Lutris* Enhydra* 3.5 Java*/XML Application Server Solution Sizing Guide

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Executive Summary

This *Lutris* Enhydra* 3.5 Java*/XML Application Server Solution Sizing Guide* provides performance and capacity metrics for the Lutris Enhydra 3.5 Java/XML Application Server running on Intel® Architecture-based servers using the Red Hat* Linux* 7.0 operating system. This sizing guide is intended to assist key decision makers in determining the optimal Intel Architecture-based server configuration to meet their particular Java application deployment needs. The solution sets described here have been extensively tested by Intel® Solution Services.

The results presented in this sizing guide demonstrate the enterprise-class capacities and performance that can be achieved on Intel processor-based servers running Open Source based software solutions like Lutris Enhydra 3.5 and Red Hat Linux. In addition, the results clearly demonstrate that increasing levels of capacity and performance are attained when the Intel processor-based servers, running enterprise-class solutions, are scaled out or scaled up. For example, in one test scenario, Intel Solution Services was able to achieve a 4x performance improvement in system response time.[1]

Lutris Enhydra 3.5 is a leading Java XML Application Server that is derived from their sponsorship of the Enhydra Open Source project. See *www.lutris.com* for more information on Lutris Enhydra 3.5 and *www.enhydra.org* for information on the Enhydra Open Source project.

Red Hat Linux is a leading Linux distribution. See *www.redhat.com* for more information on the Red Hat Linux operating system.

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Overview

This sizing guide provides an overview of a Linux-based e-Commerce solution and offers baseline capacity information to assist in choosing the best configuration. To meet customers' differing capacity needs, Intel Solution Services developed Lutris Enhydra 3.5 Application Server solutions using various Intel Architecture-based server configurations to show the performance advantages of scaling up and scaling out.

The Lutris Enhydra 3.5 Application Server solution presented in this document outlines an end-to-end e-Commerce solution running on a Red Hat Linux 7.0 operating system, powered by Intel Architecture processor technology. Intel Solution Services also tested the effect of using different manufacturer's Java Virtual Machine (JVM*) components on the different configurations. Open Source based software solutions on clusters of 2-way and 4-way Intel processor-based servers can provide high performance results. The results shown in this sizing guide clearly demonstrate the increasing levels of capacity and performance that can be achieved as more Intel Architecture-based servers are added to the cluster.

[1]Performance was measured by comparing system average response times of a baseline three-tier configuration to those of a scaled out three-tier configuration. Response time data is shown in Figure 6, page 9.

This solution is on Intel Architecture-based server platforms and the Red Hat Linux 7.0 operating system. However, the testing results given here can be generalized to Intel Architecture-based systems from other vendors, such as Compaq*, Dell*, IBM* and Hewlett-Packard*.

Intel Solution Services can provide adaptations beyond those included in this document, to meet the needs of your specific e-Business application. For more information, contact Intel Solution Services or visit our Web site.

Configurations Evaluated

The following figures show the basic hardware topology of the test environment. Load-generating client machines, along with a dedicated controller system, were connected across a 100Mbps network to the multi-tier solution configuration. Red Hat Linux 7.0 was the operating system used in all configurations. The Application server used the Lutris Enhydra 3.5 software and tests were run using various JVM applications (IBM JDK 1.3, SUN* JDK* 1.3 or TowerJ* 3.6x). The Database server was tested using Oracle8*i** and Lutris InstantDB* 3.5.

