Principled Technologies®

TEST REPORT
JANUARY 2007

# SPECjbb2005 performance and power consumption on Intel- and AMD-processor-based quad-processor servers

## Executive summary

Intel Corporation (Intel) commissioned Principled Technologies (PT) to measure the SPECjbb2005 performance and power consumption of quad-processor servers using the following two processors:

- Dual-core AMD Opteron processor model 8220 SE
- Dual-Core Intel® Xeon® processor 7140M

### KEY FINDINGS

- The Dual-Core Intel Xeon processor 7140M-based quad-processor server delivered 34 percent more performance/watt than the dual-core AMD Opteron processor model 8220 SE-based quad processor server (see Figure 1). (We calculated performance/watt using system-level power measurements.)
- The Dual-Core Intel Xeon processor 7140M-based quad-processor server delivered 46 percent higher peak performance than the dual-core AMD Opteron processor model 8220 SE-based quad processor server (see Figure 2).

SPECjbb2005 is an industry-standard benchmark created by the Standard Performance Evaluation Corp. (SPEC) to measure a server's Java performance. SPEC modeled SPECjbb2005 on the three-tier client/server architecture, with the middle layer as the primary focus. Per 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." (www.spec.org/jbb2005/docs/UserGuide.html).

SPECjbb2005 uses multiple special data groups and multiple threads as it runs. Each data unit is a "warehouse", which is a roughly 25MB collection of data objects. Each thread represents an active user posting transaction requests within a warehouse. The benchmark run begins with one warehouse and then increases the number of warehouses; its goal is to saturate the server's processor capacity. As the number of warehouses increases, so does the number of threads. The benchmark's results portray the server's throughput in bops (business operations per second). Because bops is a rate, a higher number of bops is better. (For more information on SPECjbb2005, go to www.spec.org.)

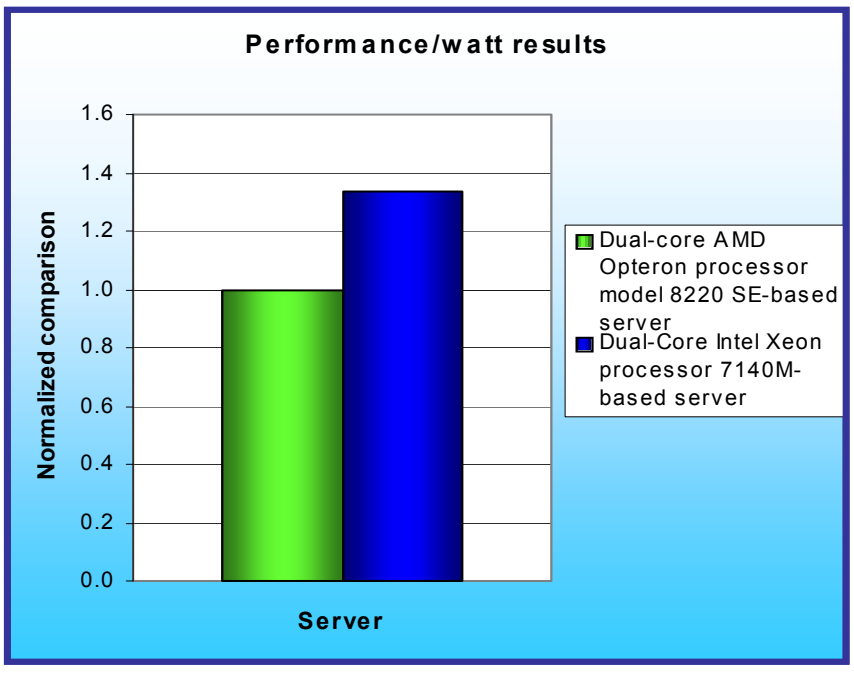



**Figure 1: Performance/watt (quad-processor) results of the test servers running SPECjbb2005. Higher numbers indicate better performance/watt.**

In this section, we discuss the best results for each server. SPECjbb2005 requires a Java Virtual Machine (JVM) on the system under test. We used the BEA JRockit 5.0 (P26.4.1 build P26.4.1-5-64782-1.5.0_06-20060726-0014-win-x86_64 JDK for Microsoft Windows) JVM for this testing and left the default installation settings. At the time of testing, this was the most current version publicly available from the BEA Web site to download. (A new version that promised improved performance was due soon.)

For complete details of the performance of each JVM by warehouse for each server, see the Test results section.

Figure 1 illustrates the performance/watt for each of the servers. In this chart, we show relative

performance. We calculated the relative performance by assigning a value of 1.00 to the performance/watt of the lower system and then expressing the other system's performance as a comparison to that number. Thus, each data point in these charts is a comparative number, with higher results indicating better performance/watt.

