

# Performance of the Intel® Modular Server on simultaneous email, Web server, Java, and database workloads

## Executive summary

Intel® Corporation (Intel) commissioned Principled Technologies (PT) to measure the system performance of the Intel Modular Server built on Intel Multi-Flex Technology while running multiple workloads individually and simultaneously on the Server Compute Modules. The goal of the study was to determine how much the performance of each Server Compute Module degraded from when each module was running alone to when all the modules were running at the same time.

### KEY FINDING

- The Intel Modular Server delivered comparable performance across all Server Compute Modules whether they were all running at the same time or each was running its test alone; the performance difference was less than 3 percent.

Figure 1 shows the Intel Modular Server used for testing. The housing contains six Server Compute Modules, an onboard SAN, which contains 14 SAS disk drives, two Ethernet Switch Modules, and a Management Module.



Each Server Compute Module is an independent dual-processor server. The Server Compute Modules share the SAN and Ethernet according to the configuration set up by the administrator. The configuration that PT used is detailed in the Test methodology section.

We ran benchmarks that simulated four types of typical business server workloads with four industry-standard tools:

Workload	Tool
Web	WebBench
email	LoadSim
Java	SPECjbb2005
Database	SysBench

The Workload section provides more information on each of these benchmarks.

Figure 1: Picture of Intel Modular Server used for testing.

Figure 2 presents two different median results for each Server Compute Module:

- Single-benchmark result.** The score when one Server Compute Module runs a benchmark while the other five Server Compute Modules are powered off.
- Multiple-benchmark result.** The score when all six Server Compute Modules are powered on and running benchmarks simultaneously.

	Benchmark	Single-benchmark results	Multiple-benchmark results	Difference (percentage)
Server Compute Module 1	LoadSim	150 milliseconds	154 milliseconds	2.67
Server Compute Module 2	WebBench	49,590.1 rps	49,963.7 rps	0.75
Server Compute Module 3	SPECjbb2005	215,609 bops	214,623 bops	0.46
Server Compute Module 4	SPECjbb2005	214,999 bops	215,248 bops	0.12
Server Compute Module 5	SysBench	792.4 tps	792.8 tps	0.05
Server Compute Module 6	SysBench	795.6 tps	796.1 tps	0.06

Figure 2: Single and multiple benchmark results for all Server Compute Modules we tested.

As Figure 2 shows, the difference between the single benchmark results and the multiple benchmarks results for the Server Compute Modules is less than 3 percent; in five of the six cases, the difference is less than 1 percent. This indicates almost no performance decline when all servers are running simultaneously.

## Workload

### LoadSim

Microsoft Exchange Server 2003 Load Simulator is a benchmark that measures a server's performance handling email. LoadSim uses the MAPI Messaging Benchmark 3 (MMB-3) to simulate MAPI email clients. The simulated clients issue requests to an Exchange server to generate an email load. LoadSim measures both the server's response time and the number of messages it delivers. LoadSim is available for free download from [www.microsoft.com/downloads/details.aspx?FamilyId=92EB2EDC-3433-47CA-A5F8-0483C7DDEA85&displaylang=en](http://www.microsoft.com/downloads/details.aspx?FamilyId=92EB2EDC-3433-47CA-A5F8-0483C7DDEA85&displaylang=en).

### SPECjbb2005

SPECjbb2005 is an industry-standard benchmark from the Standard Performance Evaluation Corp. (SPEC) that measures a server's Java performance. SPEC modeled SPECjbb2005 on the three-tier client/server architecture, with the middle layer as the primary focus. According to SPEC, "Random input selection represents the first (user) tier. SPECjbb2005 fully implements the middle tier business logic. The third tier is represented by tables of objects, implemented by Java Collections, rather than a separate database." For more information about SPECjbb2005, see [www.spec.org/jbb2005/docs/UserGuide.html](http://www.spec.org/jbb2005/docs/UserGuide.html).

### SysBench

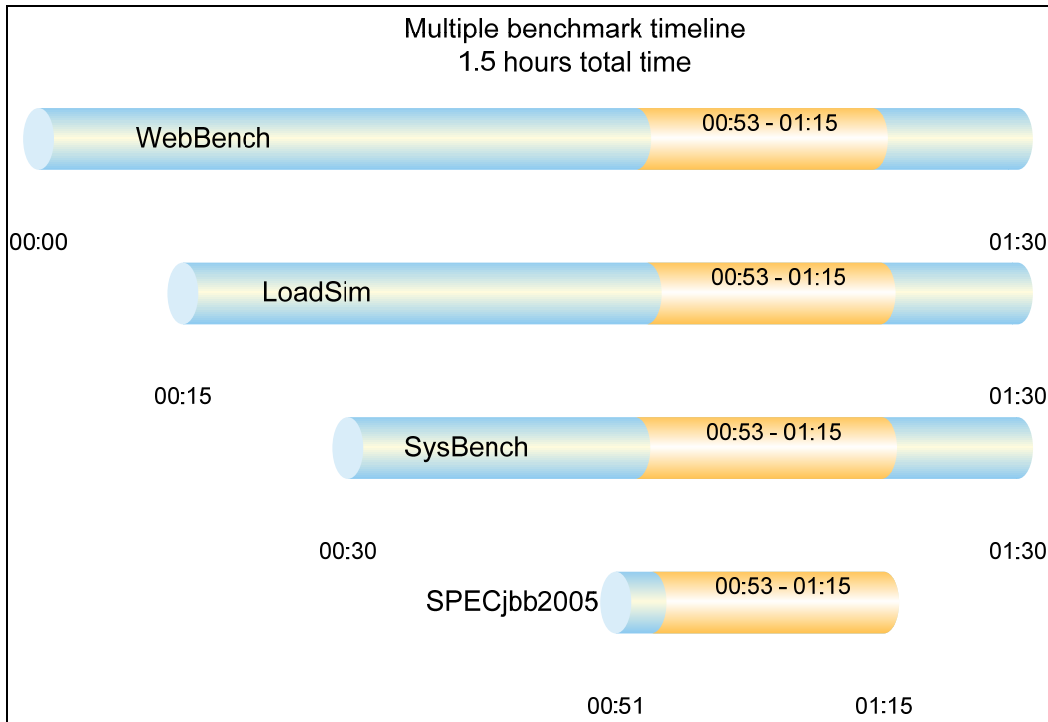
The developers at SourceForge.net ([www.sourceforge.net](http://www.sourceforge.net)) created SysBench to test various aspects of the performance of servers running database systems. The benchmark's original target was the MySQL database system (see [www.mysql.com](http://www.mysql.com)). Intel created a version of SysBench 0.4.0 that would work with Microsoft SQL Server 2005 Enterprise Edition ([www.microsoft.com/sql/editions/enterprise/default.mspx](http://www.microsoft.com/sql/editions/enterprise/default.mspx)). We ran that version in our test. SysBench created a 100,000-row SQL database and executed a batch of online transaction processing (OLTP) transactions against that data.

### WebBench

WebBench 5.0 (128-bit US version) is an industry-standard benchmark for Web server software and hardware. It uses PC clients to send Web requests to a server under test. It generates performance results by incrementally increasing the number of clients making HTTP 1.0 GET requests to the Web server; the result is a curve showing the server's performance under increasing load. The peak of that curve represents the peak throughput of the server. WebBench reports both the total number of requests per second the server handled and the server's total throughput in bytes per second. To be certain that we found the true peak performance in our testing, we verified that the server's processor utilization reached or was extremely close to 100 percent during the test.

## Test results

For testing, we staggered the starting times of the benchmarks to allow the Intel Modular Server to ramp up slowly. We began the benchmarks in the following order: WebBench, Microsoft LoadSim, SysBench, and SPECjbb2005. Figure 3 shows a timeline for the benchmark runs. To obtain the final results, we removed the first and last parts of each benchmark run, except SPECjbb2005, and computed the results based on the 22 minutes of peak performance during the SPECjbb2005 run. All other benchmarks ran longer so we could guarantee each benchmark was at maximum performance during this 22-minute period.



**Figure 3: The timeline we followed when starting the benchmarks for the multiple-benchmark runs on Server Compute Modules. The shaded areas from 00:53 to 01:15 represent the period that we measured performance.**

### LoadSim results

LoadSim results show the response time each for each server, the time in milliseconds it took to complete a request. Since the server's goal is to handle as many requests as possible, lower scores, which show a server able to handle more requests in a given time, are better. Generally the most important point is the median 95th percentile, which means 95 percent of the time the server handled request at that level.

Figure 4 shows the median LoadSim single and multiple benchmark results for Server Compute Module 1. For testing we used 500 Microsoft Exchange mailboxes.

	Server Compute Module 1	
	Single-benchmark results	Multiple-benchmark results
Median 50th percentile	106	106
Median 95th percentile	150	154
Median mean	104	104

**Figure 4: LoadSim results in milliseconds for Server Compute Module 1. Lower numbers are better.**

### SPECjbb2005 results

Figure 5 shows the median SPECjbb2005 results for all three servers. In each test, we ran four JVMs at the same time, a common practice on servers with many processors. To compute the overall score for the system, SPECjbb2005 sums the scores of all the JVMs. SPECjbb2005 computes the score of each JVM by taking the average of the results during mixes when the server is running at peak performance. (In SPEC's terms, these results are from "compliant" runs, which means we can disclose them publicly though we are not posting them on the SPEC Web site with all the files SPEC requires. We do present here all the data necessary to reproduce these results.)

	Server Compute Module 3		Server Compute Module 4	
	Single-benchmark results	Multiple-benchmark results	Single-benchmark results	Multiple-benchmark results
JVM 1	108,170	107,441	107,688	107,901
JVM 2	107,439	107,182	107,311	107,347
Total score	215,609	214,623	214,999	215,248

Figure 5: SPECjbb2005 results for each server by JVM in bops. Higher numbers are better.

Figure 6 shows the median results by warehouse for the Server Compute Module 3.

Server Compute Module 3		
	Single-benchmark results	Multiple-benchmark results
Warehouse	JVM 1	
1	28,326	28,176
2	66,828	66,073
3	90,917	90,285
4	109,617	108,896
5	108,960	108,018
6	108,285	107,937
7	107,241	106,488
8	106,747	105,866
<b>Score</b>	<b>108,170</b>	<b>107,441</b>
Warehouse	JVM 2	
1	28,623	27,777
2	61,418	61,848
3	89,879	89,690
4	109,033	108,704
5	108,229	107,951
6	107,693	107,366
7	106,480	106,412
8	105,758	105,476
<b>Score</b>	<b>107,439</b>	<b>107,182</b>
<b>Total Score</b>	<b>215,609</b>	<b>214,623</b>

Figure 6: SPECjbb2005 results for the Server Compute Module 3. Higher numbers are better.

Figure 7 shows the median results by warehouse for Server Compute Module 4 (Single and Multiple benchmarks).

Server Compute Module 4		
	Single-benchmark results	Multiple-benchmark results
Warehouse	JVM 1	
1	28,207	28,047
2	67,170	61,747
3	90,371	90,348
4	108,886	109,563
5	108,428	108,914
6	108,128	108,301
7	106,813	106,957
8	106,186	105,767
<b>Score</b>	<b>107,688</b>	<b>107,901</b>
Warehouse	JVM 2	
1	28,996	29,319
2	65,004	66,399
3	90,192	90,050
4	108,654	108,664
5	108,135	108,104
6	107,712	107,657
7	106,406	106,603
8	105,650	105,709
<b>Score</b>	<b>107,311</b>	<b>107,347</b>
<b>Total Score</b>	<b>214,999</b>	<b>215,248</b>

Figure 7: SPECjbb2005 results for the Server Compute Module 4. Higher numbers are better.

### WebBench results

We ran WebBench’s default ecommerce API test suite, which generates both secure and non-secure static and dynamic HTTP 1.0 GET requests. While running the ecommerce suite, the clients must negotiate to a secure Web server port using the Secure Socket Layer (SSL) protocol. A default WebBench test suite incrementally increases the number of clients making the HTTP 1.0 GET requests to the Web server. As the workload increases the number of clients, the Web server’s processor utilization also increases, until the processor in the Web server is saturated with work. Each workload point with a fixed number of clients is a WebBench “mix.” The ecommerce API test suite begins with a mix that involves one client; the next mix has four clients, and each subsequent mix increases the number of clients by four to a total of 60 clients. We modified the test suite so it would run 60 clients and seven engines per client for the entire test, except for the first mix. This allowed us to keep a constant Web load on the server. We performed the standard 16 mixes for testing.

A WebBench run reports the total requests per second a server can perform and the total throughput, in bytes per second, that the server delivered. WebBench reports these results for each mix. To obtain the results below, we averaged the requests per second and throughput from the mixes that ran during the middle 22 minutes of the benchmark run.

Figure 8 shows the WebBench average results in requests per second and in throughput (bytes per second) for the server compute modules. Each result below is the median of three runs.

	Server Compute Module 2	
	Single-benchmark results	Multiple-benchmark results
Requests per second	49,590.1	49,963.7
Throughput (bytes per second)	200,968,429.8	202,509,950.2

Figure 8: WebBench results for each server compute module. Higher numbers are better.

