Performance Comparison of Fujitsu PRIMERGY and PRIMEPOWER Servers

CHALLENGE
Replace a Fujitsu PRIMEPOWER® 2500 partition with a lower cost solution that provides enhancements in the following areas:

- I/O, network and database throughput
- Java application performance
- Scalability

SOLUTION
The Fujitsu PRIMERGY® RX600 S4 server was chosen as a potential solution since it can accommodate up to 24 processor cores and 128 GB of memory, making its resources comparable to those of a medium-to-large partition on a PRIMEPOWER® 2500 server.

Benchmark test results show that a PRIMERGY RX600 S4 server running Red Hat Enterprise Linux (RHEL) and using Intel® Xeon® processors can perform as well as or better than a similarly configured PRIMEPOWER 2500 server running Sun Solaris™ 10 and using SPARC processors. Furthermore, the PRIMERGY RX6400 S4 server also has a much lower total cost of ownership and better scalability.

ADDITIONAL BENEFITS
By moving from existing PRIMEPOWER servers to Intel Xeon-based PRIMERGY systems, you are migrating to a server platform based on current processor technologies and a server architecture that consumes less energy and space resources in the data center. As you search for ways to process more data in your data center while using less power and space — all at a lower cost — the PRIMERGY RX600 S4 server offers a better solution than the PRIMEPOWER 2500.

TEST ENVIRONMENT
The environment used to compare the performance and scalability of a PRIMERGY RX600 S4 server with a PRIMEPOWER® 2500 partition is outlined below.

FUJITSU PRIMERGY RX600 S4
The PRIMERGY RX600 S4 server is a 4U rack-mounted server with support for up to four quad- or six-core Intel Xeon processors, 128 GB RAM, eight hot-plug SAS hard drive bays, seven PCI Express (PCIe) slots and Integrated Remote Management Controller (iRMC).

1 256 GB using 8 GB DIMMs
FUJITSU PRIMEPOWER 2500 PARTITION

The PRIMEPOWER 2500 is an enterprise-class server in a standalone cabinet with support for eight – 128 SPARC64™ V processors; 512 GB RAM; up to 15 dynamically reconfigurable logical or physical partitions; hot-swappable disks, fans, power supplies, PCI cards and System Control Facility (SCF) controllers; and full error detection and correction across all memory paths.

INTEL WHITE-BOX SERVER

An Intel white-box server (SR6850HW4) was used as a target machine for both the PRIMERGY RX600 SR server and PRIMEPOWER 2500 partition during network throughput testing. This server was configured with four dual-core Intel Xeon processors 7140M (3.4 GHz), 4 GB of memory and a Neterion X3110 PCIe x8 10 GbE adapter. It was running Red Hat Enterprise Linux (RHEL) 5.3 2.6.18-128.el5.

Figure 1: Test environment

Table 1: Tested server configurations

<table>
<thead>
<tr>
<th></th>
<th>PRIMERGY RX600 S4</th>
<th>PRIMEPOWER 2500 (PARTITION 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS</td>
<td>RHEL 5.3</td>
<td>Solaris 10 05/09 for SPARC</td>
</tr>
<tr>
<td>RAM</td>
<td>32 GB (8 x 4 GB)</td>
<td>32 GB (32 x 1 GB)</td>
</tr>
<tr>
<td>CPU</td>
<td>4 x six-core Intel Xeon processor X7460 (2.66GHz), for a total of 24 cores</td>
<td>24 x SPARC64 V processor (1.82GHz), for a total of 24 cores</td>
</tr>
<tr>
<td>NIC</td>
<td>Neterion X3110 10 GbE PCIe (x8)</td>
<td>Neterion Xframe II 10 GbE PCI-X (66 MHz PCI slot)</td>
</tr>
<tr>
<td>HBA</td>
<td>Emulex LPe12002 PCI Express x8 8 Gb Fibre Channel (FC) dual-channel</td>
<td>Emulex LP10000 PCI-X 2 Gb FC (66 MHz PCI slot)</td>
</tr>
<tr>
<td>SAN</td>
<td>Fujitsu ETERNUS™ M8000</td>
<td>Fujitsu ETERNUS M8000</td>
</tr>
<tr>
<td>Switch</td>
<td>Fujitsu XG2000 10 GbE switch</td>
<td>Fujitsu XG2000 10 GbE switch</td>
</tr>
</tbody>
</table>
Large-scale enterprise computing and server consolidation

The Intel Xeon processor 7400 series has been designed to adapt to your diverse workloads, automatically delivering peak performance when your business needs it. With key innovations like large, on-die L3 cache, support for four or more processors and up to 256 GB of memory, servers based on the Intel Xeon processor 7400 series are ideal choices for your large virtualization projects and data-intensive, business-critical performance requirements.

With the increasing dependence on the Internet and digital data, an Intel Xeon processor-based server delivers the performance and headroom to keep your employees productive as your business grows.

