My First Server: The Dell PowerEdge T110 II Compared to HP Entry Level Servers

A Dell Technical White Paper

Don Hoffman

My First Server: The Dell PowerEdge T110 II and HP Entry Level Server Comparison

June 2011

Contents

Executive Summary

Introduction

Dell Inc. (Dell) commissioned its System Performance Analysis team to compare Dell and HP single-socket server options for customers looking to purchase their first server. The Dell PowerEdge T110 II, HP ProLiant ML110 G6, HP Proliant MicroServer, and HP Compaq 6005 Pro Business PC were compared. While not a true "server", the HP Compaq 6005 Pro Business PC was included in this study to show the benefits of purchasing an actual server, instead of using a converted desktop PC.

Using the industry-standard benchmarks SPECpower_ssj2008, SPECjbb2005, and SiSoftware Sandra 2011, these servers were rated according to performance, performance/watt, and storage bandwidth. The servers were installed with the fastest available processor and storage solution each model would support to reflect the best possible solution a customer could purchase. These high performance configurations were tested with the full Sandra 2011 SP2b benchmark suite and the SPECjbb2005 benchmark. The systems were then configured with a single SATA drive to produce a best case SPECpower_ssj2008 score.

The results showed **the Dell PowerEdge T110 II had the highest performance scores in all benchmark categories, including processor and storage performance, cryptographic bandwidth, and performance/watt (energy efficiency).**

Key Findings

Key findings from the study for power and performance are summarized below.

Processor Performance

- The **Dell PowerEdge T110 II provided higher raw processing performance** than each of the HP servers in all benchmark comparisons.
- The **Dell PowerEdge T110 II outperformed the HP servers** by at least 33% in all Sandra 2011 processor benchmarks, with the highest win being by a margin of 2692%.
- The SPECjbb2005 benchmark comparison showed the **Dell PowerEdge T110 II to have a 57% performance advantage** over its nearest competitor for Java Virtual Machine processing.

Cryptographic Bandwidth (Security Encryption)

- The Sandra 2011 benchmark includes a processor subtest that measures the cryptographic performance of the most common security algorithms in use today. **The Dell PowerEdge T110 II outperformed all of the HP servers by at least 3X**, making it the **best entry level server for data security and e-commerce applications.**

Performance per Watt

- The **Dell PowerEdge T110 II achieved a higher performance to power ratio across all load levels** than the HP ProLiant ML110 G6, HP Proliant MicroServer, and HP Compaq 6005 Pro Business PC in all tested configurations.
- The **Dell PowerEdge T110 II was more efficient** by a range of 57% to 234% compared to the HP servers in overall SPECpower_ssj2008 scores.

My First Server: The Dell PowerEdge T110 II and HP Entry Level Server Comparison

Storage Subsystem Performance

- The **Dell PowerEdge T110 II offers the highest performing storage subsystem of any of the models tested.** The Dell PowerEdge T110 II is also the only server tested that offers SAS drives in a fully hardware accelerated RAID 0 storage configuration.

Test methodology and detailed results are documented in this paper.

Methodology

SPECpower_ssj2008 and SPECjbb2005 are industry standard benchmarks created by the Standard Performance Evaluation Corporation (SPEC) to measure a server's power and performance across multiple utilization levels.

Sandra 2011 is an industry standard benchmark created by SiSoftware that measures performance of the processor, storage, and memory subsystems individually.

Appendix A details the test methodology used by Dell, Appendices B and C provide detailed configuration for the tests, and Appendix D provides detailed report data that supports the results in this paper.

Comparison 1: Processor Performance

When comparing servers, one of the most important variables to consider is overall processor performance. Each of the servers in this study was equipped with the highest speed processor available, representing the highest scoring configuration possible. Since each of the servers in this study represents different processor/chipset architectures, it was not possible to compare identical processors directly, so each system was configured for maximum performance for each processor type.

The configuration used in Comparison 1 is summarized in Table 1. This configuration for each system, known as the Maximum Performance configuration, is also utilized in Comparisons 2 and 4.

Table 1: Detailed Configuration for Comparison 1 – Maximum Performance

Comparison 1	Dell PowerEdge T110 II	HP Proliant ML110 G6	HP Proliant MicroServer	HP Compaq 6005 Pro Business PC
Sockets/Form Factor	1S/Tower	1S/Tower	1S/Tower	1S/Tower
Processors	Intel Xeon E3-1270 3.40 GHz	Intel Xeon X3470 2.93 GHz	AMD Athlon II Neo N36L 1.30 GHz	AMD Phenom II X4 B95 3.0 GHz
Physical / Logical Cores	4 / 8	4 / 8	2 / 2	4 / 4
Memory (run at maximum speed processor will support)	2 x 4GB 1333MHz UDIMMs	2 x 4GB 1333MHz UDIMMs	2 x 4GB 1333MHz UDIMMs at 800MHz	2 x 4GB 1333MHz UDIMMs at 1200 MHz
Hard Drives	4 x 250GB 15k RPM SAS 6Gbps RAID 0	4 x 250GB 7200 RPM SATA 3Gbps RAID 0	4 x 250GB 7200 RPM SATA 3Gbps RAID 0	2 x 250GB 7200 RPM SATA 3Gbps RAID 1[1]
Storage Controller	Dell PERC H200 512MB	HP Smart Array B110i	Integrated SATA RAID Controller	AMD (Xpert) RAID Controller
Software Configuration	2 x IBM J9 JVM	2 x IBM J9 JVM	1 x IBM J9 JVM[2]	2 x IBM J9 JVM

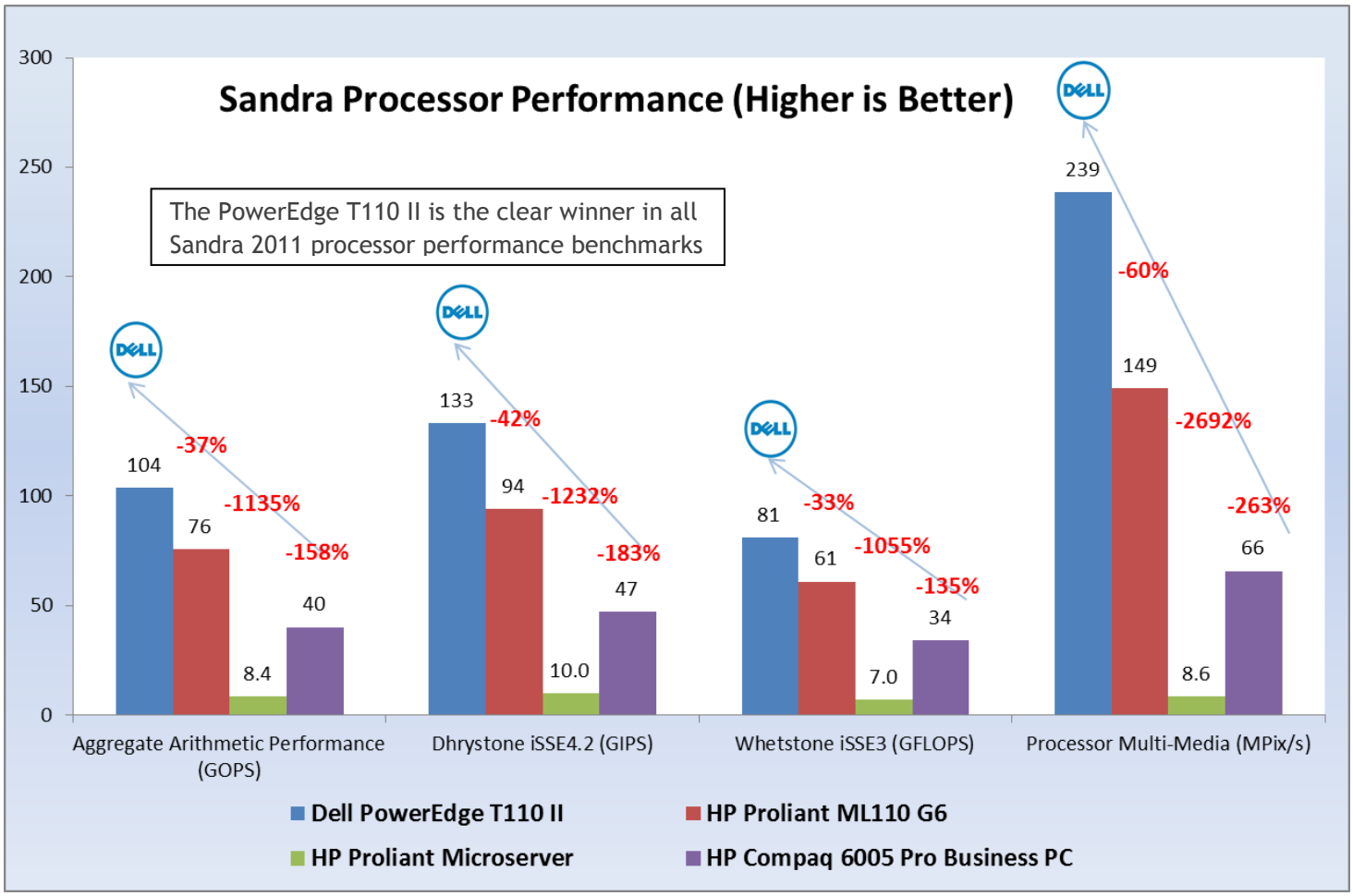
The SiSoftware Sandra 2011 processor benchmark has several subtests that are used to analyze processor performance. These subtests measure numerical integer calculations, floating point operations, and rendering of complex images. Figure 1 shows the raw performance scores for each server on each of the four processor workloads.

