43	83,741.0	69.155	6915467
	Total	**385857**	**378687**	**6352**	**818**	**96,201.8**	**5.610**	**539,766**

Notes for Support Workload

Web Server Software Notes

- Rock tunes (httpd/conf/support.conf):
- connection_timeout 1200
- cache_memory_size 2048
- gateway_connection_max 1200
- port_getn 128
- host tengger01.eng.vmware.com:80
- access_log access_port80.log
- access_log_format commonlog_binary
- error_log error_port80.log

- index_directory yes
- content_negotiation yes
- cgi_type gateway
- cgi_regex .*jsp
- cgi_listener localhost/8080

Script Engine Notes

- Following tunings used for JRock JSP container (in jrock/conf/specweb2005_support.xml)
- session_timeout 9200
- docroot /www/sw2005/support/suppjsp
- context_path /suppjsp

Errors for Support Workload

Quality of Service Errors

- No QOS Errors Found

Validation Errors

- No Validation Errors Found

For questions about this result, please contact the submitter: VMware Inc., USA

SPECweb2005 Results in Native Environment

SPECweb2005 Result

Hewlett-Packard: HP ProLiant DL 385 G1
Accoria: Rock Web Server v1.4.2 (x86_64)
Accoria: Rock JSP Container (1.2.1)

SPECweb2005 = 2321

SPECweb2005_Banking = 2600
SPECweb2005_Ecommerce = 4100
SPECweb2005_Support = 2600

Tested By: VMware Inc SPEC License #: 2933 Test Date: Oct-2007

Performance

Banking

Simultaneous User Sessions	Test Iteration	Aggregate QOS Compliance			Validation Errors
		Good	Tolerable	Fail	
2600	1	99.9%	100.0%	0.0%	0
	2	98.9%	100.0%	0.0%	0
	3	98.2%	100.0%	0.0%	0

Ecommerce

Simultaneous User Sessions	Test Iteration	Aggregate QOS Compliance			Validation Errors
		Good	Tolerable	Fail	
4100	1	100.0%	100.0%	0.0%	0
	2	100.0%	100.0%	0.0%	0
	3	100.0%	100.0%	0.0%	0

Support

Simultaneous User Sessions	Test Iteration	Aggregate QOS Compliance			Validation Errors
		Good	Tolerable	Fail	
2600	1	99.4%	99.9%	0.1%	0
	2	99.3%	100.0%	0.0%	0
	3	99.5%	100.0%	0.0%	0

Configuration

Availability Dates

SUT Hardware	Nov-2006
Backend Simulator	Aug-2006
Web Server Software	Apr-2007 (Rock Web Server) Dec-2006 (Rock JSP Container)
Operating System	Aug-2006 (for RHEL4)
Other Components	N/A

System Under Test (SUT)

# of SUTs	1
Vendor	Hewlett-Packard
Model	HP ProLiant DL 385 G1
Processor	AMD Opteron 275
Processor Speed (MHz)	2205
# Processors	1 (4 cores, 2 chips, 2 cores/chip)
Primary Cache	64KB(I) + 64KB(D)
Secondary Cache	1024 KB (per core)
Other Cache	N/A
Memory	6 GB SDRAM
Disk Subsystem	1 x 146.80GB SCSI (root), 12*133.68GB SCSI (fileset data)
Disk Controllers	HP Smart Array 6i Controller, QLogic Corp. QLA2340 Fibre Channel Adapter
Operating System	RedHat Enterprise Linux 4 Update 4 (2.6.9-42.ELsmp) x86_64
File System	ext2
Other Hardware	N/A
Other Software	JDK-1.6.0_01-linux-amd64

SUT Network

# of Controllers	3
Network Controllers	Intel 8254NXX Gigabit dual-port Adapter, HP NC7782 Gigabit Adapter
# of Networks	3
Network Type	Fast Ethernet
Network Speed	1 Gb/s
MSL (sec)	30 (Non RFC1122)
Time-Wait (sec)	60 (Non RFC1122)
MTU Size	1500