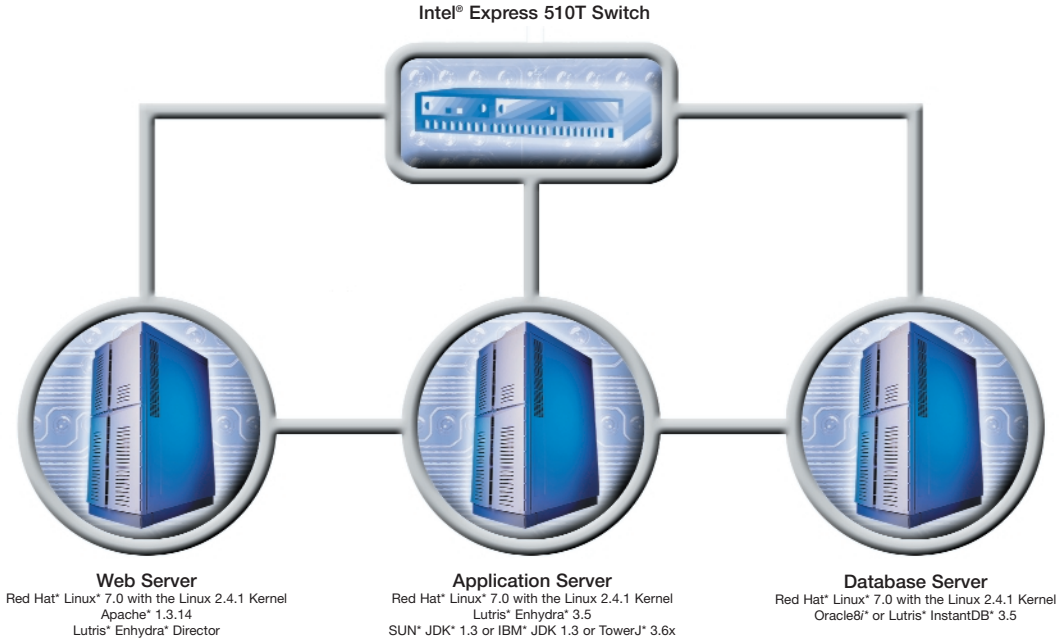

Figure 1: Logical Configuration—Lutris Enhydra* 3.5 Three-Tier Load Generation Test Environment*

Figure 2 is a simplified diagram of the physical layout of each configuration. All one-tier configurations deployed the Web server, Application server, and Database server functions on a single 2-way or 4-way Intel® Pentium® III Xeon™ processor-based server.

All two-tier configurations deployed the combined Web server and Application server functions onto a single 2-way or 4-way Intel Pentium III Xeon processor-based server that interfaced to a dedicated Database server on a 4-way Intel Pentium III Xeon processor-based server.

All three-tier configurations deployed the Web server function on the first tier 2-way Intel Pentium III processor-based server(s), the Application server function on the second tier 2-way or 4-way Intel Pentium III Xeon processor-based server(s), and the Database server function on the third tier 4-way Intel Pentium III Xeon processor-based server.

For multi-tier configurations using two Web servers, an Intel® NetStructure™ 7180 e-Commerce Director (Load Balancer) was used.