---

[1] The only factory RAID configuration for the HP Compaq 6005 Pro Business PC is RAID 1. Due to this restriction, RAID 1 was the chosen storage configuration for this study.

[2] Due to the reduced number of cores in the HP Proliant Microserver the system was tested with both 1 and 2 JVMs on SPECjbb and SPECpower. Using 1 JVM gave the best scores, so this was the configuration chosen.

Figure 1: Comparison 1 - Sandra 2011 SP2b Processor Performance Benchmarks



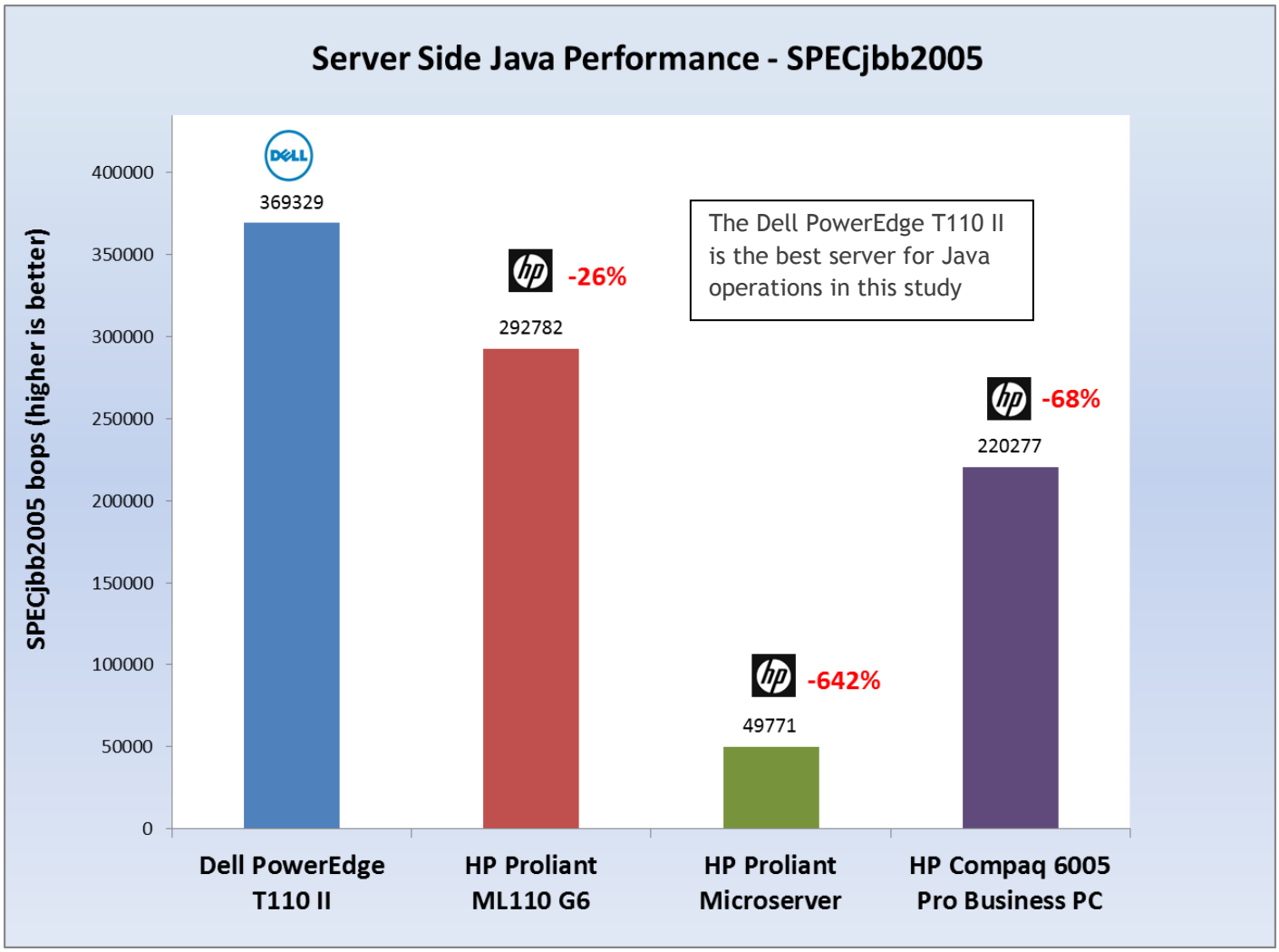
Results

In this maximum performance comparison, the Dell PowerEdge T110 II outperformed all of the HP systems in raw processing power. The PowerEdge T110 II features the latest Intel Xeon Processor E3 Family, which provides significant performance advantage over the previous generation Xeon 3400 series processor in the HP Proliant ML110 G6. In this comparison and the rest of this white paper, the very low performance of the HP Proliant Microserver and HP Compaq 6005 Pro Business Desktop is exposed. The AMD Athlon II and Phenom II processors in these systems are typically used in desktop systems and are not server-class processors, as the considerable performance shortfall of this study shows.

Comparison 1: Processor Performance, Part 2

SPECjbb2005 measures the processing performance of servers as they compute Java operations. The benchmark emulates a 3-tier system, the most common type of server-side Java application today. The number of JVMs used for this benchmark was optimized for the number of logical processors present in each server. All of the servers were able to support two JVMs, except the HP Proliant Microserver, which got the best results using only one JVM due to the lower number of cores available. Figure 2 shows the raw scores for each server measured in SPECjbb2005 bops (business operations per second).

Figure 2: Comparison 1 - Processor Performance - SPECjbb2005 benchmark



Results

The Dell PowerEdge T110 II again is the clear leader in processor performance, this time measured by Java Virtual Machine (JVM) operations per second. The older HP Proliant ML110 G6 is outperformed by 26%, while the desktop class processors in the HP Proliant Microserver and HP Compaq 6005 Pro Business PC are behind by 642% and 68% respectively.

My First Server: The Dell PowerEdge T110 II and HP Entry Level Server Comparison

SPECjbb2005 results listed by total SPECjbb2005 bops and SPECjbb2005 bops/JVM as required by SPEC fair usage guidelines.

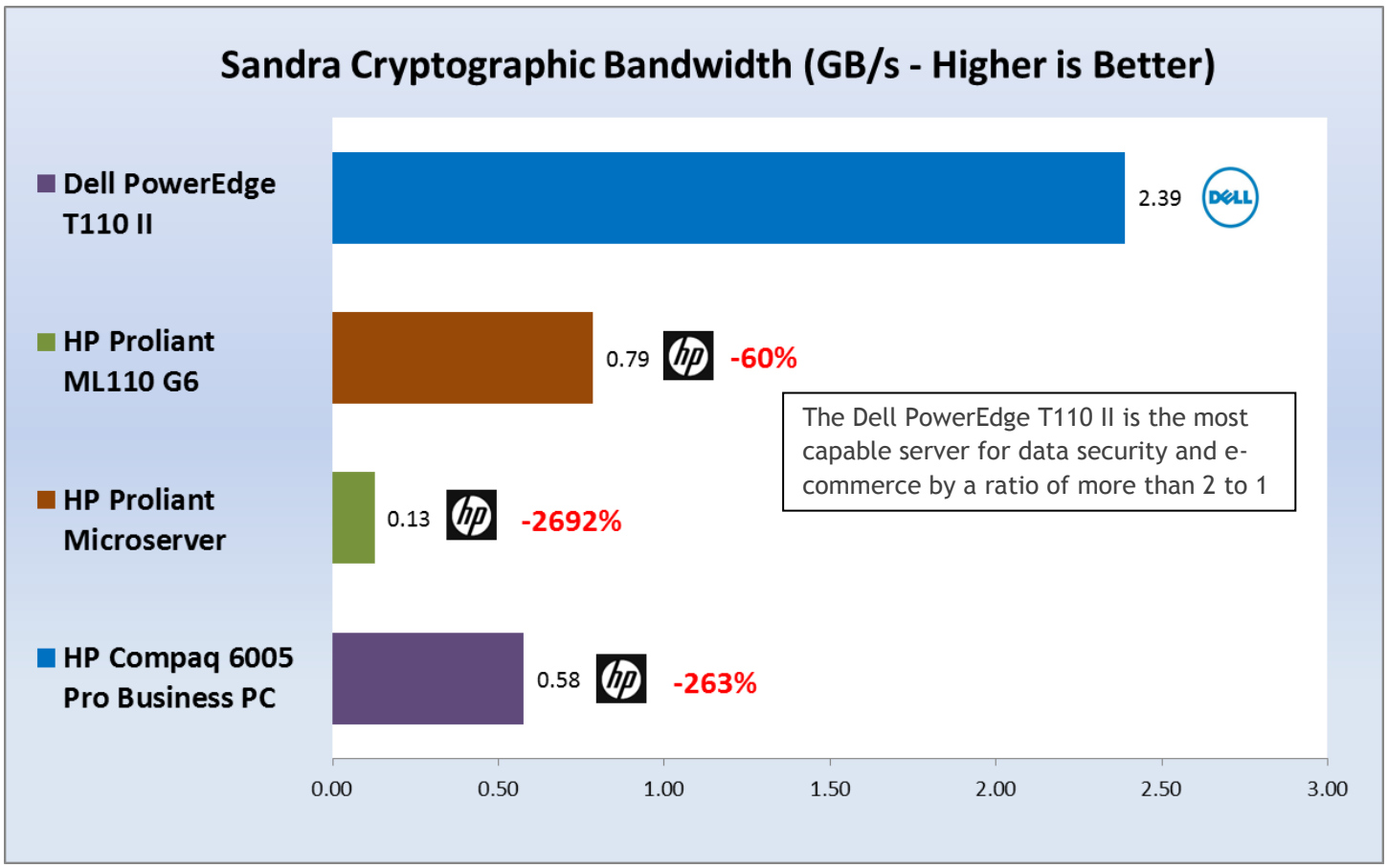
http://www.spec.org/fairuse.html#JBB2005