Web Server Software

Vendor	Accoria
Name/Version	Rock Web Server v1.4.2 (x86_64)
Dynamic Scripts	JSP
Server Cache	N/A
Log Mode	Rock Binary CLF

Script Engine

Vendor	Accoria
Name/Version	Rock JSP Container (1.2.1)
Dynamic Scripts	JSP
Server Cache	N/A
Log Mode	Rock Binary CLF

Clients

# of Clients	1 1
Model	Dell Poweredge 1850 HP ProLiant DL360 G5
Processor	Intel Xeon Intel Xeon
Processor Speed	(MHz) 3200 3000
# Processors	2 4 (4 cores, 2 chips, 2 cores/chip)
Memory	4096 MB SDRAM 8192 MB SDRAM
Network Controller	Intel Corporation 82541GI/PI Gigabit Ethernet Controller Broadcom Corporation NetXtreme II BCM5708 Gigabit Ethernet
Operating System	RedHat Enterprise Linux update4 (2.6.9-42.ELsmp) RedHat Enterprise Linux update4 (2.6.9-42.ELsmp x86_64)
JVM Version	Java(TM) SE Runtime Environment (build 1.6.0_01-b06) Java(TM) SE Runtime Environment (build 1.6.0_01-b06)
JIT Version	Java HotSpot(TM) Server VM (build 1.6.0_01-b06, mixed mode) Java HotSpot(TM) Server VM (build 1.6.0_01-b06, mixed mode)
Other Hardware	N/A N/A
Other Software	N/A N/A

Backend Simulator (BESIM)

# of Simulators	1
Model	Dell Poweredge 1850
Processor	Intel Xeon
Processor Speed	(MHz) 3200
# of Processors	2
Memory	4096 MB SDRAM
Network Controller	Intel Corporation 82541GI/PI Gigabit Ethernet Controller
Operating System	RedHat Enterprise Linux (2.4.21-47.ELsmp)
File System	ext2
Web Server	Rock Web Server v1.4.2
Server Scripts	ISAPI
Other Hardware	N/A
Other Software	N/A

Common Workload Notes

SUT Notes

- The RHEL4 was booted with one core and 6GB memory (using the boot options of maxcpus=1 and mem=6144MB)

- The fileset data was located on a 12-disk RAID-0 stripe LUN on Dell/EMC CX3-40 SAN Array
- The SUT was configured with three private Gb networks
- 2 of the networks were used for client traffic, and the third was used for Besim traffic

Operating System Notes

- Operating System Notes:
- net.ipv4.ip_forward = 0 # Controls IP packet forwarding
- net.ipv4.tcp_timestamps = 0 # default 1
- net.ipv4.tcp_max_tw_buckets = 1500000 # sets TCP time-wait buckets pool size, default 180000
- net.ipv4.tcp_rmem = 5000000 5000000 5000000 # maximum receive socket buffer size, default 131071
- net.ipv4.tcp_wmem = 5000000 5000000 5000000 # maximum TCP write-buffer space allocatable, default 4096 16384 131072
- net.ipv4.tcp_mem = 5000000 5000000 5000000 # maximum TCP buffer space allocatable, default 392192 392704 393216
- net.ipv4.tcp_window_scaling = 0 # turns TCP window scaling support off, default on
- net.ipv4.tcp_tso_win_divisor = 8
- net.core.rmem_max = 1048576 # maximum receive socket buffer size, default 131071
- net.core.wmem_max = 1048576 # maximum send socket buffer size, default 131071
- net.core.rmem_default = 1048576 # default receive socket buffer size, default 135168
- net.core.wmem_default = 1048576 # default send socket buffer size, default 135168
- net.core.optmem_max = 5000000 # default 10240, maximum amount of option memory buffers, default 20480
- net.core.netdev_max_backlog = 81920 # maximum length of the input queues for the processors, default 300
- net.ipv4.tcp_max_syn_backlog = 8192
- net.ipv4.conf.all.arp_filter=1 # enables source route verification, default 0
- net.ipv4.ip_local_port_range = 4096 63000 # enables more local ports
- ulimit -n 102400, increases the number of open file descriptors, default 1024