To calculate the performance/watt we used the following formula:

Performance/watt = the benchmark's score / average power consumption in watts during the time period in which the benchmark was delivering peak performance

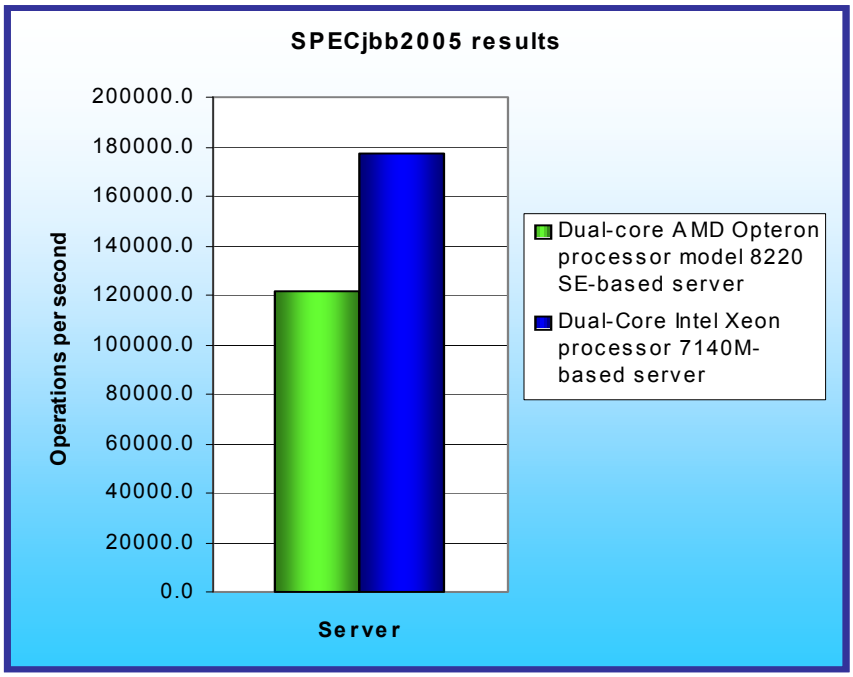



**Figure 2: SPECjbb2005 business operations per second (quad-processor) results for the test servers. Higher numbers of operations per second are better.**

As Figure 1 illustrates, the Dual-Core Intel Xeon processor 7140M-based quad-processor server delivered 34 percent more performance/watt than the dual-core AMD Opteron processor model 8220 SE-based server.

Figure 2 shows the SPECjbb2005 results, in bops, of the test servers. Each result is the median peak score of three runs of the benchmark. See the Test results section for the scores from all three runs. A higher SPECjbb2005 score indicates the server is able to handle more Java requests and thus deliver greater throughput.

The Dual-Core Intel Xeon processor 7140M-based server produced the highest results, 177,037 bops, while the dual-core AMD Opteron processor model 8220 SE-based server achieved 121,291 bops. The Dual-Core Intel Xeon processor 7140M-based server thus delivered a 46 percent performance increase over the dual-core AMD Opteron processor model 8220 SE-based server.

Figure 3 shows a plot of the power usage of the servers as they were running the benchmark. The red lines indicate the power measurement interval, the time during which the server was delivering peak performance and during which we captured power measurements. Lower power consumption is better.