- Dell PowerEdge T110 II (1 chip, 4 cores, 8 threads) 369,329 SPECjbb2005 bops, 2 JVMs, 184,664 SPECjbb2005 bops/JVM.
- HP ProLiant ML110 G6 (1 chip, 4 cores, 8 threads) 292,782 SPECjbb2005 bops, 2 JVMs, 146,391 SPECjbb2005 bops/JVM.
- HP ProLiant Microserver (1 chip, 2 cores, 2 threads) 49,690 SPECjbb2005 bops, 1 JVM, 49,690 SPECjbb2005 bops/JVM.
- HP Compaq 6005 Pro Business PC (1 chip, 4 cores, 4 threads) 220,277 SPECjbb2005 bops, 2 JVMs, 110,138 SPECjbb2005 bops/JVM.

Comparison 2: Cryptographic Bandwidth (Security Encryption)

Comparison 2 examines the capabilities of the servers at encoding/decoding secure transmissions as well as the hashing calculations performed to detect data corruption or tampering. These operations are critical to running a secure business environment and can cripple a system not equipped for this level of enterprise operation.

Figure 3: Comparison 2 - SiSoftware Sandra 2011 Cryptographic Bandwidth (Gb/s)



Results

As in Comparison 1, the Dell PowerEdge T110 II has a significant advantage in raw processing performance. Due to advanced AVX (Advanced Vector Extensions) instruction set available only in the new Intel Xeon E3 architecture of the Dell PowerEdge T110 II, the performance advantage over the HP servers is even greater. The HP servers are behind in cryptographic performance by between 60% and 2692%. This comparison shows again that the older Intel Xeon 3400 series and AMD Athlon II and Phenom II-based HP systems cannot keep up with the level of performance available in the Dell PowerEdge T110 II. The Dell PowerEdge T110 II is by far the best entry level server tested for data security and e-commerce applications in this study.

For more information on the new Intel AVX instruction set, please visit the following site:
http://software.intel.com/en-us/avx/

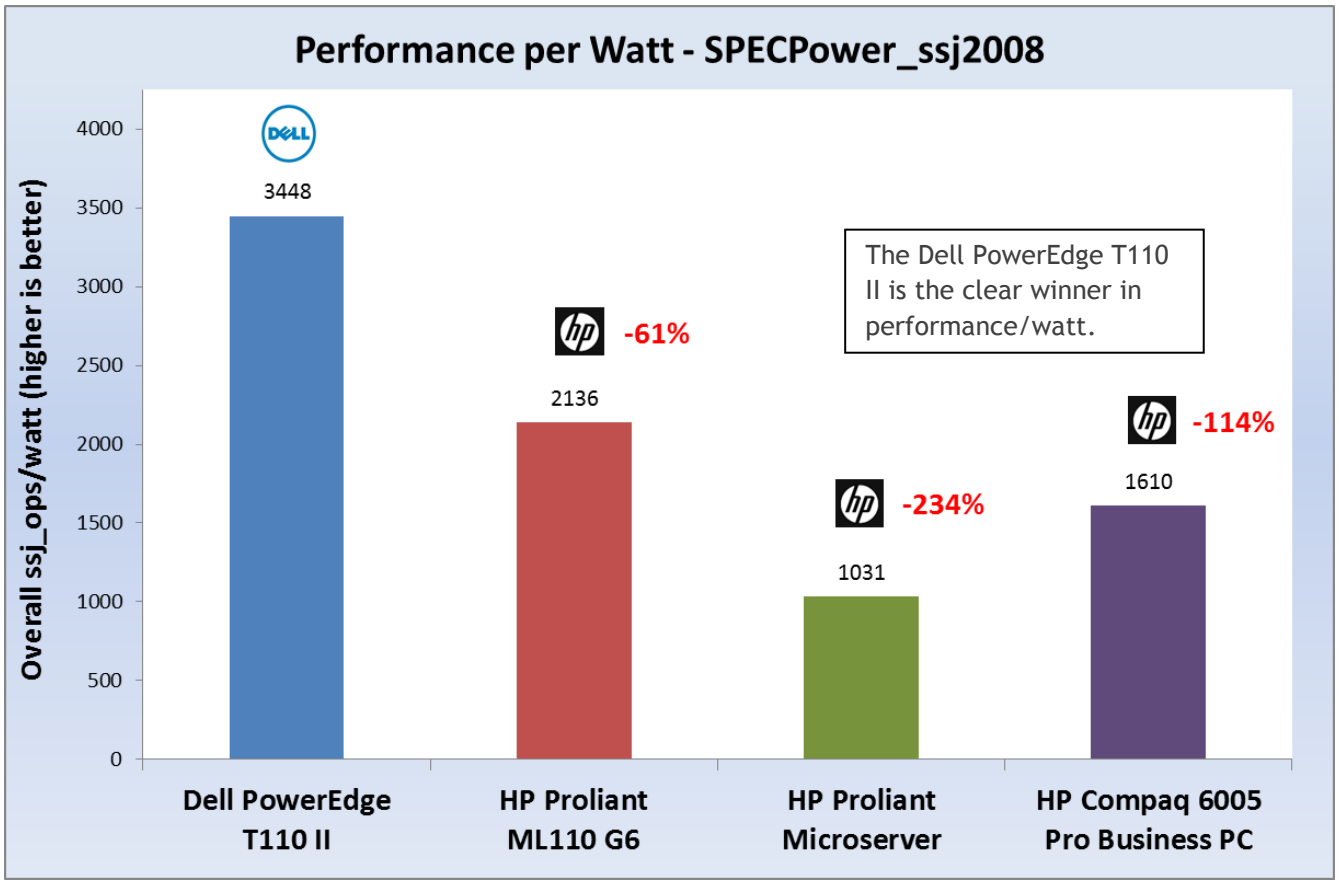
Comparison 3: Performance per Watt

Energy costs are rising and it is more important than ever before to get the most processing power for your energy dollar. The SPECpower_ssj2008 benchmark by the Standard Performance Evaluation Corporation (SPEC) measures the overall performance per watt of each system under test. The benchmark measures the system performance at 100% processor utilization as well as the power draw at this level. The processor utilization is stepped down 10% at a time until system idle is achieved. During these timed intervals the system power usage is also measured, to calculate the overall performance per watt metric shown below (ssj_ops/watt).

Appendices A and B show the hardware and software configurations for the Performance per Watt comparison. The system RAID configurations were removed and replaced with single SATA drives for the best case performance per watt for each system studied.

As Figure 4 shows, the Dell PowerEdge T110 II delivers much higher processing power per watt than any of the HP systems tested. Not only is the Dell PowerEdge T110 II the highest performing server in this study, as shown in Comparisons 1 and 2, it also does so more efficiently than its competitors.

Figure 4: Comparison 3 - SPECpower_ssj2008 Overall Performance per Watt (ssj_ops/watt)