Web Server Software Notes

- The following tunes were used for Web Server

HTTP Script Notes

- SPEC-provided JSP scripts used without modification

Client Notes

- Following tunings were used on the client system
- ulimit -n 102400, increase the file descriptors
- net.ipv4.ip_local_port_range = 1024 65535, increase the local TCP/IP ports
- net.ipv4.tcp_max_tw_buckets = 1500000
- net.ipv4.tcp_timestamps = 0
- java -Xms1024m -Xmx1024m -XX:+UseParNewGC -XX:+UseConcMarkSweepGC, options used for client driver processes

BESIM Notes

- Operating System Notes:
- net.ipv4.ip_forward = 0 # Controls IP packet forwarding
- net.ipv4.tcp_timestamps = 0 # default 1
- net.ipv4.tcp_max_tw_buckets = 1500000 # sets TCP time-wait buckets pool size, default 180000
- net.ipv4.tcp_rmem = 5000000 5000000 5000000 # maximum receive socket buffer size, default 131071
- net.ipv4.tcp_wmem = 5000000 5000000 5000000 # maximum TCP write-buffer space allocatable, default 4096 16384 131072
- net.ipv4.tcp_mem = 5000000 5000000 5000000 # maximum TCP buffer space allocatable, default 392192 392704 393216
- net.ipv4.tcp_window_scaling = 0 # turns TCP window scaling support off, default on
- net.ipv4.tcp_tso_win_divisor = 8
- net.core.rmem_max = 1048576 # maximum receive socket buffer size, default 131071
- net.core.wmem_max = 1048576 # maximum send socket buffer size, default 131071
- net.core.rmem_default = 1048576 # default receive socket buffer size, default 135168
- net.core.wmem_default = 1048576 # default send socket buffer size, default 135168
- net.core.optmem_max = 5000000 # default 10240, maximum amount of option memory buffers, default 20480
- net.core.netdev_max_backlog = 81920 # maximum length of the input queues for the processors, default 300
- net.ipv4.tcp_max_syn_backlog = 8192
- net.ipv4.conf.all.arp_filter=1 # enables source route verification, default 0
- net.ipv4.ip_local_port_range = 4096 63000 # enables more local ports
- ulimit -n 25000 # increase the descriptors
- validate_static -1
- validate_httpmod -1
- header_etag_on 0
- header_server_on 0
- log_buf_size 1048576
- tcp_send_buf_size 102400
- keepalive_max 10000000
- connection_timeout 36000
- host:81
- document_root /usr/httpd/etc/specweb05
- access_log access.log
- error_log error.log
- cgi_type isapi
- cgi_where internal