Table 1 demonstrates that the tested servers were similarly configured, with the same number of processor cores (CPUs), the same memory size and similar PCI adapters. Note the following provisos:

- Since the PCI bus architecture used in the PRIMEPOWER 2500 has limited throughput, a 2 Gb FC HBA was used in this system rather than an 8 Gb device (as used in the PRIMERGY RX600 S4), which, even if supported, would not have improved performance.
- The Neterion Xframe II 10 GbE NIC used in the PRIMEPOWER 2500 is a PCI-X card; no PCIe slots are provided in this system. The NIC used in the PRIMERGY RX600 S4 was a 10 Gbe PCIe (x8) device.
- A PRIMEPOWER 2500 partition would normally be configured with 48 – 96 GB of memory. However, the partition in the tested server only had 32 GB of memory to match the amount installed in the PRIMERGY RX600 S4.

PERFORMANCE TESTS

Benchmark tests were selected to stress a range of functional areas (SAN I/O performance, 10 GbE network performance, Java application performance and database performance). This section describes the benchmark tools used to characterize the performance and scalability of the tested servers and outlines the test methodology.

IOMETER (SAN I/O)

Iometer is an I/O subsystem measurement and characterization tool for individual or clustered systems in standalone or networked environments. Iometer is both a workload generator (that is, it performs I/O operations in order to stress the system) and a measurement tool (that is, it examines and records the performance of its I/O operations and their impact on the system). It can be configured to emulate the disk or network I/O load of any program or benchmark, or can be used to generate entirely synthetic I/O loads.

Since it is based on the client-server model, a single instance of the Iometer graphical user interface can manage multiple ‘workers,’ each of which represents a separate workload process generating asynchronous I/O activity by accessing files or block devices.

NETPERF 2.4.5 (10 GBE)

The netperf benchmark can be used to measure various aspects of networking performance. For this POC, bulk data transfer (uni-directional) tests were performed between the various servers since this is the most common type of network traffic.

SPECJBB2005 (JAVA APPLICATION)

The SPECjbb2005 benchmark evaluates servers running typical Java business applications. By emulating an order-processing application for a wholesale supplier, this benchmark can be used to characterize the hardware and software performance of Java Virtual Machine (JVM) servers.

BENCHMARK FACTORY FOR DATABASES (DATABASE)

Benchmark Factory® for Databases is a performance and code scalability testing tool that simulates users and transactions on the database and replays production or synthetic workloads in non-production environments. In this POC, the Benchmark Factory workload emulates an OLTP workload similar to the Transaction Processing Performance Council TPC-C Order-Entry workload schema, and was used in conjunction with an Oracle Database 10g R2 (10.2.0.4) database.

METHODOLOGY

To determine the scalability of the tested servers, Java application and database testing was performed using configurations with 8, 16 and 24 CPUs, while keeping memory size constant at 32 GB.

To simulate both moderate and heavy workloads, the Benchmark Factory for Databases online transaction processing (OLTP) test was run with 50% and 85% busy thresholds with each CPU configuration.

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2 8 Gb HBAs are not available for the PCI bus
3 Such as file transfers using ftp and scp
TEST RESULTS

The speed of the processors deployed in the PRIMERGY RX600 S4 was 2.66 GHz, while the speed of those in the PRIMEPOWER 2500 was 1.82 GHz (or 32% slower). To compensate for this disparity, results from the Java application and database tests have been adjusted.

Note, however, that extrapolations based solely on the clock speeds of processors of different architectures and different generations are not completely valid. Without a thorough understanding of the impact of the different architecture implementations, such extrapolations can only be regarded as approximate.

SAN I/O RESULTS

Iometer benchmark tests were run on servers configured with 24, 16 and eight CPUs; memory size was constant at 32 GB. Two workloads were used:

- To measure peak performance – a single thread accessing a single SAN hard drive
- To simulate a real-world application – multiple threads (corresponding to the number of CPUs in the configuration) accessing a single SAN hard drive

Iometer tests included I/O sizes of 32 KB, 16 KB, 8 KB, 4 KB and 512 B. To exercise reads and writes evenly, a ratio of 50% read operations to 50% write operations was used.

Test results (shown in Figures 2 and 3) show that, with a single thread, the PRIMERGY RX600 S4 outperformed the PRIMEPOWER 2500 for all I/O sizes except 32 GB; peak performance occurred with 16 KB. These results demonstrate a clear advantage for the PRIMERGY’s PCIe I/O subsystem over the PRIMEPOWER’s PCI I/O subsystem. The drop in performance experienced by the PRIMERGY RX600 S4 with 32 KB transfers can be attributed to extra buffer processing provided by the Solaris OS to accommodate large data transfers.

In most cases, adding CPUs to the PRIMERGY RX600 S4 tended to degrade I/O performance due to the additional scheduling overhead imposed by RHEL. With multiple I/O threads, the PRIMEPOWER 2500 outperformed the PRIMERGY RX600 S4 with 32 KB and 16 KB I/Os; with 8 KB and 4 KB I/Os, results were similar; and with 512 B I/Os, the PRIMERGY RX600 S4 outperformed the PRIMEPOWER 2500. These mixed results can be attributed to the superior scheduling ability of Solaris with larger I/Os outweighing the hardware advantages of the PRIMERGY RX600 S4.