### SysBench results

For testing, we created a script so each system would perform as many transactions as possible in a given time. The script processed 10,000 transactions as quickly as possible and then started over again. The output shows the completion time in seconds for each group of 10,000 transactions. We calculated the transactions per second by using the following formula:

$$\frac{\text{total transactions}}{\text{time in seconds}} = \text{transactions per second}$$

Figure 9 shows the median SysBench single and multiple benchmark results for Server Compute Module 3 and 4. Worth noting, the results are for the 22 minutes as outlined in the figure 2 timeline, so the completion time is the same for all systems.

	Server Compute Module 5		Server Compute Module 6	
	Single-benchmark results	Multiple-benchmark results	Single-benchmark results	Multiple-benchmark results
Completion time (seconds)	1320	1320	1320	1320
Transactions completed	1,045,922	1,046,458	1,050,186	1,050,816
Transactions per second	792.4	792.8	796.6	796.1

Figure 9: SysBench results for each server compute module. Higher numbers are better.

## Test methodology

Before we could install an operating system, we had to configure the storage. Figure 10 shows the disk layout by storage pool. The SAS PHYS refers to the SAS channel the Server Compute Module used for communication with the disk subsystem. For each SAS channel we tried to balance workloads with heavy disk traffic with those with lighter disk utilization.

Storage pool	Number of drives	Total disk space	Server Compute Module		Size	SAS PHYS
			#	Configuration		
A	3	203.96 GB	5	SysBench 1 OS	45 GB	2
			1	LoadSim logs	155 GB	1
B	2	135.97 GB	6	SysBench 2 OS	45 GB	3
			1	LoadSim OS	45 GB	1
			2	WebBench OS	45 GB	2
C	2	135.9 GB	3	SPECjbb2005 1 OS	45 GB	3
			5	SysBench 1 Data	90 GB	2
D	2	135.97 GB	4	SPECjbb2005 2 OS	45 GB	1
			6	SysBench 2 Data	90 GB	3
E	5	339.93 GB	1	LoadSim Data	335 GB	1

Figure 10: LoadSim results for each server compute module. Lower numbers are better.

To set up the disk, we used the Modular Server Control Web interface software, which the Intel Modular Server included. After logging in, we used the following steps:

1. From the module control, click Storage from the left navigation menu.
2. Click "Create Storage Pool".
3. Select the drives you want to use.
4. Give the pool a name.
5. Select the newly created storage pool from the storage dashboard.
6. Click "Create Virtual Drive".
7. Enter a name for the drive.
8. Select a RAID level (RAID 0 for all our testing).
9. Enter the size in gigabytes (GB).
10. Select the Server Compute Module to which you want to map the drive.
11. Select the drive number you want the drive to appear as on the server.
12. You have successfully created and assigned a new virtual drive to a server.

Figure 11 illustrates the storage layout the Modular Server Control console reports.

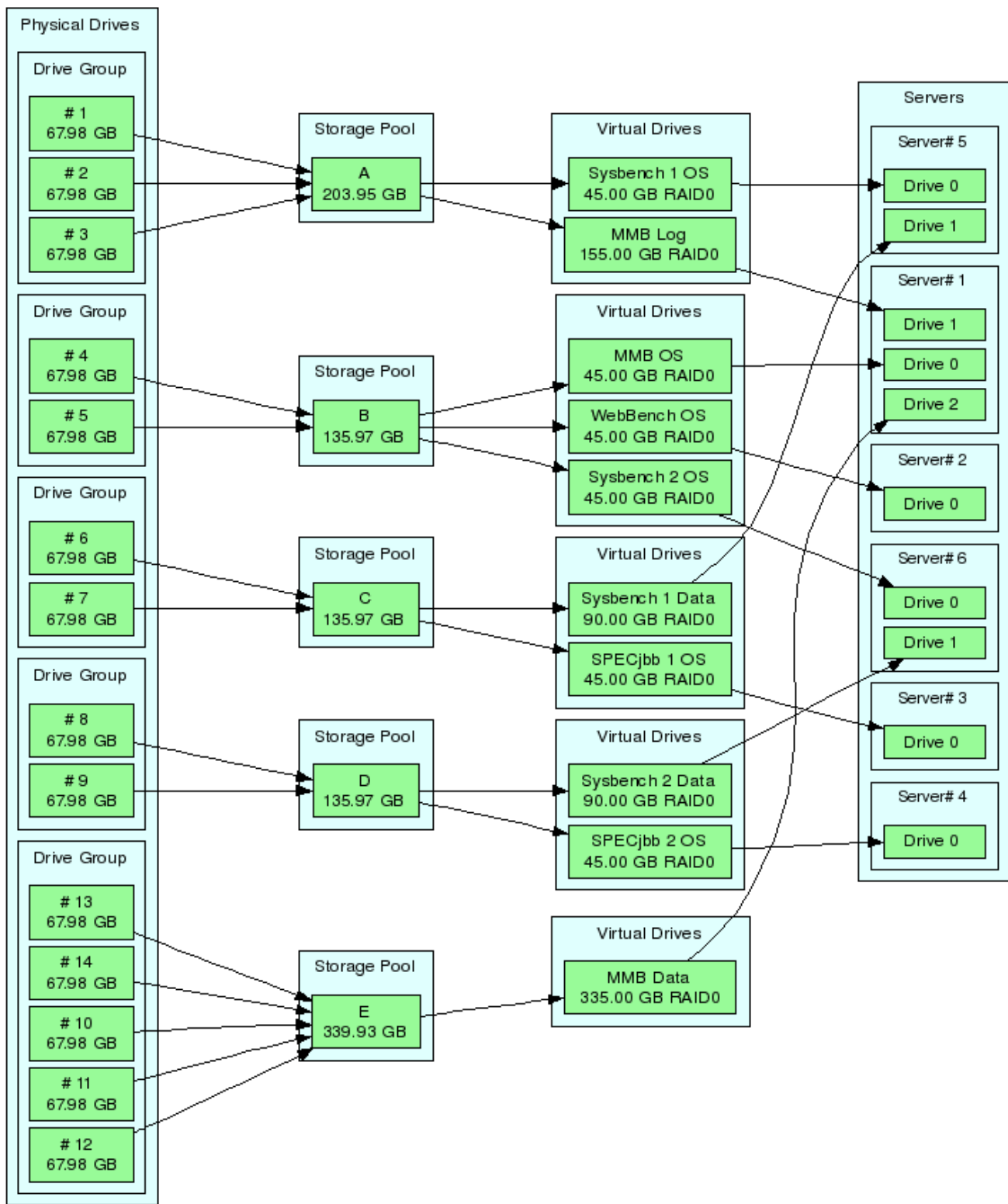


Figure 11: Intel Modular Server disk layout for testing.



## Server installation

We configured each Server Compute Module differently depending on its task. For all Server Compute Modules except the one running email, we began by installing a fresh copy of Microsoft Windows Server 2003 R2, Enterprise x64 Edition Service Pack 2. On the email Server Compute Module we installed a fresh copy of Microsoft Windows Server 2003 R2, Enterprise Edition Service Pack 2 due to the 32-bit Exchange Server requirement of the test. We followed this process for each installation:

1. Assign a computer name of "Server".
2. For the licensing mode, use the default setting of five concurrent connections.
3. Enter a password for the administrator log on.
4. Select Eastern Time Zone.
5. Use typical settings for the Network installation.
6. Use "Testbed" for the workgroup.

We applied the following updates from the Microsoft Windows Update site to the 64-bit (x64) installations:

- Windows Internet Explorer 7 for Windows Server 2003 x64 Edition and Windows XP x64 Edition
- Security Update for Outlook Express for Windows Server 2003 x64 Edition (KB941202)
- Cumulative Security Update for Internet Explorer 6 for Windows Server 2003 x64 Edition (KB939653)
- Security Update for Windows Server 2003 x64 Edition (KB933729)
- Windows Malicious Software Removal Tool x64 - October 2007 (KB890830)
- Security Update for Windows Server 2003 x64 Edition (KB936021)
- Update for Windows Server 2003 x64 Edition (KB933360)
- Security Update for Windows Server 2003 x64 Edition (KB938127)
- Security Update for Windows Server 2003 x64 Edition (KB921503)
- Security Update for Windows Server 2003 x64 Edition (KB936782)
- Update for Windows Server 2003 x64 Edition (KB932596)
- Security Update for Windows Server 2003 x64 Edition (KB926122)
- Security Update for Windows Media Player 6.4 (KB925398)
- Update for Windows Server 2003 x64 Edition (KB936357)
- Cumulative Security Update for Outlook Express for Windows Server 2003 x64 Edition (KB929123)
- Security Update for Windows Server 2003 x64 Edition (KB935839)
- Security Update for Windows Server 2003 x64 Edition (KB935840)
- Security Update for Windows Server 2003 x64 Edition (KB924667)
- Update for Windows Server 2003 x64 Edition (KB927891)
- Security Update for Windows Server 2003 x64 Edition (KB932168)
- Security Update for Windows Server 2003 x64 Edition (KB930178)
- Security Update for Windows Server 2003 x64 Edition (KB925902)

We applied the following updates from the Microsoft Windows Update site to the 32-bit installation:

- Windows Internet Explorer 7 for Windows Server 2003
- Windows Malicious Software Removal Tool - October 2007 (KB890830)
- Cumulative Security Update for Internet Explorer 6 for Windows Server 2003 (KB939653)
- Security Update for Outlook Express for Windows Server 2003 (KB941202)
- Security Update for Windows Server 2003 (KB933729)
- Security Update for Microsoft .NET Framework, Version 1.1 Service Pack 1 (KB933854)
- Security Update for Windows Server 2003 (KB936021)
- Update for Windows Server 2003 (KB933360)
- Security Update for Windows Server 2003 (KB938127)
- Security Update for Windows Server 2003 (KB921503)
- Security Update for Windows Server 2003 (KB936782)
- Security Update for Windows Server 2003 (KB926122)

- Security Update for Windows Media Player 6.4 (KB925398)
- Update for Windows Server 2003 (KB936357)
- Security Update for Windows Server 2003 (KB935839)
- Security Update for Windows Server 2003 (KB935840)
- Cumulative Security Update for Outlook Express for Windows Server 2003 (KB929123)
- Security Update for Windows Server 2003 (KB924667)
- Update for Windows Server 2003 (KB927891)
- Security Update for Windows Server 2003 (KB932168)
- Security Update for Windows Server 2003 (KB931784)
- Security Update for Windows Server 2003 (KB930178)
- Security Update for Windows Server 2003 (KB925902)

After installing the operating system, we configured each Server Compute Module depending on the setup requirements. We configured the six Server Compute Modules as follows:

- Server Compute Module 1: Mail server
- Server Compute Module 2: Web server
- Server Compute Module 3: Java server
- Server Compute Module 4: Java server
- Server Compute Module 5: SQL server
- Server Compute Module 6: SQL server

## Installing and configuring the mail server

To set up this Server Compute Module we had to install several additional software components. The following subsections detail the necessary installation processes.

### Installing the domain controller

1. Select Start→Administrative Tools→Manage Your Server.
2. Click Add or remove a role.
3. At the Configure Your Server window, click Next.
4. At the Configuration and Options screen, select Custom Configuration, and click Next.
5. At the Server Role screen, select Domain Controller, and click Next.
6. At the Summary of Selections screen, click Next.
7. At the Welcome pop-up window, click Next.
8. At the Operating System Compatibility screen, click Next.
9. For the Domain Controller Type, leave the default option (Domain controller for a new domain), and click Next.
10. At the Create New Domain screen, leave the default (Domain in a new forest), and click Next.
11. At the Install or Configure DNS window, select No, and click Next.
12. At the New Domain Name screen, type a domain name (`loadsim.com`), and click Next.
13. At the NetBIOS Domain Name screen, type a NETBIOS domain name (`loadsim`), and click Next.
14. Click Next through the following screens to accept the default options: Database and Log Folders, Shared System Volume, and Permissions.
15. At the Directory Services Restore Mode Administrative Password screen, enter a password (`password`), and click Next.
16. When the installation software prompts you to do so, insert the OS CD, and click OK.
17. At the Completing the Active Directory Installation Wizard screen, click Finish.
18. When the system prompts you to reboot the server, click Restart Now.
19. After the server reboots, log in to the system.
20. At the This Server is Now a Domain Controller window, click Finish.

## Installing Internet Information Services 6.0

1. Select Start→Control Panel→Add or Remove Programs.
2. Click Add/Remove Windows Components.
3. Select Application Servers, and click Details.
4. Click ASP.NET, and make sure a check appears in the check box.
5. Select Internet Information Services (IIS), and click Details.
6. Click NNTP Services and SMTP Services, make sure a check appears in both check boxes, and click OK.
7. Click OK to close the Application Server window.
8. At the Windows Components Wizard, click Next to begin the installation.
9. When the system prompts you to do so, insert the OS CD, and click OK.
10. At the Completing the Windows Components Wizard window, click Finish.
11. Close the Add or Remove Programs window.