Other Notes

- Result prepared by Sreekanth Setty

Banking Run Details

Test results for each iteration

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
1	login	149671	149374	291	6	20,362.5	0.932	50023
	account_summary	105538	105505	32	1	9,066.7	0.395	31588
	check_detail_html	59264	59133	129	2	4,545.8	0.382	28203
	bill_pay	96683	96650	32	1	7,764.8	0.374	29529
	add_payee	7848	7846	2	0	649.2	0.381	30414
	payee_info	5612	5604	8	0	732.5	0.567	47992
	quick_pay	46485	46390	90	5	4,734.1	0.472	37445
	billpay_status	15307	15293	14	0	1,547.9	0.446	37181
	chg_profile	8593	8589	4	0	1,107.2	0.546	47375
	post_profile	6215	6213	1	1	689.4	0.478	40786
	req_checks	8407	8363	43	1	2,112.6	1.082	92396
	post_chk_order	6031	6027	4	0	612.6	0.449	37349
	req_xfer_form	12144	12140	4	0	866.0	0.342	26220
	post_fund_xfer	8711	8709	2	0	679.5	0.366	28683
	logout	42528	42525	3	0	10,501.9	1.214	90797
	check_image	118546	118543	3	0	3,405.1	0.117	10561
	Total	**697583**	**696904**	**662**	**17**	**69,377.7**	**0.526**	**36,567**
2	login	148356	145074	3263	19	18,286.3	0.995	50009
	account_summary	104539	104013	522	4	8,134.6	0.466	31570
	check_detail_html	58848	57590	1255	3	4,090.8	0.474	28203
	bill_pay	96092	95646	440	6	6,994.4	0.446	29532
	add_payee	7849	7819	29	1	588.4	0.451	30414
	payee_info	5729	5648	80	1	677.7	0.634	47992
	quick_pay	46050	45032	1016	2	4,250.0	0.560	37444
	billpay_status	15381	15306	74	1	1,409.8	0.511	37187
	chg_profile	8378	8327	50	1	978.3	0.606	47375
	post_profile	6026	6015	11	0	605.8	0.532	40786
	req_checks	8306	8009	294	3	1,891.0	1.154	92370
	post_chk_order	6040	6001	39	0	556.0	0.515	37349
	req_xfer_form	11955	11911	44	0	772.3	0.413	26210
	post_fund_xfer	8566	8534	32	0	605.6	0.435	28683
	logout	42076	41955	118	3	9,416.2	1.233	90797
	check_image	117700	117685	0	15	3,062.9	0.135	10558
	Total	**691891**	**684565**	**7267**	**59**	**62,320.1**	**0.586**	**36,543**

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
3	login	147983	143082	4893	8	17,885.2	1.007	50034
	account_summary	104307	102970	1337	0	7,960.2	0.483	31593
	check_detail_html	58643	56694	1948	1	3,995.1	0.495	28203
	bill_pay	95756	94587	1169	0	6,830.6	0.462	29531
	add_payee	7817	7719	98	0	574.3	0.475	30414
	payee_info	5717	5563	154	0	662.7	0.666	47992
	quick_pay	45903	44410	1488	5	4,151.7	0.576	37443
	billpay_status	15305	15101	204	0	1,374.7	0.536	37184
	chg_profile	8401	8297	104	0	961.4	0.622	47375
	post_profile	6044	6009	35	0	595.5	0.546	40786
	req_checks	8304	7919	382	3	1,853.4	1.172	92400
	post_chk_order	6026	5937	89	0	543.7	0.534	37349
	req_xfer_form	11949	11792	157	0	757.2	0.439	26235
	post_fund_xfer	8515	8384	131	0	590.0	0.460	28683
	logout	41919	41541	378	0	9,193.8	1.243	90797
	check_image	117293	117287	6	0	2,991.7	0.137	10559
	Total	**689882**	**677292**	**12573**	**17**	**60,921.0**	**0.600**	**36,557**

Notes for Banking Workload

Web Server Software Notes

- Rock tunes (httpd/conf/bank.conf):
- connection_timeout 9200
- cache_memory_size 8192
- cache_file_max_size 4194304
- gateway_connection_max 2000
- disk_worker_count 68
- tcp_send_buf_size 1048576
- log_buf_size 1048576
- port_getn 256
- fast_read 1
- host tengger01.eng.vmware.com:443
- ssl_key_file /export/home/httpd/ssl.key
- cgi_listener localhost/8080
- access_log access_port443.log
- access_log_format commonlog_binary
- error_log error_port443.log
- default_mime_type text/html
- ssl_session_count 37917

- ssl_session_timeout 900
- file /bankjsp
- cgi_type gateway
- cgi_regex .*jsp

Script Engine Notes

- Following tunings used for JRock JSP container (in jrock/conf/specweb2005_bank.xml)
- session_timeout 600
- docroot /www/sw2005/bank/bankjsp
- context_path /bankjsp
- session_count 1
- session_timeout 600
- export JAVA_OPTS=-server -Xms2g -Xmx2g -Xss512k -Xcompactexplicitgc, optimize garbage collection for applications, set JVM heap size to 2GB, set stack size to 512k