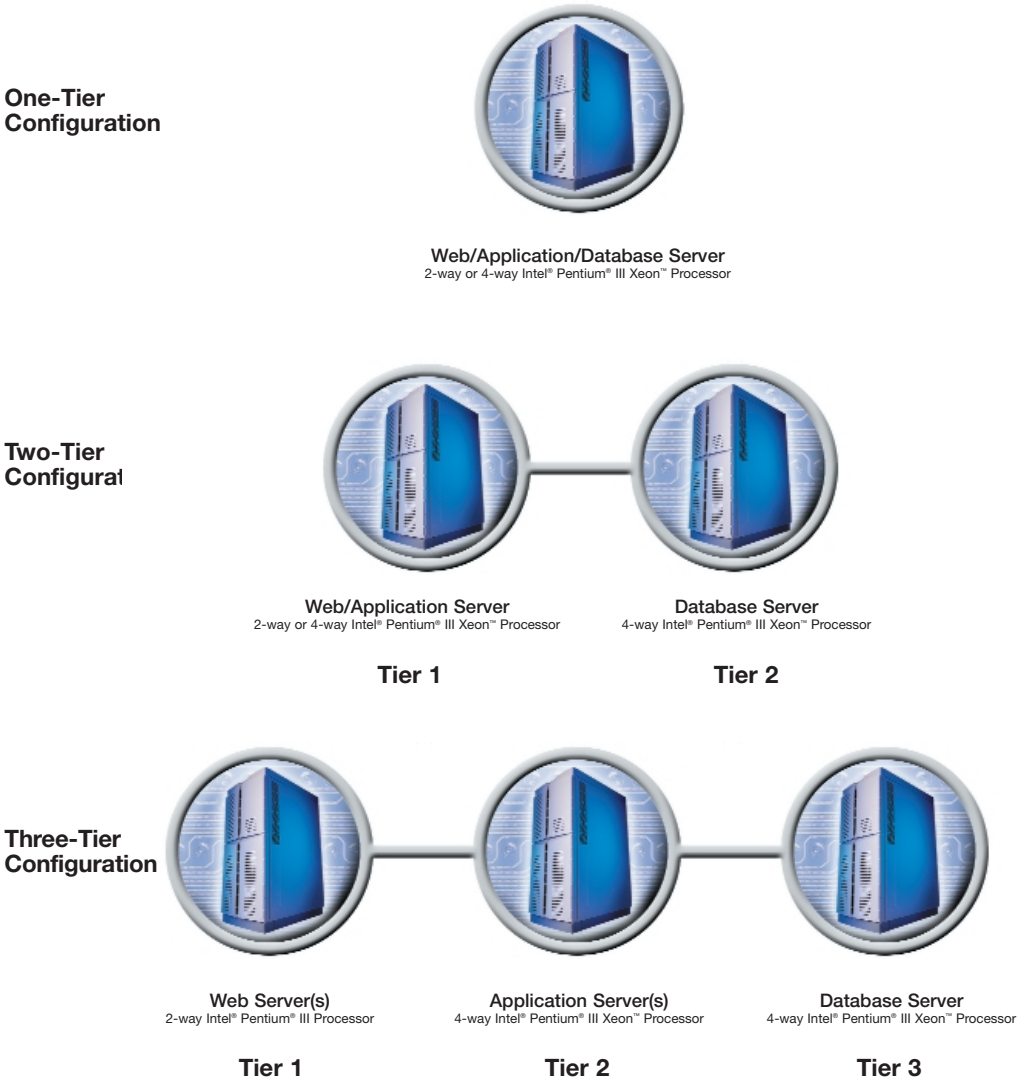

Figure 2: Configuration Overview—Lutris Enhydra* 3.5 One-Tier, Two-Tier and Three-Tier Configurations*

Performance Test Methodology

In order to assess the performance of each configuration, Intel Solution Services applied load to each configuration using a battery of 2-way and 4-way processor-based servers running Mercury Interactive* LoadRunner* 6.5. LoadRunner scripts simulate user activity, such as browsing, searching, registering, and purchasing from an e-Commerce oriented Web site.

The e-Commerce oriented Web site, in this case, was the Java Pet Store*, an industry standard test Web site developed by SUN Microsystems* and ported by Lutris to its own software architecture. Java Pet Store provides all the necessary features and functions for LoadRunner scripts to perform a variety of light and heavy user tasks with which to assess performance of the Intel-based servers.

Test Approach

SUN Java Pet Store application was used for all performance testing. In order to use Java Pet Store with Lutris Enhydra, it was necessary to port the test code from J2EE* architecture to Enhydra Superservlet Architecture. For more information on architecting Java applications to run on Lutris Enhydra application server, see *www.lutris.com* and *www.enhydra.org*.

The port of the Java Pet Store application is significant, because Java Pet Store is a representative Business-to-Consumer (B2C) application that models a typical on-line store, and is frequently referenced by other vendors and is well understood in the industry. It provides a database-driven product catalog, shopping cart, and product purchase feature.

The intent of using an application designed for J2EE was to be able to perform testing using a representative application and to easily compare the performance of Lutris Enhydra against other J2EE application servers.

User Profiles

The following user behavioral models were used during testing:

Casual Browser	Enters site, navigates, exits site
User Registration	Enters site, creates user account, browses site, logs off
User Browser	Enters site, logs on, browses, logs off
User Purchase	Enters site, logs on, adds items to shopping cart, purchases, logs off
Directed Search	Enters site, performs a few searches, exits site

Table 1: User Behavior Models

Random, 1 to 5 second think times were used in all LoadRunner user scripts. A 20% traffic distribution of the five user models described above was used to load the system under test:

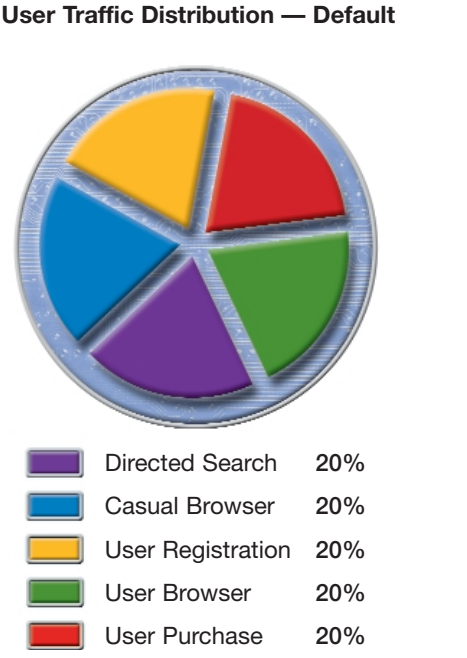

Figure 3: User Traffic Distribution

Performance Metrics

System response time was the primary metric used to gauge performance of the system under test. Network throughput metrics such as hits per second and megabytes per second were also collected to provide data points for determining network bandwidth requirements associated with deploying similar stacks. For all configurations, these metrics were measured at the network interface to the first tier. For single Web-head configurations, this point was the Web Server. For multiple Web-head configurations, this point was the Intel NetStructure 7180 e-Commerce Director (Hardware Load Balancer).

CPU, memory, disk I/O, and network I/O utilizations were also monitored for each configuration tested. In the server hardware configurations used for this study, no server specific bottlenecks in memory, disk I/O and network I/O were observed, so they are not reported. Some configurations tested reached 100% CPU utilization before reaching the response time fail point, defined as greater than 8 seconds. For these configurations, rated capacity was determined based on 80% CPU utilization to insure the system has some reserve bandwidth available to accommodate higher transient loads.

For the purposes of this document, the measure of capacity refers to the maximum number of concurrent Virtual users (Vusers) the system under test can support within limits of reasonable/ acceptable performance. In terms of response time, reasonable and acceptable performance was defined as maximum response times being less than or equal to 8 seconds. In terms of percent CPU utilization, reasonable and acceptable performance was defined as being approximately 80% CPU utilization.

Performance metrics were recorded by applying an increasing 20% Vuser traffic distribution workload to the system under test. The number of concurrent Vusers was increased to the maximum number the load testing equipment could produce without saturating the Load Generation Servers.

Performance Results

Scaling Capacity Results

Intel Solution Services began with a one-tier Intel Pentium III Xeon processor-based configuration to establish a baseline performance metric for comparison purposes. This baseline configuration consisted of a 2-way Intel Pentium III Xeon processor-based server with all three components (Web server, Application server, and Database server) running on it.

From there, the baseline configuration was scaled up and scaled out over the course of several iterative testing runs. Performance metrics, including maximum response time, hits per second handled, percent CPU utilization, and number of concurrent Vusers supported, were collected upon testing each variant configuration.

During the test runs, a workload was placed on each configuration using a standard Web testing application, Java Pet Store, which was ported from the SUN J2EE platform to the Lutris platform. Client systems running Mercury LoadRunner applied load in the form of simulated user activities on the Java Pet Store Web site.

The highest performance gains were achieved in a three-tier configuration by scaling out at Tier 1 to two 2-way servers, and scaling up and out at Tier 2 to two 4-way servers. This configuration provided a 2.5 second response time with a load of 850 concurrent Vusers. Other variant configurations provided significant performance gains as well.