## Installing Exchange Server 2003

1. Insert the Microsoft Exchange Server 2003 CD. The CD should automatically launch the installation software.
2. Choose Exchange Server Enterprise Edition.
3. Run the Setup application.
4. Click the Exchange Deployment Tools link.
5. Click the Deploy the first Exchange 2003 Server link.
6. Click the New Exchange 2003 Installation link.
7. Click the Run ForestPrep now link.
  - a. When the compatibility issue notice appears, click Continue, and check the Don't display this message again box.
  - b. At the Welcome screen, click Next.
  - c. Accept the End User License Agreement, and click Next.
  - d. At Component Selection Screen, keep the defaults, and click Next.
  - e. Leave the default account information, and click Next.
  - f. Installation should start. (This process may take a while to complete.)
  - g. When the installation completes, click Finish.
8. Return to the Exchange Server Deployment Tools screen, and click the Run DomainPrep now link.
  - a. At the Welcome screen, click Next.
  - b. Accept the End User License Agreement, and click Next.
  - c. At Component Selection Screen, keep the defaults, and click Next.
  - d. At the insecure domain notice, click OK.
  - e. When the installation completes, click Finish.
9. Return to the Exchange Server Deployment Tools screen, and click Run Setup Now.
  - a. At the Welcome screen, click Next.
  - b. Accept the End User License Agreement, and click Next.
  - c. At the Component Selection screen, the action for Microsoft Exchange should by default be Typical. (If it is not, use the drop-down box to set it to Typical.)
  - d. Click Next.
  - e. For the Installation Type, select Create new Exchange Organization, and click Next.
  - f. Type `loadsim` as the Organization Name, and click Next.
  - g. Accept the Microsoft Exchange Server Licensing Agreement, and click Next.
  - h. Review the installation summary, and click Next.
  - i. The installation should start. (This process may take a while to complete.)
  - j. When the installation completes, click Finish.
10. Close the Exchange Server Deployment Tools window.
11. Install Microsoft Exchange Server 2003 Service Pack 2.
  - a. Insert the SP2 CD, and double-click setup.exe.
  - b. Accept the default location to extract the file, and click OK.
  - c. After the extraction finishes, open Windows Explorer, and browse to the update.exe executable.
  - d. At the Welcome screen, click Next.

- e. Select I agree to accept the License Agreement, and click Next.
  - f. At the Component Selection window, leave the default option (Update), and click Next.
  - g. Verify the installation Summary, and click Next.
  - h. When the installation completes, click Finish.
12. Select Start→All Programs→Microsoft Exchange→System Manager.
  13. In the left-hand window pane, expand Servers and MailServer so the First Storage Group is visible.
  14. Right-click First Storage Group, and select Properties.
  15. Check the Enable circular logging box.
  16. Click Apply.
  17. Right-click Mailbox Store under First Storage Group, and select Properties.
  18. Select the Database tab.
  19. Next to Maintenance interval, click Customize.
  20. Remove all blue from the boxes so the system will not perform maintenance, and click OK.

## Installing and configuring the Web server

### Installing Microsoft Internet Information Server

1. Select Start→Administrative Tools→Manage Your Server.
2. Select Add or remove a role.
3. At the Configure Your Server window, click Next.
4. At the Configuration Options screen, select Custom configuration, and click Next.
5. At the Server Role screen, select Application Server, and click Next.
6. At the Application Server Options screen, select Enable ASP.NET, and click Next.
7. At the Summary of Selections screen, click Next.
8. When the installation software prompts you to do so, insert the Operating System CD, and click OK.
9. When the installation completes, click Finish.
10. Close the Manage Your Server window.

### Deploying WebBench data

WebBench includes data that must reside on the server and that the Web server must use. We loaded that data and set the Web server to use it with the following procedure:

1. Copy the file wbtrees.exe from the WebBench CD to the wwwroot directory on the server under test. (The wbtrees.exe file is on the WebBench CD at \wb50\workload).
2. On the server, execute the wbtrees.exe file. This program will copy the WebBench workload to the server.
3. In the wwwroot folder on the server, create a new folder with the name CGI-BIN.
4. Copy the file simisapi.dll to the CGI-BIN folder.
5. Click Start button→Programs→Administrative Tools→Computer Management to open the management console.
6. Go to Services and Application→Internet Information Services→Default Web Site→CGI-BIN, right-click to bring up a menu, and select Properties.
7. Go to the Directory Tab, and Set Execute Permissions to Scripts and Executables.
8. When the IIS WWW Configuration popup window appears, click Yes.
9. Close the Computer Management window.

### Configuring Internet Information Services (IIS)

We configured the Windows Internet Information Services Web server as follows:

1. Open Computer Management.
2. Go to Services and Application→Internet Information Services.
3. Right click to bring up a menu. Select Properties.
4. Click the MIME Types button.
5. In the MIME Types window, click New.

6. In the Extension field, type \*.
7. In the MIME type field, type `application/octet-stream`, and click OK.
8. Click OK to exit the MIME Types window.
9. Click OK to exit the Internet Information Services (IIS) Manager Properties window.
10. In the Computer Management window, go to Web Sites→Default Web Site under Internet Information Services, right-click to bring up a menu, and select Properties.
11. Select the Home Directory tab.
12. Check the following boxes: Script source access, Read, Write, and Directory browsing.
13. Uncheck the following boxes: Log visits and Index this resource.
14. In the Execute permissions field, select Scripts and Executables.
15. Click Apply.
16. Select the Web Site tab.
17. Uncheck Enable Logging.
18. Click OK to close the Default Web Site Properties window.
19. In the Computer Management window, go to the Web Service Extensions item under Internet Information Services.
20. In the right panel, highlight All Unknown ISAPI Extensions and click the Allow button. Acknowledge the IIS Manager warning that appears by clicking the Yes button.
21. In the right panel, highlight All Unknown CGI Extensions and click the Allow button. Acknowledge the IIS Manager warning that appears by clicking the Yes button.
22. Close the Computer Management window.

### Installing certificate services

Because WebBench includes tests that involve security, we installed Windows Certificate Services as follows:

1. Click Start→Control Panel→Add/Remove Programs.
2. Select Add/Remove Windows Components.
3. Put a check mark by Certificate Services.
4. Accept the notice that the server's name cannot be changed after you install this service.
5. Press Next.
6. Select Stand Alone Root CA, and click Next.
7. On the CA Identifying Information window, enter the server name in the Common name for this CA field, and click Next.
8. Leave the default Certificate Database Settings as they are, and click Next.
9. Click Yes at the prompt asking if you want to enable Active Server Pages (ASP) in IIS.
10. Click Yes at the prompt that explains that Internet information Services will be temporarily stopped.
11. Click Next.
12. Click Finish.
13. Click Close.

### Setting up Internet Explorer

We had to set up Internet Explorer on the server as follows to be able to get the necessary certificates:

1. Click the Internet Explorer icon on the Quick Launch toolbar.
2. Select the Tools→Internet Options menu item.
3. On the Connections tab, click the LAN Settings button.
4. Check Automatically detect settings, and click OK.
5. Click OK to exit the Internet Options window.

### Requesting the server certificate

We had to set up Internet Explorer on the server as follows to be able to get the necessary certificates:

1. Open Internet Explorer and enter the following website, `http://server/certsrv`. This should bring up a page called Microsoft Certificate Services – server.

2. Select Request a Certificate link.
3. Select Advanced Certificate Request link.
4. Select the Create and submit a certificate request to this CA link.
5. Fill out the appropriate Identifying Information details on the Advanced Certificate Request.
  - Name: Performance
  - Company: PT
  - Type of certificate needed: Server Authentication Certificate
  - Key Options:
    - CSP: Microsoft Base Cryptographic Provider v1.0
    - Usage: Exchange and Signature – select both
    - Key size: 512
    - Check Automatic key container name
    - Check Store certificate in the local computer certificate store
  - Additional Options:
    - Hash Algorithm: SHA-1
  - Otherwise use default
6. Click Submit.
7. Acknowledge the Potential Scripting Violation by clicking Yes.
8. A page should now appear informing you that there is a Certificate Pending.

### Issuing the server certificate

Next we had to issue a server certificate as follows:

1. Select Start→Programs→Administrative Tools→Certification Authority.
2. Click the server's name.
3. Select Pending Requests.
4. Right-click Pending Requests, select All Tasks, and choose Issue.
5. Close Certification Authority.

### Installing the server certificate

We then installed the server certificate as follows:

1. Open Internet Explorer.
2. Go to the page <http://server/certsrv> again.
3. Click the View the status of a pending certificate link.
4. Click the Server Authentication Certificate link.
5. Click the Install this Certificate link.
6. Acknowledge the Potential Scripting Violation warning by clicking OK.
7. A message will note that a certificate has been successfully installed.
8. Close Internet Explorer.

### Setting IIS to use the server certificate

We then set IIS to use the server certificate as follows:

1. Click Start→Programs→Administrative Tools→Computer Management to open the management console.
2. Select Services and Applications→Internet Information Services→Web Sites.
3. Right-click the Default Web site, and select Properties.
4. Select the Directory Security tab, and click Server Certificate.
5. When the Welcome to the Web Server Certificate Wizard window appears, click Next.
6. Select Assign an Existing Certificate, and click Next.
7. Select your server certificate (Intended Purpose: Server Authentication), and click Next.
8. Accept the default SSL port (443) in the next window that appears, and click Next.
9. On the Certificate Summary screen, click Next.
10. Click Finish.

## Creating SSL Communication

Finally, we had to enable SSL communication as follows:

1. Go to Computer management→Services and Application→Internet Information Services.
2. Expand the Default Web site.
3. Expand wbtrees.
4. Right-click Wbss1, and select Properties.
5. Select the Directory Security tab.
6. Under Secure communications, click Edit.
7. Check Require secure channel (SSL).
8. Check Require 128-bit encryption.
9. Click OK.
10. Click OK.

We then set the following operating system tuning parameters to reflect the WebBench recommendation in the Microsoft performance Tuning Guidelines for Windows Server 2003 document, which is available on Microsoft's Web site. When creating the following parameters, ensure that they are DWORD files, with decimal coding (rather than hexadecimal)

- HKLM\System\CurrentControlSet\Services\Inetinfo\Parameters\MaxCachesFileSize to 1048576
- HKLM\System\CurrentControlSet\Services\HTTP\Parameters\UriMaxUriBytes to 1048576
- HKLM\System\CurrentControlSet\Control\FileSystem\NtfsDisableLastAccess to 1
- HKLM\System\CurrentControlSet\Services\Tcpip\Parameters\MaxHashTableSize to 65535

## Installing and configuring the Java application server

To improve Java performance, we enabled large pages in memory on all servers. To enable this service, the administrator must first assign additional privileges to the user who will be running the application. We assigned this privilege only to the administrator, because we used that account for our tests. To enable large pages, we selected the following:

- Control Panel→Administrative Tools→Local Security Policy
- Local Policies→User Rights Assignment
- "Lock pages in memory," add users and/or groups

## Installing SPECjbb2005

We used SPECjbb2005 version 1.07, dated March 15, 2006. We followed SPEC's run rules. (For more information about SPECjbb2005 and its run rules, see [www.spec.org/jbb2005/docs/RunRules.html](http://www.spec.org/jbb2005/docs/RunRules.html).) We installed SPECjbb2005 by copying the contents of the SPECjbb2005 CD to the directory C:\SPECjbb2005v1.07 on the server's hard disk.

SPECjbb2005 requires a Java Virtual Machine on the system under test. We used the BEA JRockit 6.0 (build P27.4.0-10-90053-1.6.0\_02-20071009-1827-windows-x86\_64 JDK for Microsoft Windows) JVM for this testing and left the default installation settings.

After installation, as per the run rules, we edited the SPECjbb\_config.props file in the root SPECjbb2005 directory to include disclosure information about the server and our license information. SPECjbb2005 uses this file when generating the results output for each run. We also modified the SPECjbb.props file to change the number of JVM instances to two. This change allows a server to run two JVM instances during testing.

We created a batch file, which we placed in the root SPECjbb2005 directory, to issue the Java run command to launch the benchmark. During testing, we used the command prompt window within Microsoft Windows Server 2003 x64 Edition to run this batch file. Figure 12 shows the contents of this file, which we used on all servers.

```

runit-affinity.bat
File Edit Format View Help
@echo off
set JVM=2

:: Set JAVA_HOME to Java.exe path.
set JAVA_HOME="C:\jrockit-jdk1.6.0_02\bin"

set path=%JAVA_HOME%;%path%

:stage1
set PROFFILE=SPECjbb.props
set JAVAOPTIONS= -Xms256m -Xmx256m
rem set JBBJARS=. \jbb.jar; . \check.jar
set JBBJARS=. \jbb.jar; . \jbb_no_precompile.jar; . \check.jar; . \reporter.jar

set CLASSPATH=%JBBJARS%;%CLASSPATH%

:stage2

echo Using CLASSPATH entries:
for %%c in ( %CLASSPATH% ) do echo %%c
@echo on
start /b java %JAVAOPTIONS% spec.jbb.Controller -propfile %PROFFILE%
@echo off
set I=0
set J=F
:LOOP
set /a I=%I + 1
echo.
echo Starting JVM Number %I% with Affinity to CPU %J%
echo.

@echo on
start /AFFINITY %J% /B java -Xms3500m -Xns3000m -Xmx3500m -XXaggressive -XXlargepages -
XXcallprofiling -Xgc:genpar -XXthroughputCompaction -XXlazyUnlocking -
XXtlasize:min=4k,preferred=128k spec.jbb.JBBmain -propfile %PROFFILE% -id %I% > multi.%I%
@echo off
set J=%J%0
IF %I% == %JVM% GOTO END
GOTO LOOP
:END

:egress

```

Figure 12: The text of the batch file we used to execute the SPECjbb2005 benchmark on all servers.

In the batch file we set the Java options that control the performance of the JVM.