Results

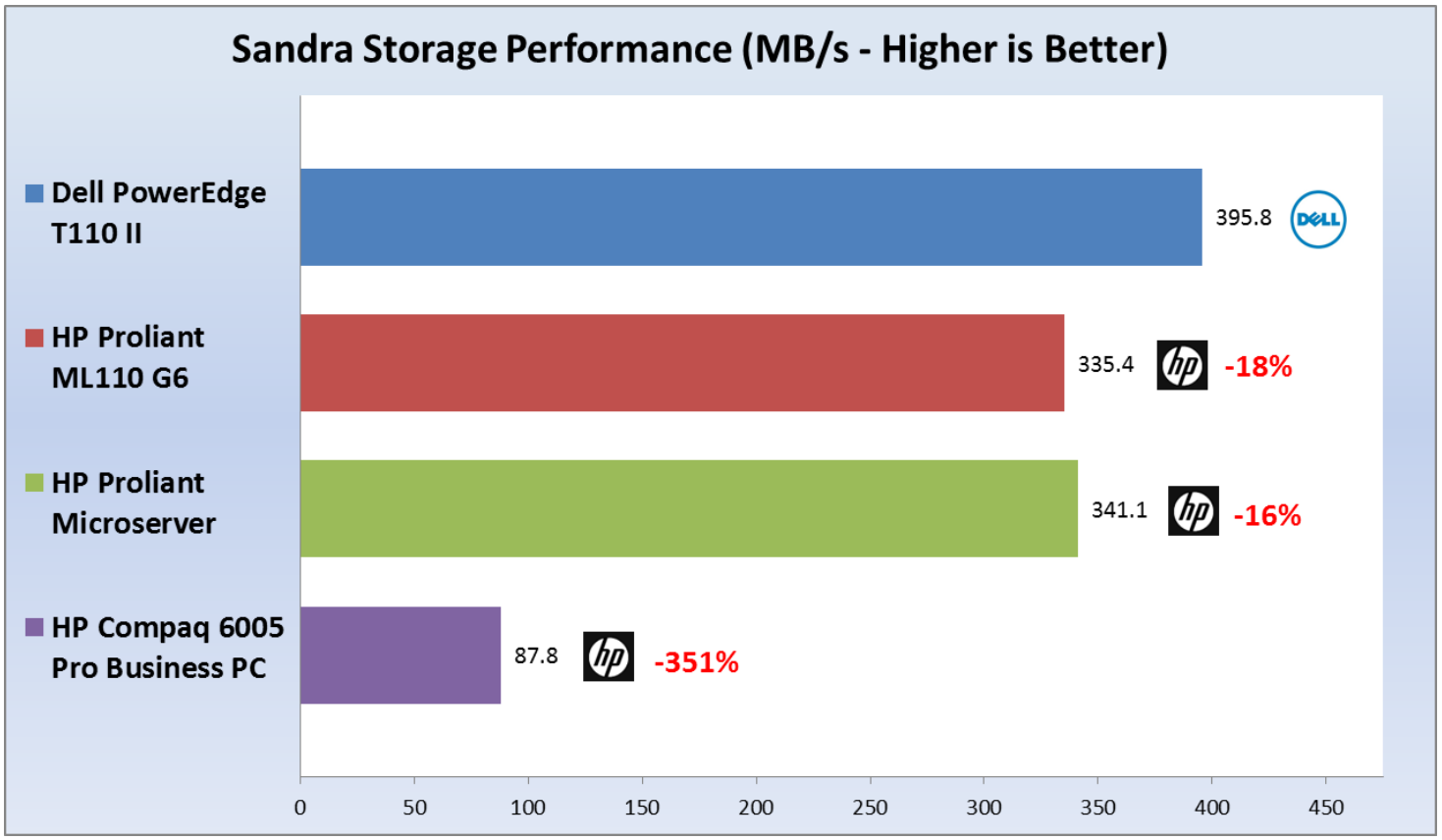
Due to the advanced power saving features in the new Intel Xeon E3 processor architecture in the Dell PowerEdge T110 II is far more efficient than any of the HP systems. The increased power usage required to complete the same amount of work significantly increases the total cost of ownership of the HP servers in this study when compared to the Dell PowerEdge T110 II. With a processor efficiency of between 57% to 234%

better than the HP Proliant and HP Compaq 6005 systems, the Dell PowerEdge T110 II provides much better value over the lifetime of the product.

Comparison 4: Storage Performance

The ability to quickly access business critical data from the internal storage subsystem is another important aspect of server performance. E-commerce and business transactions can easily be bottlenecked by poor storage subsystem performance. Comparison 4 investigates the maximum storage bandwidth of each system in this study.

Figure 5: Comparison 4 Sandra 2011 Storage Subsystem Performance



Results

The storage bandwidth achieved by the Dell PowerEdge T110 II is significantly better than any of the HP systems featured in this study. The Dell PowerEdge T110 II offers a fully hardware accelerated, 15k SAS four drive RAID 0 configuration. The HP Proliant servers only offer SATA drives in their hardware accelerated RAID 0 arrays, which is why they are 16%-18% slower. As was mentioned earlier, the HP Compaq 6005 Pro Business PC does not offer a factory RAID 0 configuration, so the best performing option for this system is a two drive SATA software accelerated RAID 1 configuration. The RAID 0 option, standard on all servers, is not present in a desktop class system like the 6005 Pro Business PC.

Summary

The results of Comparison 1 show that the Dell PowerEdge T110 II has much more raw processing power than any of the HP systems in this study. The Dell PowerEdge T110 II is the performance leader in numerical integer, floating point, image processing, and server side Java calculations. The margin of victory was significant, ranging from 26% up to 2692%.

Comparison 2 showed that the advanced AVX instructions featured in the Dell PowerEdge T110 II make it the ideal server for secure business transactions and e-commerce. The Dell PowerEdge T110 II offers between 60% up to 2692% better performance than the HP servers for encryption/decryption and hashing calculations.

When it comes to energy efficiency, the Dell PowerEdge T110 II beats the HP servers in this study by a wide margin. Comparison 3 showed that the performance/watt advantage of the Dell PowerEdge T110 II is 57% to 234% higher than the HP ProLiant and HP Compaq Desktop machines. Over the life of the product, this increased power usage can end up costing a significant amount to the bottom line. The Dell PowerEdge T110 II with its advanced power management features is the best choice for total cost of ownership.

The ability to access business critical data quickly was the goal of Comparison 4. The Sandra 2011 benchmark was used to measure storage subsystem performance. The only server in this study to offer a hardware RAID 0 configuration for SAS drives, the Dell PowerEdge T110 II was again the performance leader, beating the HP Proliant servers by 16% and 18% respectively. The results show that the HP Compaq 6005 Pro Business PC does not offer all of the features expected in a business class server, offering only RAID 1, no remote management capabilities, and 351% lower storage performance.

Appendix A—Test Methodology

SPECpower_ssj2008 Benchmark

SPECpower_ssj2008 is an industry standard benchmark created by the Standard Performance Evaluation Corporation (SPEC) to measure a server's power and performance across multiple utilization levels. SPECpower_ssj2008 consists of a Server Side Java (SSJ) workload along with data collection and control services. SPECpower_ssj2008 results portray the server's performance in ssj_ops (server side Java operations per second) divided by the power used in watts (ssj_ops/watt). SPEC created SPEcpower_ssj2008 for those who want to accurately measure the power consumption of their server in relation to the performance that the server is capable of achieving with ssj2008 workload.
SPECpower_ssj2008 consists of three main software components:

- Server Side Java (SSJ) Workload—Java database that stresses the processors, caches and memory of the system, as well as software elements such as OS elements and the Java implementation chosen to run the benchmark.
- Power and Temperature Daemon (PTDaemon)—Program that controls and reports the power analyzer and temperature sensor data.
- Control and Collect System (CCS)—Java program that coordinates the collection of all the data.

For more information on how SPECpower_ssj008 works, see http://www.spec.org/power_ssj2008/.

All results discussed in this whitepaper are from "compliant runs" in SPEC terminology, which means that although they have not been submitted to SPEC for review, Dell is allowed to disclose them for the purpose of this study. All configuration details required to reproduce these results are listed in Appendices A, B, and C and all result files from the runs compared are included in Appendix D.

All servers were configured by installing a fresh copy of Microsoft® Windows Server® 2008 Foundations R2 (Service Pack 1) with the operating system installed on a one-hard drive SATA configuration with no RAID options enabled. The only exception to this was the HP Compaq 6005 Pro Business PC. It only comes with Windows 7 Enterprise from the factory and does not offer a server OS as an option. Due to this limitation this system was installed with the client operating system offered on this system. The Lock Pages in Memory option was achieved by disabling UAC in the control panel, then setting Lock Pages in Memory to Enabled for Administrator. This configuration is the Power Efficient configuration mentioned in comparison 3 and shown in greater detail in Appendix B.

The latest driver and firmware update packages available to both servers were installed at the beginning of this study. Refer to Appendix B for details.

The Dell System Performance Analysis Team ran SPECpower_ssj2008 ten times per configuration across all four servers and chose the run with the highest overall ssj_ops/watt for each configuration to compare for this study.

SPECpower_ssj2008 BIOS Settings

BIOS settings differed between the four systems, so we tuned each system for best-known SPECpower_ssj2008 performance results. To improve power efficiency, we changed the memory speed of both the Dell PowerEdge T110 II and HP Proliant ML110 G6 systems to 1066MHz from the default of 1333MHz. For the AMD based HP Proliant Microserver and HP Compaq 6005 Pro Business PC the memory speed was already running below maximum speed so this was not changed. Virtualization was not used in these tests so Virtualization support was disabled on all servers in this study.

Below is a table listing the SPECpower_ssj2008 BIOS settings for each system

Table 2: SPECpower_ssj2008 BIOS settings for each system

BIOS Settings				
System	PowerEdge T110 II	ML110 G6	HP Microserver	HP 6005 Pro Business PC
HW Prefetcher	Disabled	Disabled	Not Available	Not Available
Adjacent Sector Prefetcher	Disabled	Disabled	Not Available	Not Available
DCU IP Prefetcher	Disabled	Disabled	Not Available	Not Available
DCU Streamer Prefetcher	Disabled	Not Available	Not Available	Not Available
Virtualization	Disabled	Disabled	Disabled	Disabled
C-States	Enabled	Enabled	Enabled	Enabled
Memory Frequency	1067MHz for SPECpower	1067MHz for SPECpower	800MHz (maximum proc will support)	1200MHz (Max proc will support)
	1333MHz for SPECjbb	1333MHz for SPECjbb	800MHz (maximum proc will support)	1200MHz (Max proc will support)

SPECpower_ssj2008 OS Tuning

To improve Java performance, large pages were enabled by entering Control Panel->Administrative Tools->Local Security Policy->Local Policies->User Rights Assignment->Lock Pages in Memory. An option was changed to add Administrator.