Configuration	*Tiers*	*Platform*	*Software tested*
1a	One-Tier	2-way 700 MHz Intel® Pentium® III Xeon™ Processor	Lutris* InstantDB*, IBM* JDK* 1.3
1b	One-Tier	2-way 700 MHz Intel Pentium III Xeon Processor	Oracle8*i** Database, IBM JDK 1.3
1c	One-Tier	4-way 700 MHz Intel Pentium III Xeon Processor	Oracle8*i* Database, IBM JDK 1.3
2a	Two-Tier	Web/Application Server with 2-way 700 MHz Intel Pentium III Xeon Processor, Database Server with 4-way 700 MHz Intel Pentium III Xeon Processor	Oracle8*i* Database, IBM JDK 1.3
2b	Two-Tier	Web/Application Server with 4-way 700 MHz Intel Pentium III Xeon Processor, Database Server with 4-way 700 MHz Intel Pentium III Xeon Processor	Oracle8*i* Database, IBM JDK 1.3
3a	Three-Tier	Web Server with 2-way 800 MHz Intel Pentium III Processor, Application Server with 2-way 700 MHz Intel Pentium III Xeon Processor, Database Server with 4-way 700 MHz Intel Pentium III Xeon Processor	Oracle8*i* Database, SUN* JDK* 1.3
3b	Three-Tier	Web Server with 2-way 800 MHz Intel Pentium III Processor, Two Application Servers with 2-way 700 MHz Intel Pentium III Xeon Processor, Database Server with 4-way 700 MHz Intel Pentium III Xeon Processor	Oracle8*i* Database, SUN JDK 1.3
3c	Three-Tier	Web Server with 2-way 800 MHz Intel Pentium III Processor, Application Server with 4-way 700 MHz Intel Pentium III Xeon Processor, Database Server with 4-way 700 MHz Intel Pentium III Xeon Processor	Oracle8*i* Database, IBM JDK 1.3, SUN JDK 1.3 or TowerJ* 3.6x
3d	Three-Tier	Two Web Servers with two 2-way 800 MHz Intel Pentium III Processor, Two Application Servers with two 4-way 700 MHz Intel Pentium III Xeon Processor, Database Server with 4-way 700 MHz Intel Pentium III Xeon Processor	Oracle8*i* Database, SUN JDK 1.3

Table 2: Configurations Tested (See Figures 4 and 5)

In addition to hardware scaling, Intel Solution Services tested the effect of using different manufacturer's Java Virtual Machine (JVM) components on these configurations. Testing showed that using the IBM* JVM 1.3 provided a significant performance improvement over SUN JVM 1.3 and TowerJ 3.x compiled Java code. On one configuration, IBM JVM showed a 4x performance improvement over SUN, and 5x over TowerJ. For details on the JVM comparison, see "JVM Performance Results" on page 10.

The results presented in this sizing guide demonstrate the enterprise-class capacities and performance that can be achieved on Intel processor-based servers running Open Source based software solutions, like Lutris Enhydra 3.5 and Red Hat Linux. As shown by the results presented in this study, Open Source based