- *-Xms3500m* This option sets the minimum heap size. We set the minimum and maximum heap sizes to be the same, so the heap size would stay a constant 3500MB.
- *-Xns3200m* This option sets the JVM nursery size.
- *-Xmx3500m* This option sets the maximum heap size.
- *-XXaggressive* This option basically tells the JVM to perform at maximum speed.
- *-XXlargepages* This option tells the JVM to use large pages.
- *-XXcallprofiling* This option enables call profiling for code optimizations.
- *-Xgc:genpar* This option sets generational parallel garbage collection.
- *-XXthroughputCompaction* This option adjusts the compaction ratio dynamically based on live data in the heap.
- *-XXlazyUnlocking* This option affects when the JVM releases locks.



- `-XXtlsize` This option sets the thread-local area size the JVM uses.

## Installing and configuring the database server

### Installing Microsoft Internet Information Server

1. Select Start→Administrative Tools→Manage Your Server.
2. Select Add or remove a role.
3. At the preliminary steps screen, click Next.
4. At the Server Role screen, select Application Server, and click Next.
5. At the Summary of Selections screen, click Next.
6. When the installation software prompts you to do so, insert the OS CD, and click OK.
7. When the installation completes, click Finish.
8. Close the Manage Your Server window.

### Installing Microsoft SQL Server 2005

1. Insert the SQL Server 2005 CD into the server.
2. Click the Server Components link under the Install section to begin the installation.
3. Accept the license agreement, and click Next.
4. Click Next to install the prerequisites.
5. After the prerequisites complete installing screen, click Next.
6. At the Welcome screen, click Next.
7. At the System Configuration Check, assuming everything has a status of success, click Next.
8. Enter the registration information, and click Next.
9. At the Components to Install screen, select SQL Server Database Services, and click Advanced.
10. Instruct the software to install both the Database Services and Client Components by clicking the drop-down arrow on both and selecting Entire feature will be installed on local hard drive.
11. Click Next to start the installation.
12. For Instance Name, leave the default option, and click Next.
13. At the Service Account screen, select Use the built-in system account (Local account), and click Next.
14. Keep the default option for Authentication Mode, and click Next.
15. For Collation Settings, leave the defaults, and click Next.
16. Accept the default Error and Usage Report Settings, and click Next.
17. At the Ready to Install screen, click Install to begin the installation.
18. When the installation software prompts you to do so, insert Microsoft SQL Server 2005 disk 2, and click OK.
19. When the setup process completes, click Next.
20. Click Finish to complete the installation.

### Creating the test database and generating data

1. Select Start→Microsoft SQL Server 2005→SQL Server Management Studio.
2. In the Connect to Server window, use the drop-down menu next to Server name to select Browse for more.
3. In the Browse for Server window, select the Network Servers tab, and wait for it to retrieve data.
4. When Database Engine appears, expand the menu, select Server, and click OK.
5. At the Connect to Server window, the server name should appear.
6. Click Connect to connect to the server.
7. Right-click the Database folder in the left-hand window, and select New Database from the pop-up menu.
8. In the Database name field, type `sbttest`, and click OK.
9. Open a command prompt by selecting Start→Run, type `cmd`, and click OK.
10. In the command prompt, type `cd` to change to C:\.
11. To prepare the database, type `vsysbench.exe --test=oltp --oltp-table-size=100000 prepare`, and press Enter.
12. When the command finishes, you see the C:\ prompt.

13. Type `exit`, and press Enter to close the command prompt.
14. In SQL Server 2005 Management Studio, stop the database service by right-clicking Server in the left-hand window pane, and then select Stop from the drop-down menu.
15. Using Windows Explorer, create the folder `C:\backup`.
16. With Windows Explorer, copy all `sbtest` files from `C:\Program File\Microsoft SQL Server\MSSQL.1\MSSQL\Data\` to `c:\backup`. (You should see two files: `sbtest.mdf` and `sbtest_log.ldf`.)
17. Close Windows Explorer once the copy completes.
18. Restart the database service using SQL Server 2005 Management Studio by right-clicking server and selecting start.

We created a batch file, which we placed in the root directory, to issue the command to launch SysBench. During testing, we used the command prompt window within Microsoft Windows Server 2003 x64 Edition to run this batch file. Figure 13 shows the contents of this file, which we used on all servers.

```

logman start agate_sysbench1_perflog_single_run

echo %time% >> C:\sysbench_%_RUN%.log

Set START_HOUR=%TIME:~0,2%
Set START_MINUTE=%TIME:~3,2%
Set START_SECOND=%TIME:~6,2%

Set /A END_HOUR=%START_HOUR% + 1
Set END_MINUTE=%START_MINUTE%
Set END_SECOND=%START_SECOND%

:_LOOP

Set HOUR=%TIME:~0,2%
Set MINUTE=%TIME:~3,2%
Set SECOND=%TIME:~6,2%

If %HOUR% GTR %END_HOUR% (
goto _exit
)

If %HOUR% GEQ %END_HOUR% (
IF %MINUTE% GTR %END_MINUTE% (
goto _exit
)
)

c:\sysbench.exe --test=oltp --oltp-table-size=100000 --num-threads=64 run
1>>C:\sysbench_%_RUN%.log 2>>C:\sysbench_%_RUN%.err
echo %time% >> C:\sysbench_%_RUN%.log

goto _LOOP

:_EXIT

logman stop agate_sysbench1_perflog_single_run

echo DONE

```

Figure 13: The text of the batch file we used to execute SysBench on all servers.

## Installing the mail test client

The LoadSim benchmark requires one physical test client system. We used the following process to set up the test client.

1. Install Microsoft Windows Server 2003 R2 Enterprise Edition, using mailclient as the system name.
2. Install Windows Server 2003 Service Pack 2 with the default settings.
3. Open the Network Connections window by right-clicking My Network Places and selecting Properties.
4. Right-click the network connection, and click Properties.
5. Highlight TCP/IP, and select Properties.
6. Select Use the following IP address, and enter the correct information
7. Click OK to close the two Properties windows.
8. Right-click My Computer, and select Properties.
9. Click the Computer Name tab.
10. Click Change.
11. Select Domain in the member of section, and type the domain `test.com` into the text box.
12. In the pop-up window, enter administrator for user name and password for password, and click OK.
13. At the Welcome to the domain screen, click OK.
14. When the warning that you must restart dialog appears, click OK.
15. Click OK to close the System Properties window.
16. Click Yes to the pop-up message to restart the computer.
17. Log in to the domain by using administrator and password.
18. Install Microsoft Outlook 2003 with the default settings. (Outlook 2003 doesn't require any configuration.)
19. Install LoadSim 2003 by double-clicking the loadsim.msi installation file. Accept all defaults.
20. Open LoadSim 2003, and make sure no error messages appear.

## Configuring LoadSim 2003

1. Start LoadSim by clicking Start Menu→All Programs→Exchange LoadSim→LoadSim 2003.
2. From the LoadSim menu bar, select Configuration→Topology Properties.
3. Click the Servers tab.
4. In the left pane, click the + next to the name of this server.
5. In the left pane, select the First Storage Group.
6. In the right pane, set the number of users to 500.
7. Select the Security and Credentials tab.
8. Leave the Credentials choice set to Login to users using the account LoadSim is running on.
9. In the password portion of the tab, enter the password "Password1", and click OK.
10. From the LoadSim menu bar, choose File→Save As
11. Save a backup copy of the simulation file as C:\loadsim.sim.
12. From the LoadSim menu bar, select Run→Create Topology, and wait until the Creating Users and Creating DLs tasks complete.
13. From the LoadSim menu bar, select Run→Initialize Test.
14. When a dialog box appears with the question Do you want to initialize Public Folders from this client machine?, click Yes.
15. The run is complete when the bottom left corner of the LoadSim window shows Status: Idle. This task typically takes about 2 to 3 hours to complete.

## Backing up the mail database

Once you've set up LoadSim and created its initial mail database, you need to back up that database so you can have clean copies for each test. Use this process to back up that database.

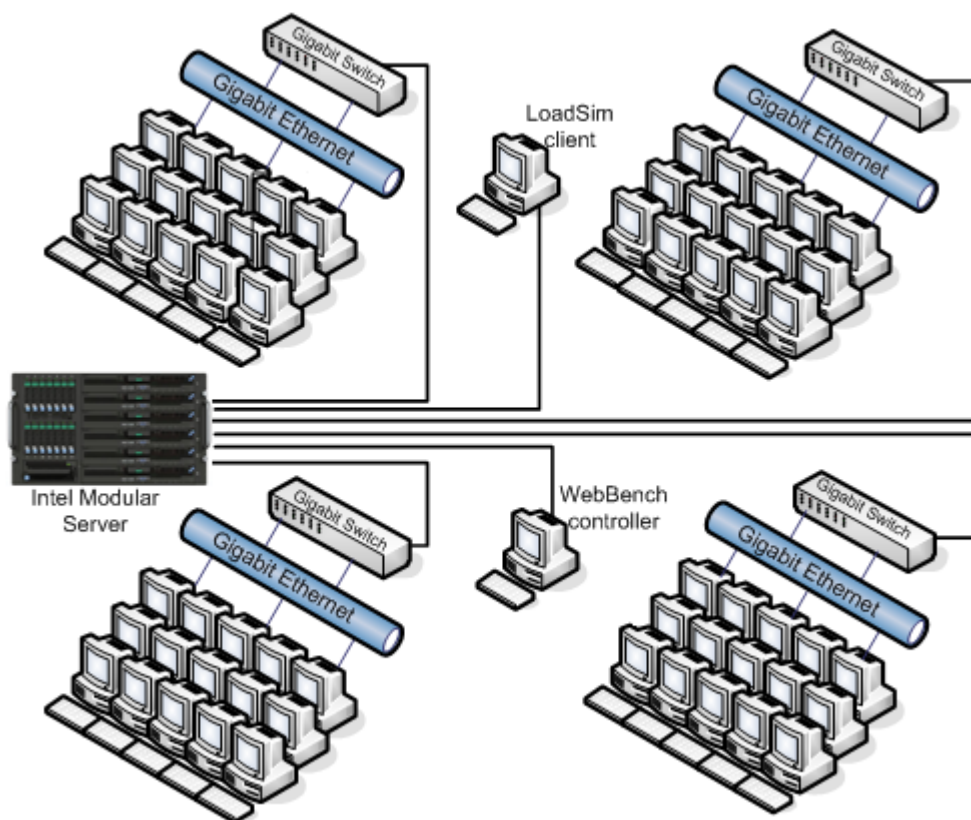
1. Select Start→All Programs→Microsoft Exchange→System Manager in the mail server.
2. In the left pane, expand Servers until First Storage Group appears highlighted.
3. In the right pane, right-click Mailbox Store, and select Dismount Store from the menu.
4. Click Yes on the Do you want to continue? pop-up message. When you've dismounted the Mailbox Store, a red arrow appears in the window pane.

5. Right-click Public Folder Store, and select Dismount Store from the menu.
6. Click Yes on the Do you want to continue? pop-up message. The red arrow appears when you've dismounted the Public Folder Store.
7. Using Windows Explorer, create a new folder e:\backup.
8. With Windows Explorer, copy all files from C:\ to C:\backup. This process may take several minutes.
9. Close Windows Explorer.
10. In Exchange System Manager, right-click Mailbox Store, and select Mount Store from the menu.
11. Click OK on the pop-up message, The store was successfully mounted.
12. Right-click Public Folder Store, and select Mount Store from the menu.
13. Click OK on the pop-up message, The store was successfully mounted.
14. Close Exchange System Manager.

### Network test bed configuration

To generate the workload, we used a network with 62 client PCs. Each PC contained an Intel Pentium 4 3.0GHz with HT Technology processor, 512MB of system memory, a 40GB hard drive, and a Gigabit Ethernet network adapter. We configured each client with Windows XP Professional with Service Pack 2 and all critical updates available as of June 7, 2007.

We split 60 of the clients into four segments, or subnets, of 15 clients each. We connected each segment to the server under test via one NETGEAR\* GS724T Gigabit Smart Switch\*. To balance the load on the server and to prevent a network throughput bottleneck, we connected each segment to a separate network port. We used the remaining two clients for the WebBench controller and LoadSim client. Figure 14 illustrates the test bed configuration.



**Figure 14: Illustration of the test network we used to generate the WebBench and LoadSim workload.**

## Appendix A – Test system configuration information

This appendix provides detailed configuration information about the 64-bit and 32-bit Server Compute Module configurations we tested.