Operating System Power Management mode for all solutions was changed to Power Saver and the plan Advanced Options edited to turn off the Hard Drive after 1 minute.

We configured all servers with a separate IP address on the same subnet as our SPECpower_ssj2008 controller system where the Director, CCS, and PTDaemon components were located, and connected both servers directly to the controller system through NIC 1 for their respective runs.

SPECpower_ssj2008 Configuration

IBM J9 Java Virtual Machine (JVM)[3] was used for all systems, as this JVM provided the best performance for SPECpower_ssj2008 of any of the available choices at the time that this study was undertaken.

The following JVM options were used on all servers, as they are the best-known JVM tunings for SPECpower_ssj2008 for the IBM J9 JVM when running with larger memory configurations:

-Xms1875m -Xmx1875m -Xmn1400m -Xaggressive -Xcompressedrefs -Xgcpolicy:gencon -XlockReservation -Xnloa -XtlhPrefetch -Xlp

The bindings chosen were different for each system because of the differing core counts and number of JVMs used for each configuration. Below is a bullet list of the affinity for each system's JVMs to the total available number of logical processors.

- Dell PowerEdge T110 II - start /affinity [F,F0]
- HP Proliant ML110 G6 - start /affinity [F,F0]
- HP Proliant Microserver - start /affinity [3]
- HP Compaq 6005 Pro Business PC - start /affinity [3,C]

[3] JVM build 2.4, J2RE 1.6.0 IBM J9 2.4 Windows Server® 2008 amd64-64 jvmwa64 60sr5-20090519_35743

Power Meter Configuration

We used the Yokogawa WT210 Digital Power Meter for the actual power measurement of the servers, as this is the most commonly used analyzer for SPECpower_ssj2008 publications at the time that this study was undertaken.

SPECjbb2005

SPECjbb2005 is an industry standard benchmark created by the Standard Performance Evaluation Corporation (SPEC) to measure a server's Server Side Java (SSJ) performance. SPECjbb2005 evaluates the performance of server side Java by emulating a three-tier client/server system (with emphasis on the middle tier). The benchmark exercises the implementations of the JVM (Java Virtual Machine), JIT (Just-In-Time) compiler, garbage collection, threads and some aspects of the operating system. It also measures the performance of CPUs, caches, memory hierarchy and the scalability of shared memory processors.

For more information on SPECjbb2005, see http://www.spec.org/jbb2005/.

All results discussed in this whitepaper are from "compliant runs" in SPEC terminology, which means that although they have not been submitted to SPEC for review, Dell is allowed to disclose them for the purpose of this study. All configuration details required to reproduce these results are listed in Appendices A, B, and C and all result files from the runs compared are included in Appendix D.

All servers were configured by installing a fresh copy of Microsoft® Windows Server® 2008 Foundations R2 (Service Pack 1) with the operating system installed on a RAID 0 configuration when available. The only exception to this was the HP Compaq 6005 Pro Business PC. It only comes with Windows 7 Enterprise from the factory and does not offer a server OS as an option. Due to this limitation this system was installed with the client operating system offered on this system. The Lock Pages in Memory option was achieved by disabling UAC in the control panel, then setting Lock Pages in Memory to Enabled for Administrator. For the HP Compaq 6005 Pro Business PC RAID 1 was the only RAID option available. This configuration is the Maximum Performance configuration mentioned in Comparison 1, Table 1.

The latest driver and firmware update packages available to all servers were installed at the beginning of this study. Refer to Appendix B for details.

The Dell System Performance Analysis Team ran SPECjbb2005 ten times per configuration across all four servers and chose the run with the highest SPECjbb2005 bops for each configuration to compare for this study.

SPECjbb2005 BIOS Settings

The same BIOS settings were used for the SPECjbb2005 testing as was used for SPECpower_ssj2008. Table 2 shows this configuration earlier in Appendix A. The only exception was that for the Intel based systems the memory frequency was adjusted back to the default (maximum performance) setting. The power plan for each system was selected as Maximum Performance in the BIOS to match the OS settings below.

SPECjbb2005 OS Tuning

The optimal settings chosen for the SPECpower_ssj2008 comparison are also the best ones for SPECjbb2005 testing. The only difference is the OS power plan was set to Maximum performance and the Advanced Options edited to reset the hard drive sleep time to 20 minutes.

SPECjbb2005 Configuration

IBM J9 Java Virtual Machine (JVM)[4] was also used for all SPECjbb2005 testing as this JVM provided the best performance for SPECjbb2005 of any of the available choices at the time that this study was undertaken. The JVM bindings for SPECjbb were also the same as the ones used in SPECpower_ssj2008 listed above.

SiSoftware Sandra 2011

Sandra 2011 is an industry standard benchmark created by the SiSoftware. This benchmark was created to measure the performance of each subsystem in a computer. This data can be analyzed individually to investigate specific subsystem performance or as a whole to benchmark total system performance. This study chose a subset of the total metrics available, ones that would be relevant to small business server customers. Below is a list of each benchmark and a short description of what it measures:

- **Aggregate Arithmetic Performance** – measured in Giga Operations Per Second (GOPS), this metric is a rating derived from the Integer and Floating Point processor tests within Sandra 2011.
- **Dhrystone iSSE4.2** – measured in Giga Integer operations Per Second (GIPS), this test measures the capability of a processor to calculate integer based operations. Examples of this are complex matrix multiplication and Monte Carlo simulations.
- **Whetstone iSSE3** (Giga FLoating point Operations Per Second) – this benchmark measures the floating-point computational performance of a system. This type of calculation is most common in graphic rendering and scientific analysis.
- **Processor Multimedia** (Mega Pixels per Second) – the final Sandra 2011 processor test, this measures the calculation speed achieved when rendering a series of complex fractal images.
- **Cryptographic Bandwidth** (Gb/s) – this is a specialized test that measures the total throughput of a system when computing the most common security encryption and decryption functions. Also, included in this test are the file hashing calculations necessary to detect file corruption and tampering.
- **Storage Performance** (MB/s) – this test measures the storage subsystem performance. Using sequential reads and writes, the maximum level of data transfer is achieved and recorded.

For more information on SiSoftware Sandra 2011, see http://www.sisoftware.net/

Sandra 2011 SP2b was purchased directly from SiSoftware and installed from the USB key provided. All benchmark options remained set to the default configuration and resulted in scores compliant with the benchmark run rules.

All servers were configured by installing a fresh copy of Microsoft® Windows Server® 2008 Foundations R2 (Service Pack 1) with the operating system installed on a RAID 0 configuration when available. The only exception to this was the HP Compaq 6005 Pro Business PC. It only comes with Windows 7 Enterprise from the factory and does not offer a server OS as an option. Due to this limitation this system was installed with the client operating system offered on this system. The Lock Pages in Memory option was achieved by disabling UAC in the control panel, then setting Lock Pages in Memory to Enabled for Administrator. For the HP Compaq 6005 Pro Business PC RAID 1 was the only RAID option available. Also, the HP Compaq 6005 Pro Business PC only offers Windows 7 Enterprise from the factory, so this was the configuration tested. This configuration is the Maximum Performance configuration mentioned in Comparison 1, Table 1.

The latest driver and firmware update packages available to all servers were installed at the beginning of this study. Refer to Appendix B for details.

---

[4] JVM build 2.4, J2RE 1.6.0 IBM J9 2.4 Windows Server® 2008 amd64-64 jvmwa64 60sr5-20090519_35743

Sandra 2011 BIOS Settings

The BIOS settings for the Sandra 2011 runs differed from the SPEC runs in that all hardware prefetchers were changed back to their default setting of enabled. Table 3 below shows this configuration. The power plan for each system was selected as Maximum Performance in the BIOS to match the OS settings below.

Table 3: Sandra 2011 BIOS settings for each system

BIOS Settings - Sandra 2011 SP2b				
System	PowerEdge T110 II	ML110 G6	HP Microserver	HP 6005 Pro Business PC
HW Prefetcher	Enabled	Enabled	Not Available	Not Available
Adjacent Sector Prefetcher	Enabled	Enabled	Not Available	Not Available
DCU IP Prefetcher	Enabled	Enabled	Not Available	Not Available
DCU Streamer Prefetcher	Enabled	Not Available	Not Available	Not Available
Virtualization	Disabled	Disabled	Disabled	Disabled
C-States	Enabled	Enabled	Enabled	Enabled
Memory Frequency	1333 MHz	1333 MHz	800MHz (maximum proc will support)	1200MHz (Max proc will support)
Power Management	Maximum Performance	Maximum Performance	Maximum Performance	Maximum Performance

Sandra 2011 OS Tuning

The optimal settings for Sandra 2011 are to set the OS power plan to Maximum performance and the Advanced Options edited to reset the hard drive sleep time to 20 minutes. No other special configuration of the operating system or the benchmark itself is required to set up and run Sandra 2011. The option for running all Sandra 2011 tests was selected and the benchmark executed the chosen script without any further user interaction.