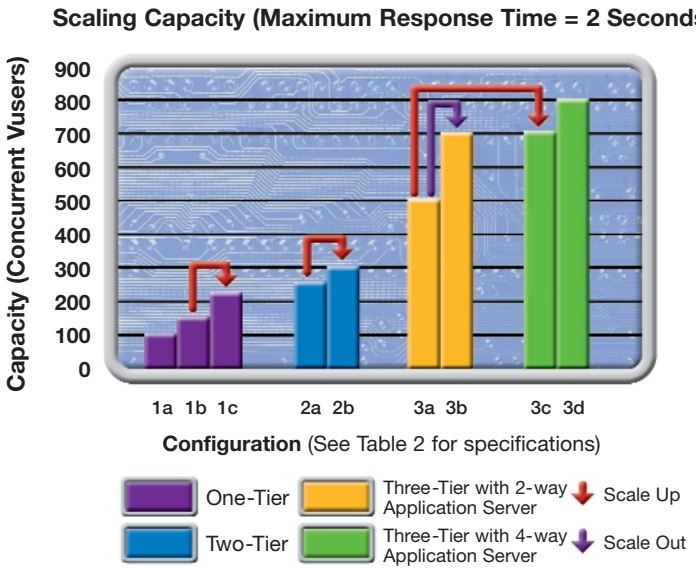

Figure 4: Scaling Capacity at Maximum Response Time of 2 Seconds

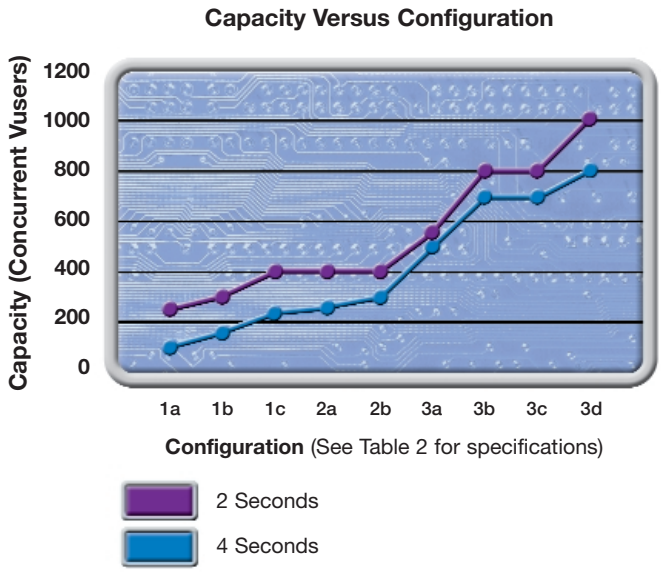

Figure 5: Capacity at 2 Second and 4 Second Maximum Response Times

software solutions on clusters of 2-way and 4-way Intel processor-based servers can provide high performance results. It also clearly demonstrates the increasing levels of capacity and performance that can be achieved as more Intel processor-based servers are added to the cluster.

System Response Time Performance Results

Figure 6 below shows the 4x improvement in system response time achieved by Intel Solution Services by scaling out the baseline three-tier configuration at Tier 1 and Tier 2. The baseline three-tier configuration consisted of a 2-way Intel processor-based system for the Web server (Tier 1), a 2-way processor-based system for the Application server (Tier 2), and a 4-way processor-based system for the Database server (Tier 3). The Application server was configured first with clustering of 1, then with clustering of 2 servers. Intel Solution Services then scaled out both Tier 1 and Tier 2, which cut the system average response time at a load of 700 Vusers from 14 seconds to

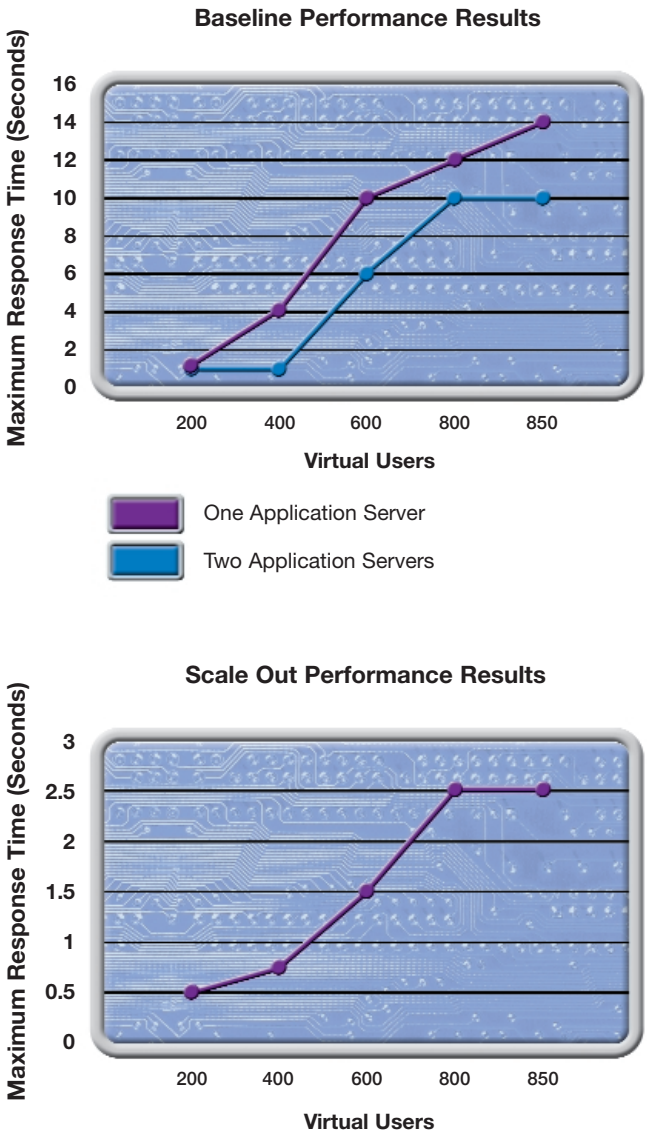

Figure 6: Maximum Response Time-Baseline (Top) and Scale Out at Tier 1 and Tier 2 (Bottom)

2.5 seconds. The resulting three-tier configuration consisted of two 2-way processor-based servers at Tier 1, two 2-way processor-based servers at Tier 2, and a 4-way processor-based server at Tier 3.