Server	Server Compute Module with Windows Server 2003 R2, Enterprise x64 Edition	Server Compute Module with Microsoft Windows Server 2003 R2, Enterprise Edition
<b>General</b>		
Number of processor packages	2	2
Number of cores per processor package	4	4
Number of hardware threads per core	1	1
System Power Management Policy	Always on	Always on
<b>CPU</b>		
Vendor	Intel	Intel
Name	Intel Xeon E5345	Intel Xeon E5345
Stepping	7	7
Socket type	LGA 771	LGA 771
Core frequency (GHz)	2.33 GHz	2.33 GHz
Front-side bus frequency (MHz)	1,333 MHz	1,333 MHz
L1 cache	4 x 32 KB	4 x 32 KB
L2 cache	2 x 4MB (each 4MB shared by two cores)	2 x 4MB (each 4MB shared by two cores)
<b>Platform</b>		
Vendor and model number	Intel MFSYS25	Intel MFSYS25
Motherboard model number	MF5000SI	MF5000SI
Motherboard chipset	Intel 5000P	Intel 5000P
Motherboard revision number	B1	B1
BIOS name and version	Intel SB5000.86B.10.00.0032.111220 071613	Intel SB5000.86B.10.00.0032.111220 071613
BIOS settings	Default	Default
Chipset INF driver	Intel 8.1.1.1010	Intel 8.1.1.1010
<b>Memory module(s)</b>		
	<b>SysBench</b>	<b>LoadSim</b>
Vendor and model number	Kingston KVR667D2D4F5/2G	Kingston KVR667D2D4F5/2G
Type	PC2-5300	PC2-5300
Speed (MHz)	667 MHz	667 MHz
Speed in the system currently running @ (MHz)	667 MHz	667 MHz
Timing/Latency (tCL-tRCD-iRP-tRASmin)	5-5-5-15	5-5-5-15
Size	8 GB (4 x 2GB)	8 GB (4 x 2GB)
Number of RAM modules	4	4
Chip organization	Double-sided	Double-sided
<b>Memory module(s)</b>		
	<b>SPECjbb2005</b>	
Vendor and model number	Kingston KVR667D2D8F5/1G	N/A
Type	PC2-5300	N/A
Speed (MHz)	667 MHz	N/A

Server	Server Compute Module with Windows Server 2003 R2, Enterprise x64 Edition	Server Compute Module with Microsoft Windows Server 2003 R2, Enterprise Edition
Speed in the system currently running @ (MHz)	667 MHz	N/A
Timing/Latency (tCL-tRCD-iRP-tRASmin)	5-5-5-15	N/A
Size	8 GB (8 x 1 GB)	N/A
Number of RAM modules	8	N/A
Chip organization	Double-sided	N/A
<b>Memory module(s)</b>		
<b>WebBench</b>		
Vendor and model number	Micron MT9HTF6472FY-667D5D4	N/A
Type	PC2-5300	N/A
Speed (MHz)	667 MHz	N/A
Speed in the system currently running @ (MHz)	667 MHz	N/A
Timing/Latency (tCL-tRCD-iRP-tRASmin)	5-5-5-15	N/A
Size	4 GB (8 x 512 MB)	N/A
Number of RAM modules	4	N/A
Chip organization	Double-sided	N/A
<b>Hard disk</b>		
Vendor and model number	Seagate ST973451SS	Seagate ST973451SS
Number of disks in system	14	14
Size	73.4 (each) GB	73.4 (each) GB
Buffer size	16 MB	16 MB
RPM	15,000 RPM	15,000 RPM
Type	SAS	SAS
Controller	LSI Adapter, SAS 3000 series, 4-port with 1064E-StorPort	LSI Adapter, SAS 3000 series, 4-port with 1064E-StorPort
Controller driver	LSI 1.25.5.0	LSI 1.25.5.0
<b>Operating system</b>		
Name	Microsoft Windows Server 2003 R2 x64 Edition	Microsoft Windows Server 2003 R2
Build number	3790	3790
Service Pack	SP2	SP2
Microsoft Windows update date	10/19/07	10/19/07
File system	NTFS	NTFS
Kernel	ACPI Multiprocessor x64-based PC	ACPI Multiprocessor-based PC
Language	English	English

Server	Server Compute Module with Windows Server 2003 R2, Enterprise x64 Edition	Server Compute Module with Microsoft Windows Server 2003 R2, Enterprise Edition
Microsoft DirectX version	9.0c	9.0c
<b>Graphics</b>		
Vendor and model number	ATI ES1000	ATI ES1000
Chipset	ATI ES1000	ATI ES1000
BIOS version	BK-ATI.VER008.005.030.000	BK-ATI.VER008.005.030.000
Type	Integrated	Integrated
Memory size	16 MB	16 MB
Resolution	1,280 x 1,024	1,280 x 1,024
Driver	ATI 8.24.3.0	ATI 8.24.3.0
<b>Network card/subsystem</b>		
Vendor and model number	Intel Pro 1000 EB	Intel Pro 1000 EB
Type	Integrated	Integrated
Driver	Intel 9.7.34.0	Intel 9.7.34.0
<b>Optical drive</b>		
Vendor and model number	None installed	None installed
<b>USB ports</b>		
Number of ports	2	2
Type of ports (USB 1.1, USB 2.0)	USB 2.0	USB 2.0

Figure 15: Detailed system configuration information for the test servers.

## Appendix B – Intel Modular Server enclosure configuration information

This appendix provides detailed configuration information about the Intel Modular Server enclosure.

Enclosure	Intel Modular Server chassis
<b>General dimension information</b>	
Height (inches)	10.5
Width (inches)	19
Depth (inches)	28
U size in server rack	6
Number of compute modules	6
<b>Power supplies</b>	
Total number	4
Wattage of each	1,050W
<b>Cooling fans</b>	
Total number	4
Dimensions (H x W) of each	5" x 5"
Voltage	12V
Amps	4.8A
Additional cooling	I/O cooling module (module w/ six small fans)

Figure 16: Detailed system configuration information for the Intel Modular Server enclosure.



## Appendix C – SPECjbb2005 output

This appendix provides the SPECjbb2005 output files from the median run for the two Server Compute Modules running this benchmark.

### Server Compute Module 3 single-benchmark run

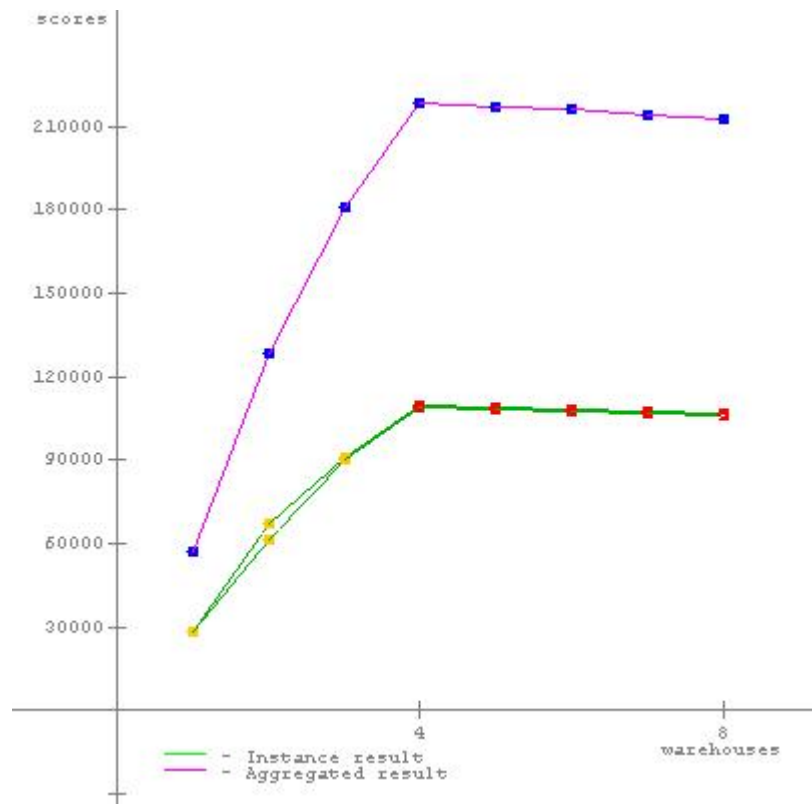
SPECjbb2005

**SPECjbb2005 bops = 215609,  
SPECjbb2005 bops/JVM = 107805**

Intel Server Compute Module

BEA JRockit 6.0 (build P27.4.0-10-90053-1.6.0\_02-20071009-1827-windows-x86\_64 JDK for Microsoft Windows)

JVM run	JVM Scores
1	108170
2	107439
<b>SPECjbb2005 bops = 215609, SPECjbb2005 bops/JVM = 107805</b>	



Hardware	
Hardware Vendor	Intel
Vendor URL	<a href="http://www.Intel.com">http://www.Intel.com</a>
Model	Server Compute Module
Processor	Intel Xeon E5345
MHz	2330
# of Chips	2
# of Cores	8
# of Cores/Chip	4

Software	
Software Vendor	BEA
Vendor URL	<a href="http://www.bea.com">http://www.bea.com</a>
JVM Version	JRockit 6.0 (build P27.4.0-10-90053-1.6.0_02-20071009-1827-windows-x86_64 JDK for Microsoft Windows)
JVM Command Line	start /AFFINITY %J% /B C:\jrockit-jdk1.6.0_02\bin\java.exe -Xms3500m -Xns3000m -Xmx3500m -XXaggressive -XXlargepages -XXcallprofiling -Xgc:genpar -XXthroughputCompaction -

<b>HW Threading Enabled?</b>	No
<b>Procs Avail to Java</b>	8
<b>Memory (MB)</b>	8192
<b>Memory Details</b>	4 x 2GB PC2-5300
<b>Primary cache</b>	32 KB + 32 KB
<b>Secondary cache</b>	2 x 4MB (each 4MB shared by two cores)
<b>Other cache</b>	
<b>Filesystem</b>	NTFS
<b>Disks</b>	
<b>Other hardware</b>	

	XXlazyUnlocking - XXtlasize:min=4k,preferred=128k spec.jbb.JBBmain
<b>JVM Initial Heap Memory (MB)</b>	3500
<b>JVM Maximum Heap Memory (MB)</b>	3500
<b>JVM Address bits</b>	64
<b>JVM CLASSPATH</b>	.\jbb.jar; .\jbb_no_precompile.jar; .\check.jar; .\reporter.jar;
<b>JVM BOOTCLASSPATH</b>	C:\jrockit-jdk1.6.0_02\jre\bin\jrockit\jrockit1.6.0.jar; C:\jrockit-jdk1.6.0_02\jre\bin\jrockit\jmap.jar; C:\jrockit-jdk1.6.0_02\jre\bin\jrockit\jmxmapi.jar; C:\jrockit-jdk1.6.0_02\jre\bin\jrockit\rmp.jar; C:\jrockit-jdk1.6.0_02\jre\bin\jrockit\latency.jar; C:\jrockit-jdk1.6.0_02\jre\lib\resources.jar; C:\jrockit-jdk1.6.0_02\jre\lib\rt.jar; C:\jrockit-jdk1.6.0_02\jre\lib\sunrsasign.jar; C:\jrockit-jdk1.6.0_02\jre\lib\sse.jar; C:\jrockit-jdk1.6.0_02\jre\lib\jce.jar; C:\jrockit-jdk1.6.0_02\jre\lib\charsets.jar; C:\jrockit-jdk1.6.0_02\jre\classes
<b>OS Version</b>	Microsoft Server 2003 R2 Enterprise x64 Edition, Service Pack 2
<b>Other software</b>	None

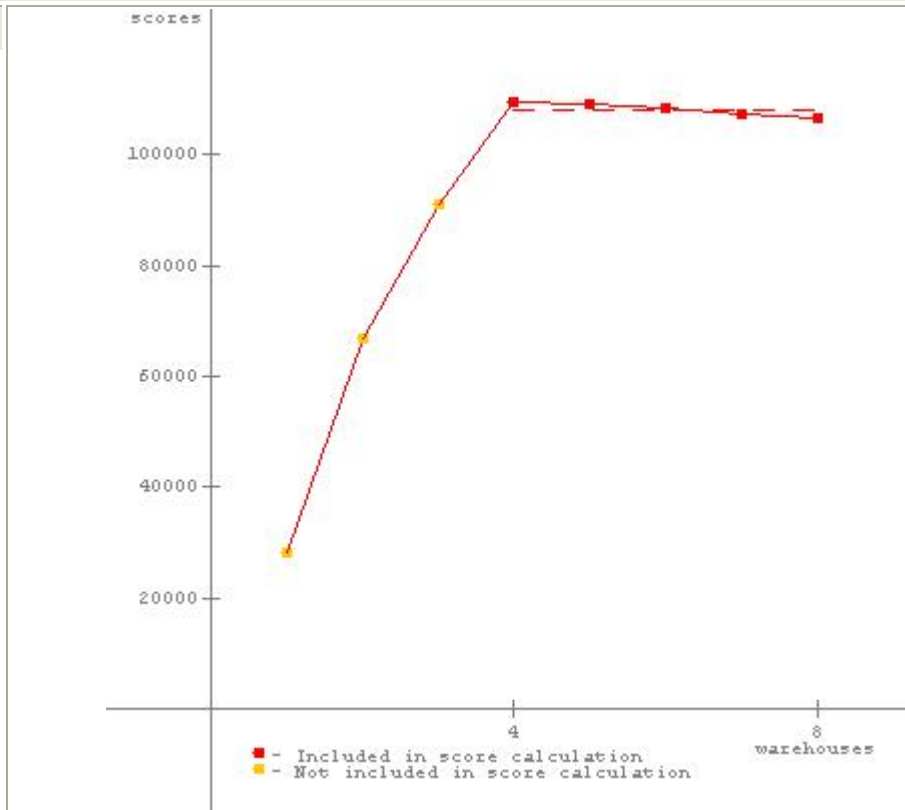
<b>Test Information</b>	
<b>Tested by</b>	Principled Technologies, Inc.
<b>SPEC license #</b>	3184
<b>Test location</b>	Durham, NC
<b>Test date</b>	Jan 10, 2008
<b>H/w available</b>	
<b>JVM available</b>	
<b>OS available</b>	
<b>Other s/w available</b>	

<b>AOT Compilation</b>	
<b>Tuning</b>	
"lock pages in memory" was enabled for the user running the benchmark. Each JVM instance was bound to a single CPU node	
<b>Notes</b>	

## JVM 1 scores

No errors. Valid run.