Appendix B—Server Hardware Configuration Information

Table 4: Server Hardware Configuration Information

	Dell PowerEdge T110 II	HP ProLiant ML110 G6	HP ProLiant Microserver	HP Compaq 6005 Pro Business PC
Memory Modules				
Total RAM in system (GB)	8	8	8	8
Vendor and model number	Hynix GMT251U7BFR8A	Hynix GMT251U7BFR8A	Hynix GMT251U7BFR8A	Samsung M391B5273CH0-YH9
Type	PC3L-10600E	PC3L-10600E	PC3L-10600E	PC3L-10600E
Speed (MHz)	1333	1333	1333	1333
Speed in system as tested	1333 and 1066 MHz	1333 and 1066 MHz	800 MHz	1200 MHz
Timing/latency	CAS 9	CAS 9	CAS 9	CAS 9
Number of RAM modules	2 x 4 GB	2 x 4 GB	2 x 4 GB	2 x 4 GB
Rank organization	Dual Rank x 8	Dual Rank x 8	Dual Rank x 8	Dual Rank x 8
Hard Disk				
Vendor and model number	Dell ST3450857SS	Seagate ST3500418AS	Seagate ST3500418AS	Seagate ST3500418AS
Number of disks in system	4	4	4	2
Size (GB)	500	250	250	500
RPM	15,000	7200	7200	7200
Type	SAS 6 Gbps	SATA 3 Gbps	SATA 3 Gbps	SATA 3 Gbps
RAID Type	RAID 0	RAID 0	RAID 0	RAID 1
Controller	Dell PERC H200	HP Smart Array B110i	Embedded AMD Controller	AMD (Xpert) RAID Controller Embedded
Operating System				
Name	Microsoft® Windows Server® Foundations 2008 R2 Enterprise SP1	Microsoft® Windows Server® Foundations 2008 R2 Enterprise SP1	Microsoft® Windows Server® Foundations 2008 R2 Enterprise SP1	Microsoft® Windows 7 Enterprise
Build number				
File system	NTFS	NTFS	NTFS	NTFS
Language	English	English	English	English
Network Adapter				
Vendor and model number	Broadcom® BCM5772 NetXtreme® II	Broadcom® NC107i NetXtreme®	Broadcom® NC107i NetXtreme®	Broadcom® BCM5761 NetXtreme®
Type	Integrated	Integrated	Integrated	Integrated

Appendix C—Server Firmware and Drivers

Table 5: Server Firmware and Drivers

Driver/Firmware Versions	Dell PowerEdge T110 II	HP ProLiant ML110 G6	HP Proliant Microserver	HP Compaq 6005 Pro Business PC
System BIOS	1.0.3	2010.12.15 (Released 3/1/2011)	2011.01.17 (A) (Released 2/28/2011)	1.12 Rev. A (Release 4/1/ 2011)
Network Firmware	6.2.14	2.1.5.9 (B) 6 Oct 2010	2.1.5.9 (B) 6 Oct 2010	2.0 Rev. (A) 3 May 2010
Network Drivers	16.2.0	OS Native	10.100.4.0 (OS Native)	14.0.0.7 Rev A
HBA Firmware	07.02.42.00	3.66 (B)	3.2.1.54933	N/A
HBA Drivers	2.0.12.20	6.16.0.64 (4 Apr 2011)	3.2.1540.60 (8 Sep 2010)	3.1.1548.155 Rev. A 22 Oct 2009
Chipset Driver	9.2.0.10.21	OS Native	8.73.4 (8 Sep 2010)	1.3.0.49
Video Driver	1.1.3.0	OS Native	OS Native	4.1.11.1332
Integrated Management Controller Firmware	1.70.15 BMC	4.22 (A) 7 Apr 2011	No iLO present	No iLO present
Management Controller Driver	N/A	1.4.0.0	N/A	N/A

Appendix D—Comparison 1-4 Detailed Results

For each comparison, the first page of the result files for each benchmark is shown. SPECjbb2005 and SPECpower_ssj2008 benchmarks contain results files which are generated with graphic and tabular results for each server. Sandra 2011 SP2b only provides a text output file, so this will not be included in this section. Full Sandra 2011 SP2b, SPECjbb2005, and SPECpower_ssj2008 results files for each server are attached to this document for reference.