Software and Settings Results

Intel Solution Services assessed the performance impact of various software choices and settings. Two in particular had significant impact on performance: the choice of Java Virtual Machine (JVM) used, and the value of the Apache* "MaxClients" setting.

JVM Performance Results

On the configuration used to perform this JVM performance comparison, at a load of 600 concurrent users, using the IBM JVM 1.3 provided the following performance improvements (Figure 7):

- 4x improvement in system response time over using SUN JVM 1.3
- 5x improvement in system response time over using TowerJ 3.x "compiled" Java code.

All one-tier and two-tier configurations tested in this study used the IBM JVM. All 3-tier configurations tested in this study used the SUN JVM.

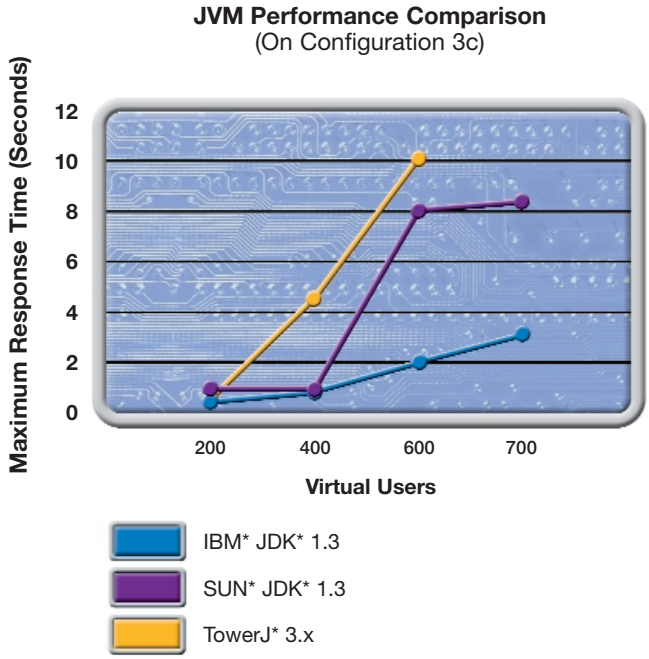

Figure 7: JVM Performance Comparison

Apache* "MaxClients" Setting Results

The default configurations settings in the httpd.conf file for the Apache Web Server are set to provide maximum compatibility from platform to platform, not raw performance.

The MaxClients setting in the httpd.conf file is especially important for installations that need to support high capacity/high performance deployments. This setting limits the number of httpd child processes that Apache can spawn to process incoming requests. The default setting for this parameter is 150.

Tests determined that once the MaxClients limit is exceeded (it occurs at ~300 Vusers in this example), Apache refuses to process any additional requests and the system response times rise into the tens of seconds range, as high as 33 seconds in one instance, as Apache attempts to process an ever increasing number of requests with limited pool of httpd child processes.

The same configuration with MaxClients set to 1024 supported a maximum system response time of less than 3.5 seconds at a load of approximately 700 Vusers.

Recommendations and Conclusions

As shown by the results presented in this test, Open Source based software solutions on clusters of 2-way and 4-way Intel processor-based servers can provide high performance results. It also demonstrates the increasing levels of capacity and performance that can be achieved as more Intel Architecture-based servers are added to the cluster.

The highest performance gains were achieved in a three-tier configuration by scaling out at Tier 1 (Web) to two 2-way processor-based servers, and scaling up and out at Tier 2 to two 4-way processor-based servers. This configuration provided a 2.5 second response time with a load of 850 concurrent Vusers. Other variant configurations provided significant performance gains as well.

Testing showed that using the IBM JVM 1.3 provided a significant performance improvement over SUN JVM 1.3 and TowerJ 3.x compiled Java code. On one configuration, IBM JVM showed a 4x performance improvement over SUN, and 5x over TowerJ.

Taking It to the Next Level

For a detailed discussion on the metrics and procedures used in testing these configurations, and detailed statistical data, please contact your Intel Solution Services representative.

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