Errors for Banking Workload

Quality of Service Errors

- No QOS Errors Found

Validation Errors

- No Validation Errors Found

Ecommerce Run Details

Test results for each iteration

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
1	index	91147	91147	0	0	12,968.3	1.487	139069
	search	45446	45446	0	0	8,556.9	1.850	184039
	browse	81581	81581	0	0	12,977.5	1.628	155486
	browse_productline	69680	69680	0	0	13,036.1	1.882	182864
	productdetail	55738	55738	0	0	3,077.4	0.934	53966
	customize1	117565	117565	0	0	19,892.1	1.665	165384
	customize2	62166	62166	0	0	10,472.2	1.658	164654
	customize3	42711	42711	0	0	7,740.9	1.775	177149
	cart	36725	36725	0	0	2,779.1	0.783	73967
	login	26194	26194	0	0	1,302.0	0.507	48585
	shipping	24685	24685	0	0	1,089.3	0.444	43134
	billing	23427	23427	0	0	800.9	0.345	33416
	confirm	17602	17602	0	0	579.3	0.325	32169
	Total	**694667**	**694667**	**0**	**0**	**95,272.1**	**1.407**	**134,053**

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
2	index	90571	90571	0	0	12,909.0	1.492	139130
	search	45454	45454	0	0	8,569.9	1.852	184044
	browse	81237	81237	0	0	12,939.2	1.634	155479
	browse_productline	69642	69642	0	0	13,045.3	1.884	182852
	productdetail	55687	55687	0	0	3,063.2	0.934	53696
	customize1	117241	117241	0	0	19,863.5	1.667	165384
	customize2	61753	61753	0	0	10,416.0	1.661	164650
	customize3	42479	42479	0	0	7,710.2	1.781	177178
	cart	36579	36579	0	0	2,767.5	0.786	73853
	login	26018	26018	0	0	1,297.5	0.510	48681
	shipping	24491	24491	0	0	1,082.2	0.446	43134
	billing	23257	23257	0	0	796.2	0.347	33416
	confirm	17487	17487	0	0	576.3	0.328	32169
	Total	**691896**	**691896**	**0**	**0**	**95,036.1**	**1.410**	**134,080**
3	index	90744	90744	0	0	12,889.5	1.495	139130
	search	45690	45690	0	0	8,585.1	1.853	184046
	browse	81336	81336	0	0	12,912.1	1.637	155494
	browse_productline	69697	69697	0	0	13,013.4	1.886	182886
	productdetail	55743	55743	0	0	3,072.5	0.939	53989
	customize1	117423	117423	0	0	19,826.3	1.668	165383
	customize2	61867	61867	0	0	10,399.8	1.662	164652
	customize3	42605	42605	0	0	7,706.6	1.784	177177
	cart	36689	36689	0	0	2,762.2	0.787	73743
	login	26111	26111	0	0	1,300.4	0.513	48783
	shipping	24585	24585	0	0	1,082.7	0.447	43134
	billing	23384	23384	0	0	797.8	0.349	33417
	confirm	17582	17582	0	0	577.4	0.330	32169
	Total	**693456**	**693456**	**0**	**0**	**94,925.9**	**1.412**	**134,081**

Notes for Ecommerce Workload

Web Server Software Notes

- Rock tunes (httpd/conf/ecommerce.conf):
- connection_timeout 9200
- cache_memory_size 2048
- gateway_connection_max 1200
- disk_worker_count 68
- tcp_send_buf_size 1048576
- log_buf_size 1048576

- port_getn 1
- servlet_session_count 57917
- servlet_session_timeout 800
- host host:80
- access_log access_port80.log
- access_log_format commonlog_binary
- error_log error_port80.log
- index_directory yes
- content_negotiation yes
- cgi_type gateway
- cgi_regex .*jsp
- cgi_listener localhost/8080
- host host:443
- document_root /www
- ssl_key_file /export/home/httpd/ssl.key
- ssl_cert_file /export/home/httpd/ssl.cer
- access_log access_port443.log
- access_log_format commonlog_binary
- error_log error_port443.log
- default_mime_type text/html
- ssl_session_count 37917
- ssl_session_timeout 900
- file /ecommjsp
- cgi_type gateway
- cgi_regex .*jsp
- cgi_listener localhost/8080