Figure 6: Comparison 1 - SPECjbb2005 Results for Dell PowerEdge T110 II

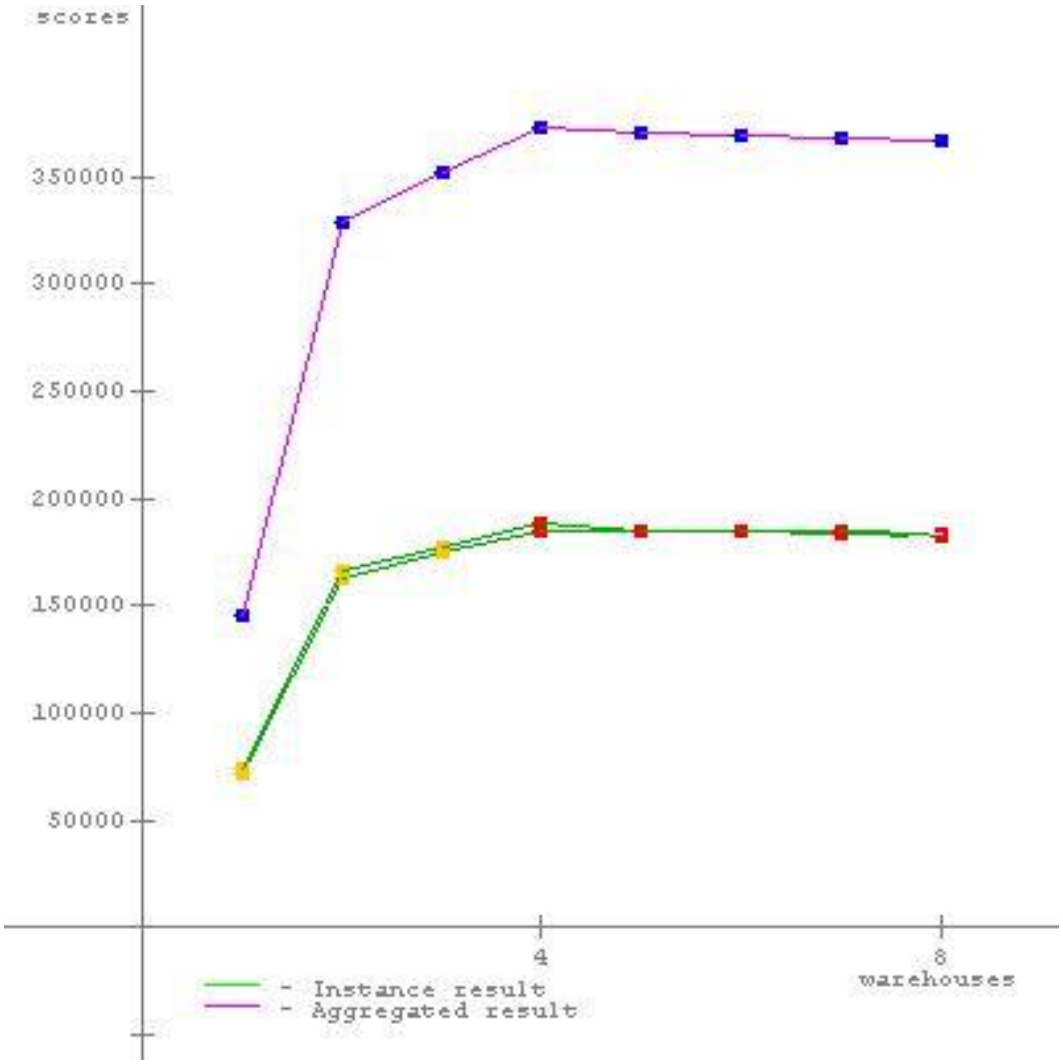


Figure 7: Comparison 1 - SPECjbb2005 Results for HP Proliant ML110 G6

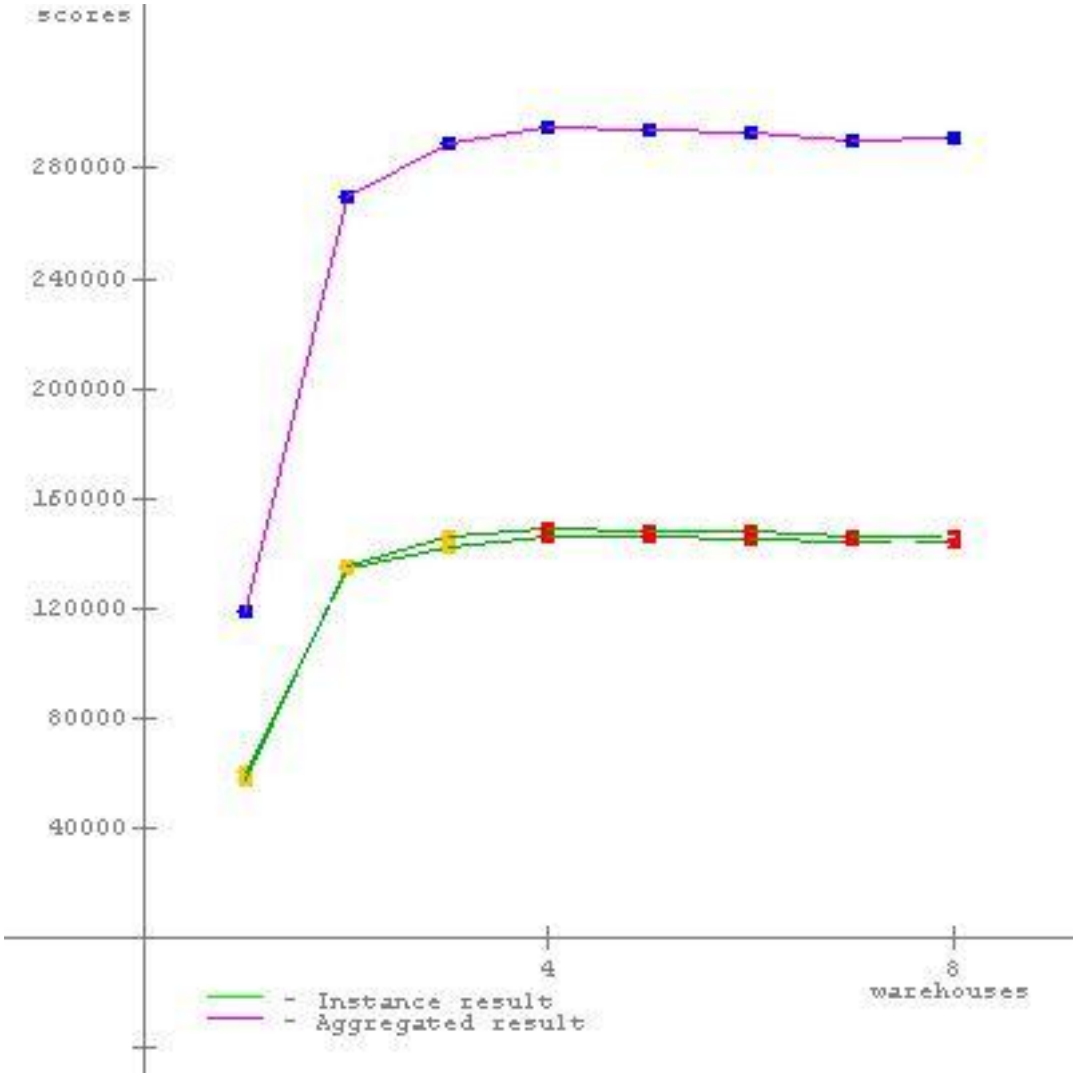


Figure 8: Comparison 1 - SPECjbb2005 Results for HP Proliant Microserver

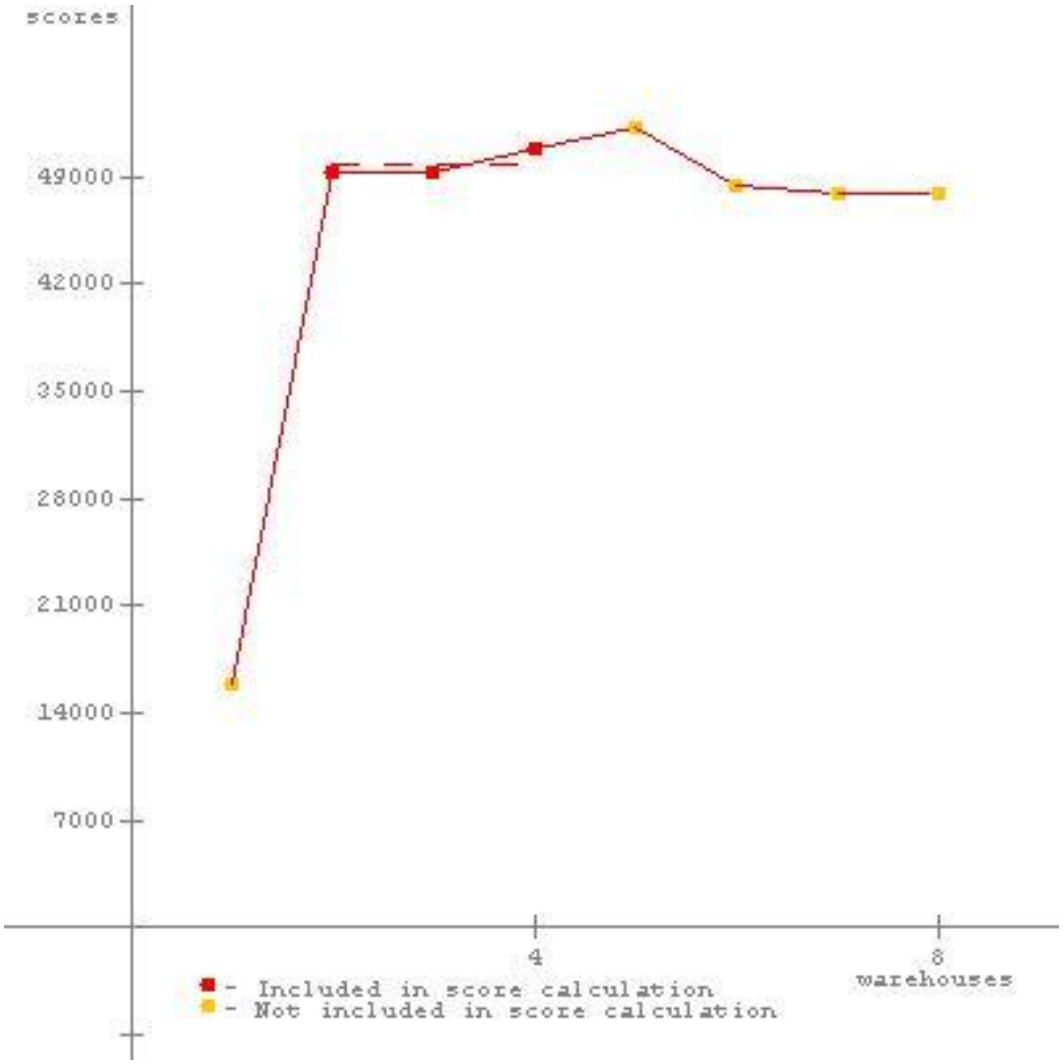
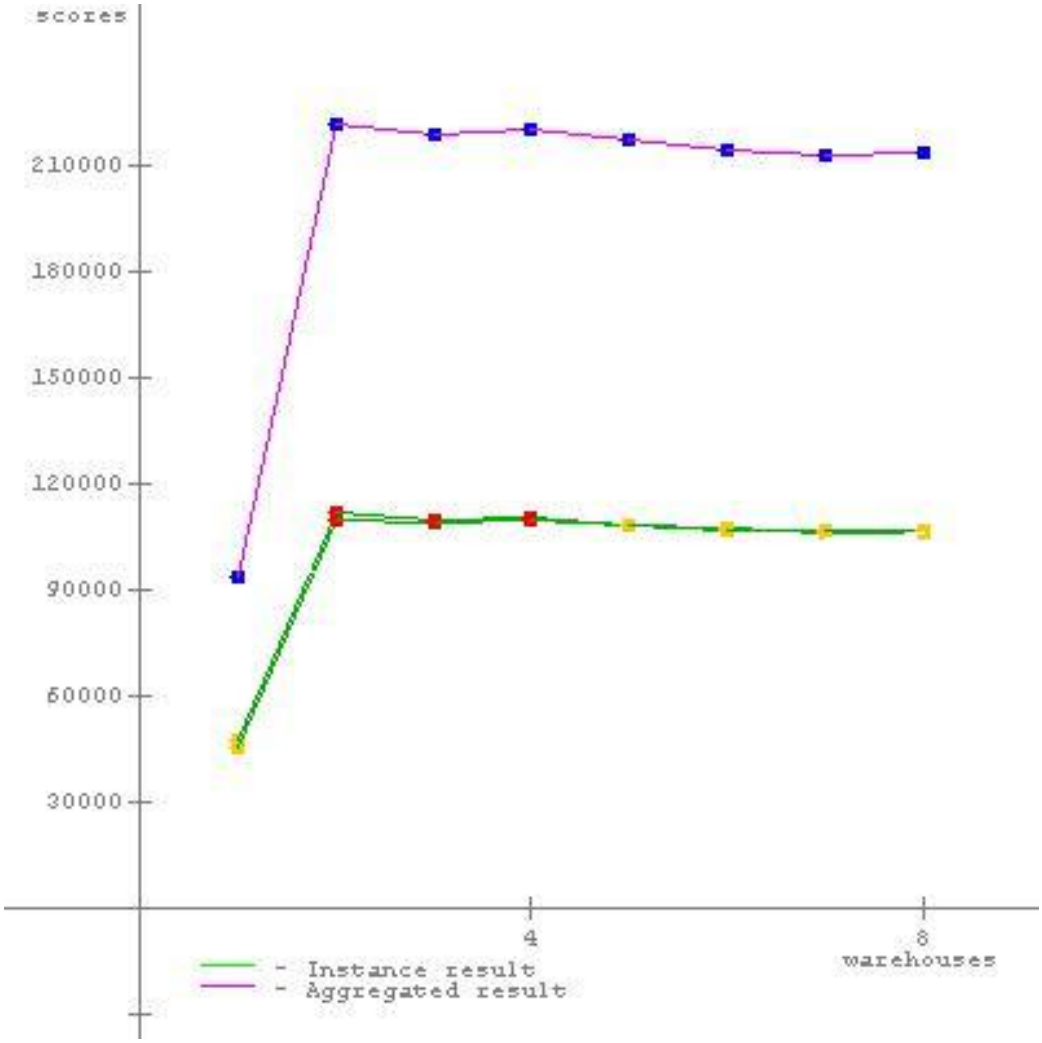


Figure 9: Comparison 1 - SPECjbb2005 Results for HP Compaq 6005 Pro Business PC



Comparison 2: Sandra 2011 SP2b Cryptographic Bandwidth results.