Warehouses	SPECjbb2005 bops	Incl. in metric
1	28326	
2	66828	
3	90917	
4	109617	*
5	108960	*
6	108285	*
7	107241	*
8	106747	*
<b>SPECjbb2005</b>	<b>(from 4 to 8)</b>	<b>108170 SPECjbb2005 bops</b>



SPEC license # 3184

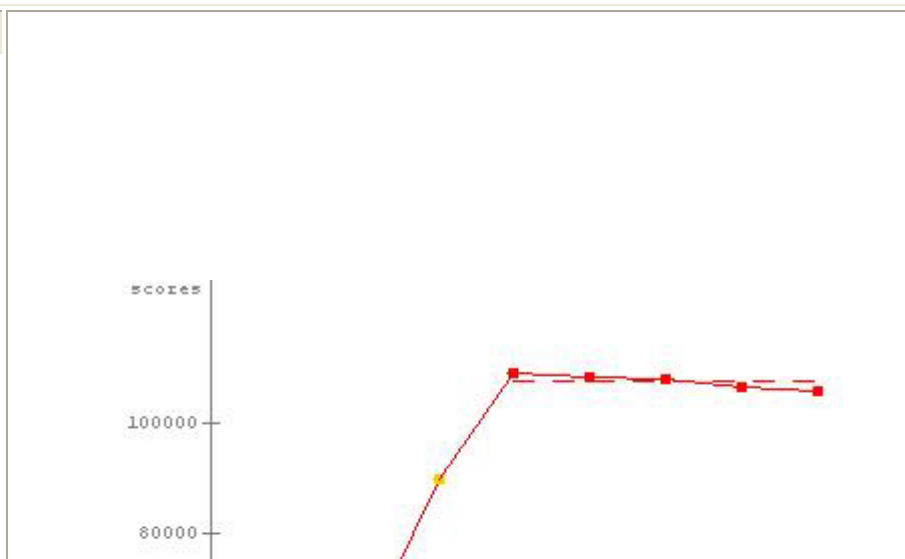
Tested by: Principled Technologies, Inc

Test date: Jan 10, 2008

## JVM 2 scores

No errors. Valid run.

Warehouses	SPECjbb2005 bops	Incl. in metric
1	28623	
2	61418	
3	89879	
4	109033	*
5	108229	*
6	107693	*
7	106480	*
8	105758	*
<b>SPECjbb2005</b>	<b>(from 4 to 8)</b>	<b>107439 SPECjbb2005</b>



Principled Technologies, Inc.: Performance of the Intel® Module simultaneous email, Web server, Java, and database workload:

		<b>bops</b>	
<b>SPEC license #</b> 3184	<b>Tested by:</b> Principled Technologies, Inc		<b>Test date:</b> Jan 10, 2008

SPECjbb2005 Version: [SPECjbb2005 1.07, March 15, 2006]  
 Reporting page, Copyright © 2005 SPEC. All rights reserved

**Server Compute Module 3 multi-benchmark run**

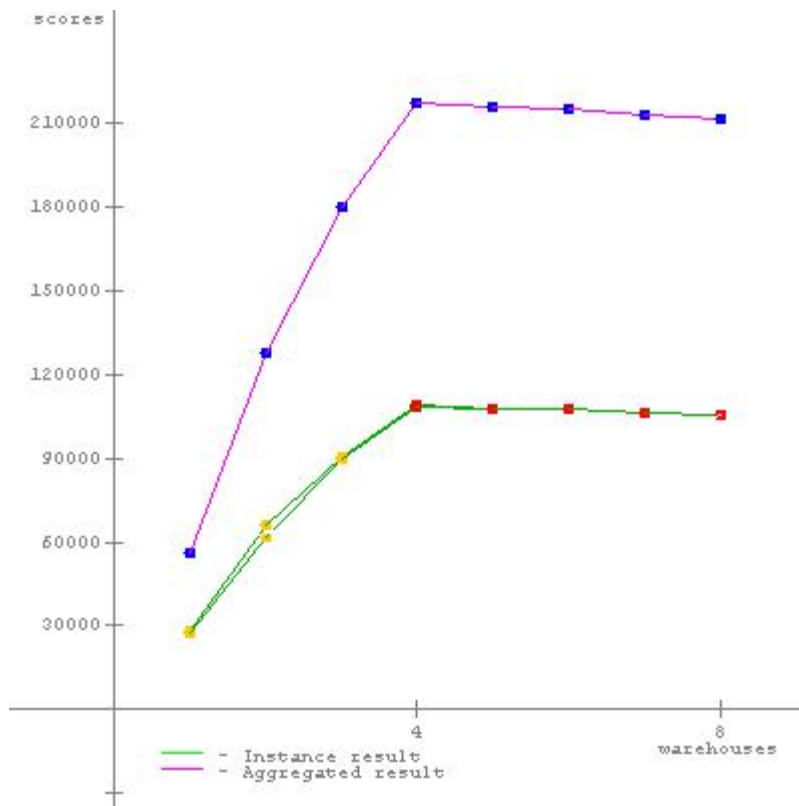
**SPECjbb2005**

**SPECjbb2005 bops = 214623,  
 SPECjbb2005 bops/JVM = 107312**

Intel Server Compute Module

BEA JRockit 6.0 (build P27.4.0-10-90053-1.6.0\_02-20071009-1827-windows-x86\_64 JDK for Microsoft Windows)

JVM run	JVM Scores
1	107441
2	107182
<b>SPECjbb2005 bops = 214623,            SPECjbb2005 bops/JVM = 107312</b>	



Hardware	
<b>Hardware Vendor</b>	Intel
<b>Vendor URL</b>	<a href="http://www.intel.com">http://www.intel.com</a>
<b>Model</b>	Server Compute Module
<b>Processor</b>	Intel Xeon E5345
<b>MHz</b>	2330

Software	
<b>Software Vendor</b>	BEA
<b>Vendor URL</b>	<a href="http://www.bea.com">http://www.bea.com</a>
<b>JVM Version</b>	JRockit 6.0 (build P27.4.0-10-90053-1.6.0_02-20071009-1827-windows-x86_64 JDK for Microsoft Windows)
<b>JVM Command</b>	start /AFFINITY %J% /B C:\jrockit-

# of Chips	2
# of Cores	8
# of Cores/Chip	4
HW Threading Enabled?	No
Procs Avail to Java	8
Memory (MB)	8192
Memory Details	4 x 2GB PC2-5300
Primary cache	32 KB + 32 KB
Secondary cache	2 x 4MB (each 4MB shared by two cores)
Other cache	
Filesystem	NTFS
Disks	
Other hardware	

Line	jdk1.6.0_02\bin\java.exe -Xms3500m -Xns3000m -Xmx3500m -XXaggressive -XXlargepages -XXcallprofiling -Xgc:genpar -XXthroughputCompaction -XXlazyUnlocking -XXtlasize:min=4k,preferred=128k spec.jbb.JBBmain
JVM Initial Heap Memory (MB)	3500
JVM Maximum Heap Memory (MB)	3500
JVM Address bits	64
JVM CLASSPATH	.\jbb.jar; .\jbb_no_precompile.jar; .\check.jar; .\reporter.jar;
JVM BOOTCLASSPATH	C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jrocket1.6.0.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jmap.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jmxmap.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jrm.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\latency.jar; C:\jrocket-jdk1.6.0_02\jre\lib\resources.jar; C:\jrocket-jdk1.6.0_02\jre\lib\rt.jar; C:\jrocket-jdk1.6.0_02\jre\lib\sunrsasign.jar; C:\jrocket-jdk1.6.0_02\jre\lib\sse.jar; C:\jrocket-jdk1.6.0_02\jre\lib\jce.jar; C:\jrocket-jdk1.6.0_02\jre\lib\charsets.jar; C:\jrocket-jdk1.6.0_02\jre\classes
OS Version	Microsoft Server 2003 R2 Enterprise x64 Edition, Service Pack 2
Other software	None

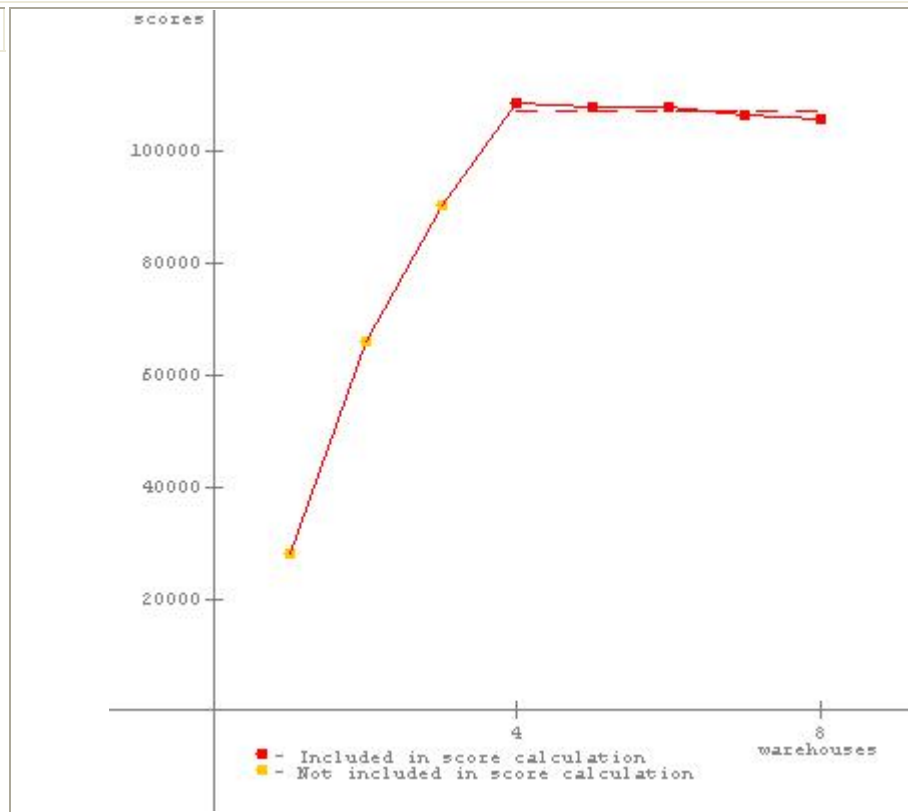
Test Information	
Tested by	Principled Technologies, Inc.
SPEC license #	3184
Test location	Durham, NC
Test date	Jan 10, 2008
H/w available	
JVM available	
OS available	
Other s/w available	

AOT Compilation	
Tuning	
"lock pages in memory" was enabled for the user running the benchmark. Each JVM instance was bound to a single CPU node	
Notes	

## JVM 1 scores

**No errors. Valid run.**

Warehouses	SPECjbb2005 bops	Incl. in metric
1	28176	
2	66073	
3	90285	
4	108896	*
5	108018	*
6	107937	*
7	106488	*
8	105866	*
<b>SPECjbb2005</b>	<b>(from 4 to 8)</b>	<b>107441</b> <b>SPECjbb2005</b> <b>bops</b>



**SPEC license # 3184**

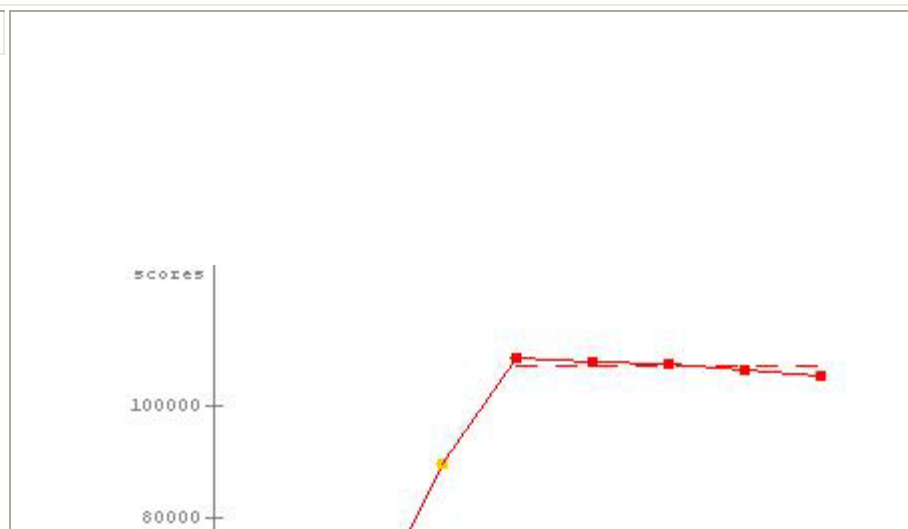
**Tested by:** Principled Technologies, Inc

**Test date:** Jan 10, 2008

## JVM 2 scores

**No errors. Valid run.**

Warehouses	SPECjbb2005 bops	Incl. in metric
1	27777	
2	61848	
3	89690	
4	108704	*
5	107951	*
6	107366	*
7	106412	*
8	105476	*
<b>SPECjbb2005</b>	<b>(from 4 to 8)</b>	<b>107182</b>



Principled Technologies, Inc.: Performance of the Intel® Module simultaneous email, Web server, Java, and database workload:

		<b>SPECjbb2005 bops</b>	
<b>SPEC license #</b> 3184	<b>Tested by:</b> Principled Technologies, Inc		<b>Test date:</b> Jan 10, 2008