Note that, when multiple I/O threads are used, Iometer measures the cumulative throughput of all workload threads.

Figure 2: SAN I/O test results – single thread

Figure 3: SAN I/O test results – multiple threads
**JAVA APPLICATION RESULTS**

SPECjbb2005 benchmark tests were run on servers configured with 24, 16 and eight CPUs; memory size was constant at 32 GB. All tests used a single JVM. After adjusting PRIMEPOWER 2500 results to simulate equivalent CPU speeds, results (shown in Figures 4 and 5) for the eight-CPU configurations were equal; neither system suffered a system or JVM bottleneck. As the number of CPUs increased, the PRIMERGY RX600 S4 demonstrated much higher levels of scalability. However, the scalability of the PRIMEPOWER 2500 was limited by its 32 GB memory size; additional tests with 96 GB of memory showed the benefit of a larger memory footprint when increasing the number of processors in a system.

Note that the results achieved in this POC differ from results published on www.spec.org for the PRIMERGY RX600 S4. This disparity is due to the use of RHEL and the Sun Java runtime environment in the POC as opposed to Microsoft® Windows Server® 2003 R2 and the Oracle JRockit Java runtime environment in the published benchmark. There are no published results for a configuration similar to the tested PRIMEPOWER 2500 server.

Results from the SPECjbb2005 benchmark are very dependent on how well the tested Java environment has been tuned (particularly its run-time options and other areas involving the use by the OS of shared memory).

Figure 4: Java application test results – 32 GB of memory

Figure 5: Java application test results – additional testing with 96 GB of memory

**10 GBE NETWORK RESULTS**

The netperf TCP_STREAM test was run with message sizes of 1 KB, 4 KB and 8 KB and maximum transmission units (MTUs) of 1500 B and 9000 B. The test was run three times for each message size.

Four instances of the netperf driver were used, each bound to a specific CPU. With fewer instances, 100% processor utilization would have been reached, limiting overall results.

Using a jumbo frame
Results (shown in Figures 6 and 7) reflect the significant advantage delivered by a combination of the PCIe bus in the PRIMERGY RX600 S4 and the more efficient network stack of the RHEL OS as opposed to the PCI architecture of the PRIMEPOWER 2500. Higher throughput was achieved with the larger MTU, which reduced the load on the processor (that is, the number of packets transmitted was less for MTU 9000 than for MTU 1500 when transferring the same amount of data).

When the PRIMERGY RX600 S4 was tested an 8 KB message and MTU 1500, netperf driver errors occurred. Thus, only two results are plotted for this particular scenario.

Results also show the benefit of having a faster processor in the receiving server than that in the transmitting server. For example, compare the throughput of the 3.4 GHz Intel white-box server when transmitting data to the 2.66 GHz PRIMERGY RX600 S4 server as opposed to the throughput of the PRIMERGY RX600 S4 when transmitting to the Intel white-box server.

Figure 6: 10 GbE test results – MTU 9000

![Netperf tests 10GbE with MTU 9000](image)

Figure 7: 10 GbE test results – MTU 1500

![Netperf tests 10GbE with MTU 1500](image)

**DATABASE RESULTS**

The Benchmark Factory® for Databases benchmark was run on servers configured with 24, 16 and eight CPUs; memory size was constant at 32 GB. For each configuration, testing was performed at 50% and 85% CPU utilization.

Results (shown in Figure 8) at 50% CPU utilization are similar after PRIMEPOWER 2500 numbers have been adjusted to simulate equivalent processor speeds. However, results at 85% utilization show the PRIMERGY RX600 S4 to be performing better and being more scalable than the PRIMEPOWER 2500.

The Oracle database has evolved to the point where it attempts to self-tune the size of internal areas it requires to function. Methods used to size the various work areas are not well documented and may vary from one release to another, as well as from one platform to another.

5 This disparity reflects limitations in the PCI bus architecture rather than the capabilities of the Neterion 10 GbE network adapter and driver.
When tested with 24 CPUs, results for the PRIMEPOWER 2500 indicated that lack of memory resources may have been limiting overall performance. To confirm this hypothesis, 85% CPU utilization testing on the PRIMEPOWER 2500 was repeated using 96 GB rather than 32 GB of memory. The new results (shown in Figure 9) demonstrated near straight-line scalability between eight – 24 CPUs.

**Figure 8: Benchmark test results – 32 GB of memory**

**CPU COMPARISON**

In many cases, the above test results demonstrate the superior performance of the Intel Xeon processors used in the PRIMERGY RX600 S4 over the SPARC processors used in the PRIMEPOWER 2500. It should also be noted that Intel Xeon processors can help reduce data center requirements for power, cooling and space, as shown in Figure 10.

Since the PRIMERGY RX600 S4 is rack-mounted, Figure 10 shows how this server can reduce volumetric space requirements (ft³) as well as its data center footprint (ft²).
Figure 10: Environmental comparison between PRIMERGY RX600 S4 and PRIMEPOWER 2500