The results for Sandra 2011 SP2b are output into text format, there are no graphical representations of the data. The result files will be attached to the end of this document for reference, but there are no visuals that can be shown for this section of the study.

Comparison 3: SPECpower_ssj2008 Performance per Watt results.

The result files for the section of the study are shown below.

Figure 10: Comparison 3 - SPECpower_ssj2008 Results for Dell PowerEdge T110 II

SPECpower_ssj2008

Dell Inc. PowerEdge T110 II (Intel Xeon E3-1270, 3.40 GHz)				SPECpower_ssj2008 = 3,448 overall ssj_ops/watt	
Test Sponsor:	Dell Inc.	SPEC License #:	55	Test Method:	Single Node
Tested By:	Dell Inc.	Test Location:	Round Rock, TX, USA	Test Date:	Jun 2, 2011
Hardware Availability:	Apr-2011	Software Availability:	Sep-2009	Publication:	Unpublished
System Source:	Single Supplier	System Designation:	Server	Power Provisioning:	Line-powered

Benchmark Results Summary

Performance			Power	Performance to Power Ratio
Target Load	Actual Load	ssj_ops	Average Active Power (W)	
100%	99.9%	399,774	101	3,960
90%	89.9%	359,648	94.4	3,809
80%	79.6%	318,375	83.6	3,810
70%	70.1%	280,215	72.0	3,891
60%	60.1%	240,484	60.9	3,948
50%	50.2%	200,619	52.9	3,793
40%	40.0%	160,135	46.2	3,466
30%	29.8%	119,077	41.1	2,898
20%	19.8%	79,254	34.5	2,299
10%	10.0%	39,926	29.3	1,360
	Active Idle	0	21.5	0
			∑ssj_ops / ∑power =	3,448

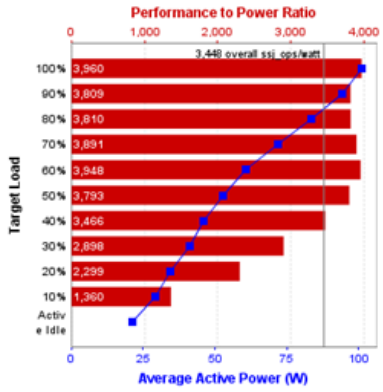


Figure 11: Comparison 3 - SPECpower_ssj2008 Results for HP Proliant ML110 G6

SPECpower_ssj2008

Hewlett Packard HP ML110 G6 (Intel Xeon X3470, 2.93 GHz)			SPECpower_ssj2008 = 2,136 overall ssj_ops/watt		
Test Sponsor:	Dell Inc.	SPEC License #:	55	Test Method:	Single Node
Tested By:	Dell Inc.	Test Location:	Round Rock, TX, USA	Test Date:	Jul 8, 2011
Hardware Availability:	Jan-2011	Software Availability:	Sep-2009	Publication:	Unpublished
System Source:	Single Supplier	System Designation:	Server	Power Provisioning:	Line-powered

Benchmark Results Summary

Performance			Power	Performance to Power Ratio
Target Load	Actual Load	ssj_ops	Average Active Power (W)	
100%	99.5%	316,904	115	2,755
90%	89.8%	285,809	107	2,683
80%	79.9%	254,527	98.8	2,575
70%	69.8%	222,346	90.1	2,468
60%	59.9%	190,653	79.8	2,389
50%	50.6%	160,992	72.7	2,214
40%	39.9%	127,155	61.9	2,054
30%	29.8%	94,825	55.0	1,724
20%	20.2%	64,307	50.5	1,272
10%	10.0%	31,796	46.1	690
	Active Idle	0	42.4	0
			∑ssj_ops / ∑power =	**2,136**

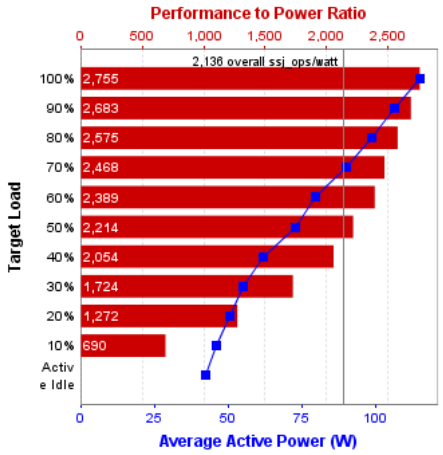


Figure 12: Comparison 3 - SPECpower_ssj2008 Results for HP Microserver

SPECpower_ssj2008

Hewlett Packard HP Microserver (AMD Athlon II Neo N36L, 1.30 GHz)			SPECpower_ssj2008 = 1,031 overall ssj_ops/watt		
Test Sponsor:	Dell Inc.	SPEC License #:	55	Test Method:	Single Node
Tested By:	Dell Inc.	Test Location:	Round Rock, TX, USA	Test Date:	Apr 19, 2011
Hardware Availability:	Jan-2011	Software Availability:	Sep-2009	Publication:	Unpublished
System Source:	Single Supplier	System Designation:	Server	Power Provisioning:	Line-powered

Benchmark Results Summary

Performance			Power	Performance to Power Ratio
Target Load	Actual Load	ssj_ops	Average Active Power (W)	
100%	98.7%	54,126	32.7	1,655
90%	90.2%	49,479	31.1	1,590
80%	80.8%	44,314	32.3	1,372
70%	69.4%	38,095	29.7	1,281
60%	60.1%	32,984	28.6	1,151
50%	49.2%	26,974	26.8	1,006
40%	40.3%	22,122	25.1	881
30%	30.4%	16,694	23.9	699
20%	20.2%	11,083	23.0	481
10%	9.9%	5,458	20.1	271
	Active Idle	0	18.6	0
			∑ssj_ops / ∑power =	**1,031**

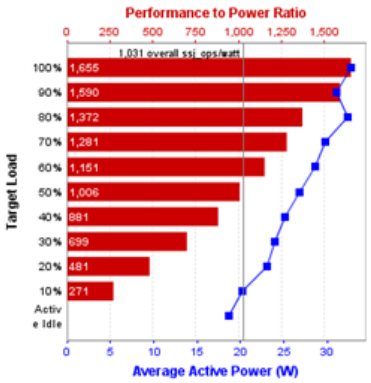


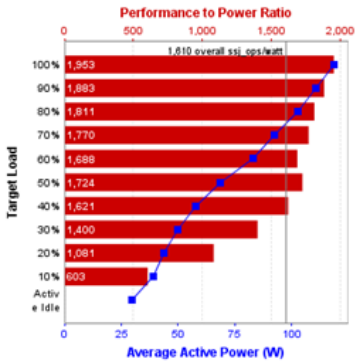
Figure 13: Comparison 3 - SPECpower_ssj2008 Results for HP Compaq 6005 Pro Business PC

SPECpower_ssj2008

Hewlett Packard HP Compaq 6005 ProBusiness PC (AMD Phenom II X4 B95, 3.00 GHz)			SPECpower_ssj2008 = 1,610 overall ssj_ops/watt		
Test Sponsor:	Dell Inc.	SPEC License #:	55	Test Method:	Single Node
Tested By:	Dell Inc.	Test Location:	Round Rock, TX, USA	Test Date:	Apr 20, 2011
Hardware Availability:	Jan-2011	Software Availability:	Sep-2009	Publication:	Unpublished
System Source:	Single Supplier	System Designation:	Server	Power Provisioning:	Line-powered

Benchmark Results Summary

Performance			Power	Performance to Power Ratio
Target Load	Actual Load	ssj_ops	Average Active Power (W)	
100%	99.2%	231,326	118	1,953
90%	89.4%	208,468	111	1,883
80%	79.8%	186,036	103	1,811
70%	70.0%	163,259	92.2	1,770
60%	59.9%	139,666	82.8	1,688
50%	50.5%	117,840	68.3	1,724
40%	40.3%	93,873	57.9	1,621
30%	29.9%	69,743	49.8	1,400
20%	20.4%	47,482	43.9	1,081
10%	10.0%	23,397	38.8	603
	Active Idle	0	29.9	0
			∑ssj_ops / ∑power =	**1,610**



Comparison 4: Sandra 2011 SP2b Storage Subsystem Bandwidth results.

The results for Sandra 2011 SP2b are output into text format, there are no graphical representations of the data. The result files will be attached to the end of this document for reference, but there are no visuals that can be shown for this section of the study.