SPECjbb2005 Version: [SPECjbb2005 1.07, March 15, 2006]  
 Reporting page, Copyright © 2005 SPEC. All rights reserved

**Server Compute Module 4 single-benchmark run**

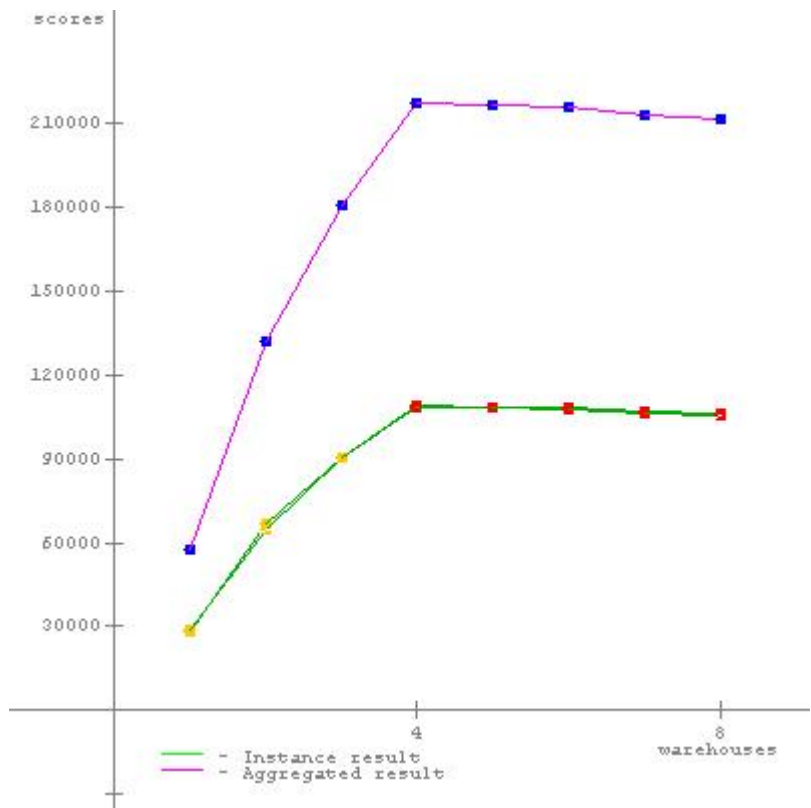
SPECjbb2005

**SPECjbb2005 bops = 214999,  
 SPECjbb2005 bops/JVM = 107500**

Intel Server Compute Module

BEA JRockit 6.0 (build P27.4.0-10-90053-1.6.0\_02-20071009-1827-windows-x86\_64 JDK for Microsoft Windows)

JVM run	JVM Scores
1	107688
2	107311
<b>SPECjbb2005 bops = 214999,            SPECjbb2005 bops/JVM = 107500</b>	



Hardware	
<b>Hardware Vendor</b>	Intel
<b>Vendor URL</b>	<a href="http://www.intel.com">http://www.intel.com</a>
<b>Model</b>	Server Compute Module
<b>Processor</b>	Intel Xeon E5345

Software	
<b>Software Vendor</b>	BEA
<b>Vendor URL</b>	<a href="http://www.bea.com">http://www.bea.com</a>
<b>JVM Version</b>	JRockit 6.0 (build P27.4.0-10-90053-1.6.0_02-20071009-1827-windows-x86_64 JDK for Microsoft Windows)

MHz	2330
# of Chips	2
# of Cores	8
# of Cores/Chip	4
HW Threading Enabled?	No
Procs Avail to Java	8
Memory (MB)	8192
Memory Details	4 x 2GB PC2-5300
Primary cache	32 KB + 32 KB
Secondary cache	2 x 4MB (each 4MB shared by two cores)
Other cache	
Filesystem	NTFS
Disks	
Other hardware	

JVM Command Line	start /AFFINITY %J% /B C:\jrocket-jdk1.6.0_02\bin\java.exe -Xms3500m -Xns3000m -Xmx3500m -XXaggressive -XXlargepages -XXcallprofiling -Xgc:genpar -XXthroughputCompaction -XXlazyUnlocking -XXtlasize:min=4k,preferred=128k spec.jbb.JBBmain
JVM Initial Heap Memory (MB)	3500
JVM Maximum Heap Memory (MB)	3500
JVM Address bits	64
JVM CLASSPATH	.\jbb.jar; .\jbb_no_precompile.jar; .\check.jar; .\reporter.jar;
JVM BOOTCLASSPATH	C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\rocket1.6.0.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jmap.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jmxmap.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\rmp.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\latency.jar; C:\jrocket-jdk1.6.0_02\jre\lib\resources.jar; C:\jrocket-jdk1.6.0_02\jre\lib\rt.jar; C:\jrocket-jdk1.6.0_02\jre\lib\sunrsasign.jar; C:\jrocket-jdk1.6.0_02\jre\lib\sse.jar; C:\jrocket-jdk1.6.0_02\jre\lib\jce.jar; C:\jrocket-jdk1.6.0_02\jre\lib\charsets.jar; C:\jrocket-jdk1.6.0_02\jre\classes
OS Version	Microsoft Server 2003 R2 Enterprise x64 Edition, Service Pack 2
Other software	None

Test Information	
Tested by	Principled Technologies, Inc.
SPEC license #	3184
Test location	Durham, NC
Test date	Jan 10, 2008
H/w available	
JVM available	
OS available	

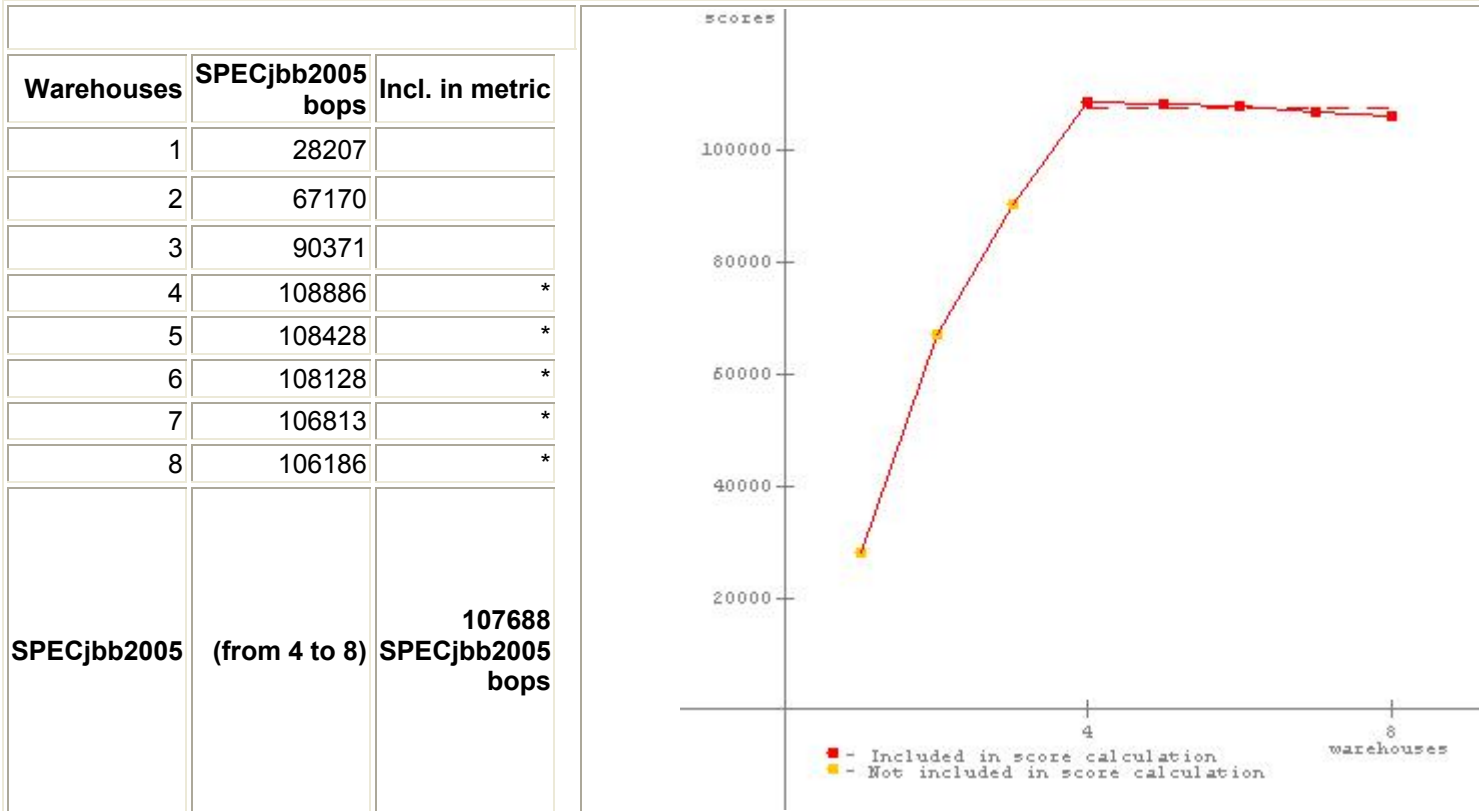
AOT Compilation	
Tuning	
"lock pages in memory" was enabled for the user running the benchmark. Each JVM instance was bound to a single CPU node	
Notes	



Other s/w available	
---------------------	--

## JVM 1 scores

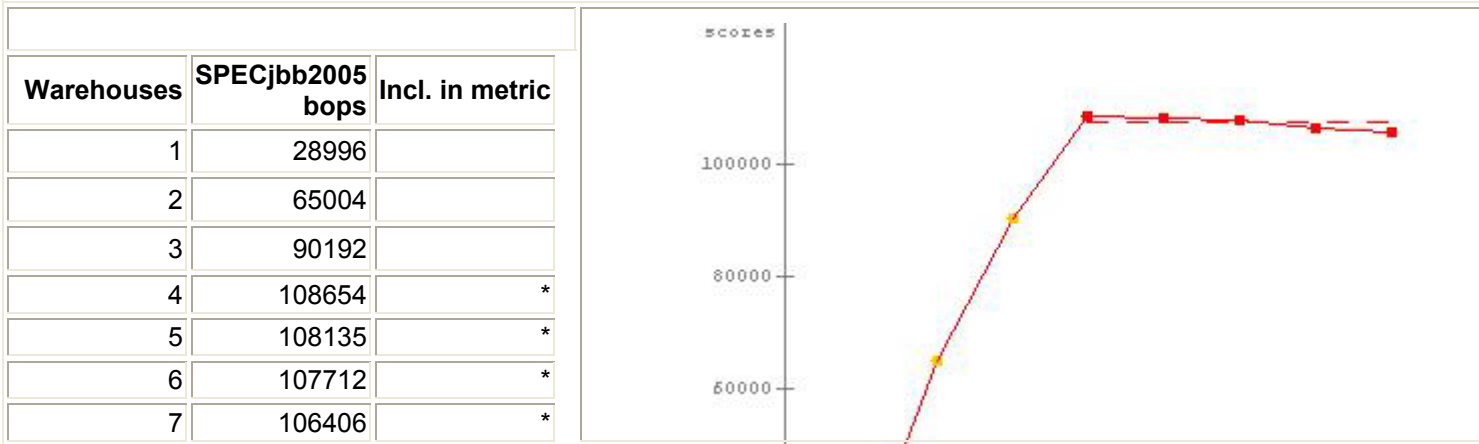
**No errors. Valid run.**



SPEC license # 3184	Tested by: Principled Technologies, Inc	Test date: Jan 11, 2008
---------------------	---	-------------------------

## JVM 2 scores

**No errors. Valid run.**



8	105650	*
<b>SPECjbb2005</b>	<b>(from 4 to 8)</b>	<b>107311</b> <b>SPECjbb2005</b> <b>bops</b>

<b>SPEC license #</b> 3184	<b>Tested by:</b> Principled Technologies, Inc	<b>Test date:</b> Jan 11, 2008
----------------------------	--	--------------------------------

SPECjbb2005 Version: [SPECjbb2005 1.07, March 15, 2006]  
 Reporting page, Copyright © 2005 SPEC. All rights reserved