Script Engine Notes

- Following tunings used for JRock JSP container (in jrock/conf/specweb2005_ecommerce.xml)
- session_timeout 900
- docroot /www/sw2005/ecommerce/ecommjsp
- context_path /ecommjsp
- export JAVA_OPTS=-server -Xms2g -Xmx2g -Xss512k -Xcompactexplicitgc, optimize garbage collection for applications, set JVM heap size to 2GB, set stack size to 512k

Errors for Ecommerce Workload

Quality of Service Errors

- No QOS Errors Found

Validation Errors

- No Validation Errors Found

Support Run Details

Test results for each iteration

Iteration	Request Type	Total Reqs	QOS			Weighted ABR	Avg Resp Time (sec)	Average Bytes/Req
			Good	Tolerable	Fail			
1	home	37481	37382	99	0	903.5	0.702	60338
	search	58115	58100	15	0	632.0	0.363	27222
	catalog	54040	54030	10	0	732.5	0.421	33929
	product	114021	113218	604	199	3,101.7	0.832	68095
	fileCatalog	103803	102823	788	192	4,399.8	1.209	106102
	file	62582	61823	649	110	3,128.4	1.398	125134
	download	31292	31256	6	30	84,891.3	67.909	6790980
	Total	**461334**	**458632**	**2171**	**531**	**97,789.1**	**5.426**	**530,612**
2	home	37306	37249	57	0	885.9	0.713	60335
	search	57841	57798	43	0	620.1	0.375	27236
	catalog	53459	53437	22	0	713.7	0.432	33916
	product	113149	112146	983	20	3,033.4	0.852	68111
	fileCatalog	103404	102089	1272	43	4,318.6	1.229	106106
	file	62384	61435	910	39	3,072.6	1.413	125132
	download	31118	31080	4	34	84,916.4	69.330	6932982
	Total	**458661**	**455234**	**3291**	**136**	**97,560.7**	**5.539**	**540,409**
3	home	37388	37369	19	0	885.6	0.701	60331
	search	58010	58010	0	0	620.3	0.362	27237
	catalog	53561	53561	0	0	713.3	0.422	33920
	product	113407	112822	585	0	3,032.5	0.833	68111
	fileCatalog	103621	102697	924	0	4,316.5	1.212	106108
	file	62458	61677	781	0	3,068.3	1.401	125133
	download	31180	31154	1	25	85,175.3	69.582	6958225
	Total	**459625**	**457290**	**2310**	**25**	**97,811.7**	**5.541**	**542,060**

Notes for Support Workload

Web Server Software Notes

- Rock tunes (httpd/conf/support.conf):
- connection_timeout 1200
- cache_memory_size 2048
- cache_file_max_size 4194304
- gateway_connection_max 1200
- disk_worker_count 68
- tcp_send_buf_size 1048576
- log_buf_size 1048576
- port_getn 128

- fast_read 1
- host tengger01.eng.vmware.com:80
- access_log access_port80.log
- access_log_format commonlog_binary
- error_log error_port80.log
- index_directory yes
- content_negotiation yes
- cgi_type gateway
- cgi_regex .*jsp
- cgi_listener localhost/8080

Script Engine Notes

- Following tunings used for JRock JSP container (in jrock/conf/specweb2005_support.xml)
- session_timeout 9200
- docroot /www/sw2005/support/suppjsp
- context_path /suppjsp
- session_count 1
- export JAVA_OPTS=-server -Xms2g -Xmx2g -Xss512k -Xcompactexplicitgc, optimize garbage collection for applications, set JVM heap size to 2GB, set stack size to 512k

Errors for Support Workload

Quality of Service Errors

- No QOS Errors Found

Validation Errors

- No Validation Errors Found

For questions about this result, please contact the submitter: VMware Inc