**Server Compute Module 4 multi-benchmark run**

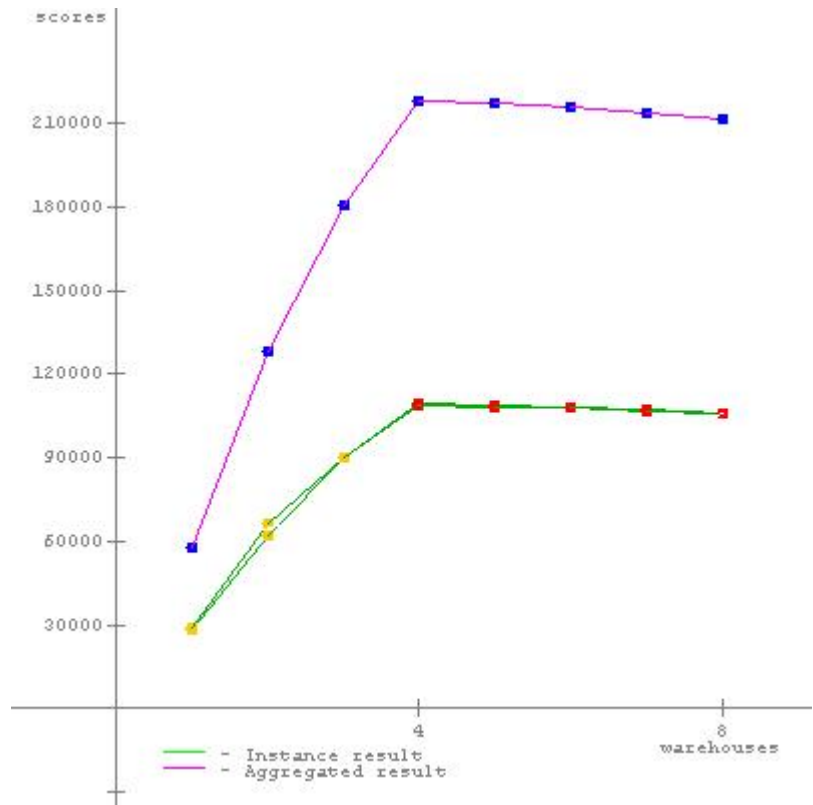
**SPECjbb2005**

**SPECjbb2005 bops = 215248,**  
**SPECjbb2005 bops/JVM = 107624**

Intel Server Compute Module

BEA JRockit 6.0 (build P27.4.0-10-90053-1.6.0\_02-20071009-1827-windows-x86\_64 JDK for Microsoft Windows)

JVM run	JVM Scores
1	107901
2	107347
<b>SPECjbb2005 bops = 215248,</b> <b>SPECjbb2005 bops/JVM = 107624</b>	



Hardware	
<b>Hardware Vendor</b>	Intel
<b>Vendor URL</b>	<a href="http://www.intel.com">http://www.intel.com</a>
<b>Model</b>	Server Compute Module

Software	
<b>Software Vendor</b>	BEA
<b>Vendor URL</b>	<a href="http://www.bea.com">http://www.bea.com</a>
<b>JVM Version</b>	JRockit 6.0 (build P27.4.0-10-90053-1.6.0_02-20071009-1827-windows-

<b>Processor</b>	Intel Xeon E5345
<b>MHz</b>	2330
<b># of Chips</b>	2
<b># of Cores</b>	8
<b># of Cores/Chip</b>	4
<b>HW Threading Enabled?</b>	No
<b>Procs Avail to Java</b>	8
<b>Memory (MB)</b>	8192
<b>Memory Details</b>	4 x 2GB PC2-5300
<b>Primary cache</b>	32 KB + 32 KB
<b>Secondary cache</b>	2 x 4MB (each 4MB shared by two cores)
<b>Other cache</b>	
<b>Filesystem</b>	NTFS
<b>Disks</b>	
<b>Other hardware</b>	

	x86_64 JDK for Microsoft Windows)
<b>JVM Command Line</b>	start /AFFINITY %J% /B C:\jrocket-jdk1.6.0_02\bin\java.exe -Xms3500m -Xns3000m -Xmx3500m -XXaggressive -XXlargepages -XXcallprofiling -Xgc:genpar -XXthroughputCompaction -XXlazyUnlocking -XXtlsize:min=4k,preferred=128k spec.jbb.JBBmain
<b>JVM Initial Heap Memory (MB)</b>	3500
<b>JVM Maximum Heap Memory (MB)</b>	3500
<b>JVM Address bits</b>	64
<b>JVM CLASSPATH</b>	.\jbb.jar; .\jbb_no_precompile.jar; .\check.jar; .\reporter.jar;
<b>JVM BOOTCLASSPATH</b>	C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jrocket1.6.0.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jmap.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\jmxmap.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\rmp.jar; C:\jrocket-jdk1.6.0_02\jre\bin\jrocket\latency.jar; C:\jrocket-jdk1.6.0_02\jre\lib\resources.jar; C:\jrocket-jdk1.6.0_02\jre\lib\rt.jar; C:\jrocket-jdk1.6.0_02\jre\lib\sunrsasign.jar; C:\jrocket-jdk1.6.0_02\jre\lib\sse.jar; C:\jrocket-jdk1.6.0_02\jre\lib\jce.jar; C:\jrocket-jdk1.6.0_02\jre\lib\charsets.jar; C:\jrocket-jdk1.6.0_02\jre\classes
<b>OS Version</b>	Microsoft Server 2003 R2 Enterprise x64 Edition, Service Pack 2
<b>Other software</b>	None

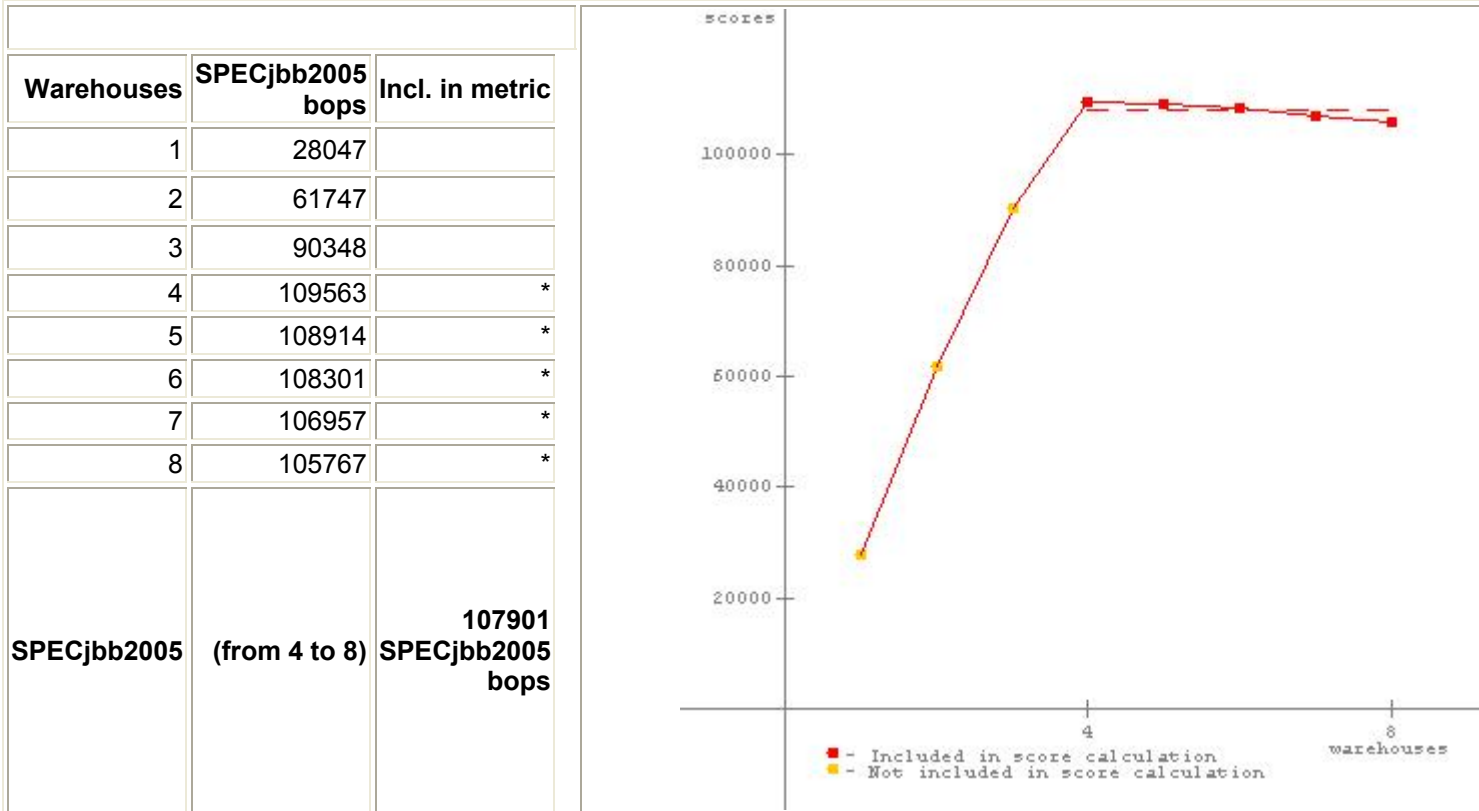
Test Information	
<b>Tested by</b>	Principled Technologies, Inc.
<b>SPEC license #</b>	3184
<b>Test location</b>	Durham, NC
<b>Test date</b>	Jan 10, 2008
<b>H/w available</b>	
<b>JVM available</b>	
<b>OS available</b>	

AOT Compilation	
Tuning	
"lock pages in memory" was enabled for the user running the benchmark. Each JVM instance was bound to a single CPU node	
Notes	

Other s/w available	
---------------------	--

## JVM 1 scores

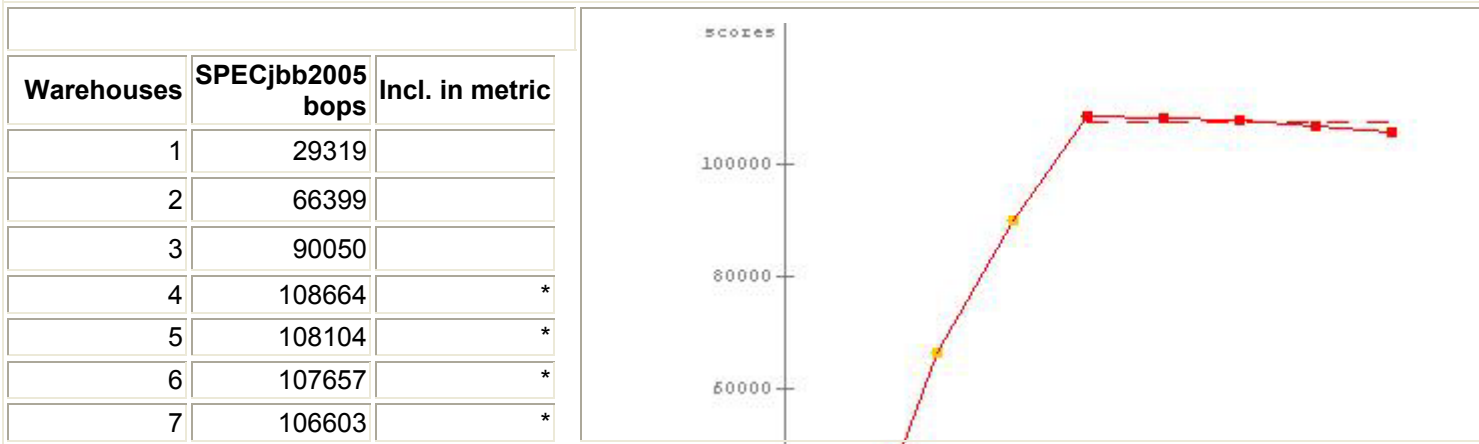
**No errors. Valid run.**



SPEC license # 3184	Tested by: Principled Technologies, Inc	Test date: Jan 21, 2008
---------------------	---	-------------------------

## JVM 2 scores

**No errors. Valid run.**



8	105709	*	
<b>SPECjbb2005</b>	<b>(from 4 to 8)</b>	<b>107347</b> <b>SPECjbb2005</b> <b>bops</b>	
<b>SPEC license # 3184</b>		<b>Tested by:</b> Principled Technologies, Inc	<b>Test date:</b> Jan 21, 2008

SPECjbb2005 Version: [SPECjbb2005 1.07, March 15, 2006]  
*Reporting page, Copyright © 2005 SPEC. All rights reserved*



Principled Technologies, Inc.  
 1007 Slater Road, Suite 250  
 Durham, NC 27703  
[www.principledtechnologies.com](http://www.principledtechnologies.com)  
[info@principledtechnologies.com](mailto:info@principledtechnologies.com)

Principled Technologies is a registered trademark of Principled Technologies, Inc.  
 Intel, Xeon, and Pentium are registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.\*All other product names are the trademarks of their respective owners.

**Disclaimer of Warranties; Limitation of Liability:**

PRINCIPLED TECHNOLOGIES, INC. HAS MADE REASONABLE EFFORTS TO ENSURE THE ACCURACY AND VALIDITY OF ITS TESTING, HOWEVER, PRINCIPLED TECHNOLOGIES, INC. SPECIFICALLY DISCLAIMS ANY WARRANTY, EXPRESSED OR IMPLIED, RELATING TO THE TEST RESULTS AND ANALYSIS, THEIR ACCURACY, COMPLETENESS OR QUALITY, INCLUDING ANY IMPLIED WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE. ALL PERSONS OR ENTITIES RELYING ON THE RESULTS OF ANY TESTING DO SO AT THEIR OWN RISK, AND AGREE THAT PRINCIPLED TECHNOLOGIES, INC., ITS EMPLOYEES AND ITS SUBCONTRACTORS SHALL HAVE NO LIABILITY WHATSOEVER FROM ANY CLAIM OF LOSS OR DAMAGE ON ACCOUNT OF ANY ALLEGED ERROR OR DEFECT IN ANY TESTING PROCEDURE OR RESULT.

IN NO EVENT SHALL PRINCIPLED TECHNOLOGIES, INC. BE LIABLE FOR INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH ITS TESTING, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. IN NO EVENT SHALL PRINCIPLED TECHNOLOGIES, INC.'S LIABILITY, INCLUDING FOR DIRECT DAMAGES, EXCEED THE AMOUNTS PAID IN CONNECTION WITH PRINCIPLED TECHNOLOGIES, INC.'S TESTING. CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES ARE AS SET FORTH HEREIN.