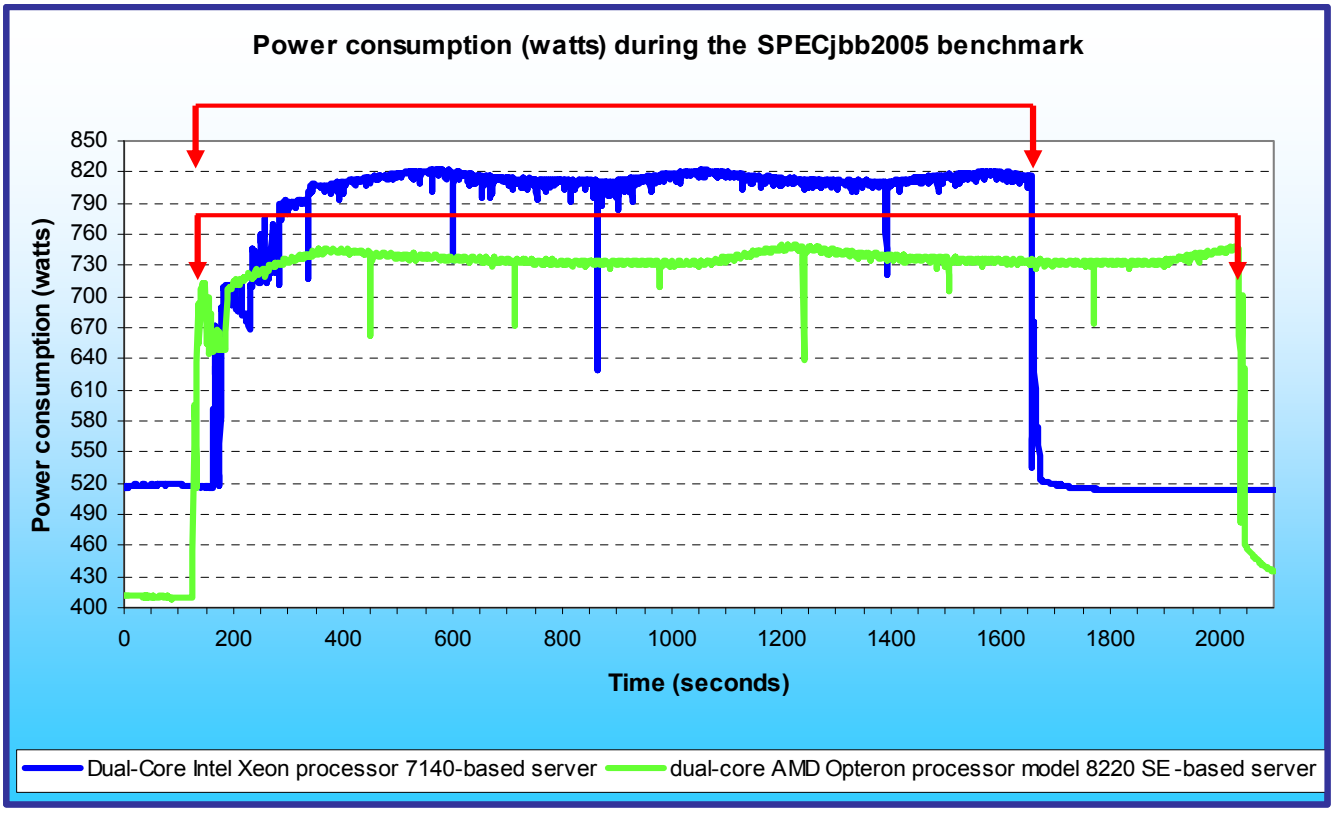



**Figure 3: Power consumption (in watts) of each of the servers throughout the course of executing the SPECjbb2005 benchmark. Lower power consumption is better.**

# Test results

Figure 4 shows the median SPECjbb2005 results for both 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 our testing, all servers achieved peak performance during mixes 4 through 8. (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.)

| Operations per second | | |
|---|---|---|
| | **Dual-core AMD Opteron processor model 8220 SE-based server** | **Dual-Core Intel Xeon processor 7140M-based server** |
| **JVM 1** | 28,145 | 44,024 |
| **JVM 2** | 30,363 | 44,336 |
| **JVM 3** | 31,470 | 44,385 |
| **JVM 4** | 31,313 | 44,292 |
| **Total Score** | **121,291** | **177,037** |

**Figure 4: SPECjbb2005 results for each server by JVM. Higher numbers are better.**

Figure 5 shows the results by warehouse for the dual-core AMD Opteron processor model 8220 SE-based server for all three runs. Run 2 produced the median results.

| Dual-core AMD Opteron processor model 8220 SE-based server | | | |
|---|---|---|---|
| | **Run 1** | **Run 2** | **Run 3** |
| Warehouse | | **JVM 1** | |
| 1 | 13,434 | 14,076 | 14,022 |
| 2 | 28,388 | 29,011 | 29,143 |
| 3 | 27,137 | 28,038 | 28,191 |
| 4 | 26,922 | 27,386 | 28,168 |
| 5 | 27,218 | 27,433 | 28,684 |
| 6 | 27,357 | 26,901 | 27,995 |
| 7 | 26,802 | 26,367 | 27,852 |
| 8 | 26,803 | 27,386 | 28,134 |
| **Score** | 27,482 | 28,145 | 28,501 |
| Warehouse | | **JVM 2** | |
| 1 | 14,236 | 14,341 | 14,786 |
| 2 | 30,190 | 30,358 | 30,674 |
| 3 | 30,242 | 30,432 | 30,709 |
| 4 | 30,263 | 30,300 | 30,754 |
| 5 | 30,070 | 30,261 | 30,542 |
| 6 | 29,844 | 29,909 | 29,919 |
| 7 | 29,711 | 29,676 | 29,961 |
| 8 | 29,587 | 29,779 | 29,785 |
| **Score** | 30,231 | 30,363 | 30,713 |
| Warehouse | | **JVM 3** | |
| 1 | 14,415 | 14,418 | 14,596 |
| 2 | 31,270 | 31,486 | 31,581 |
| 3 | 31,950 | 31,604 | 31,649 |
| 4 | 31,535 | 31,319 | 31,723 |
| 5 | 31,180 | 30,934 | 31,522 |
| 6 | 30,810 | 30,670 | 31,047 |
| 7 | 30,759 | 30,606 | 31,072 |
| 8 | 30,683 | 30,497 | 30,976 |
| **Score** | 31,585 | 31,470 | 31,651 |
| Warehouse | | **JVM 4** | |
| 1 | 14,595 | 14,617 | 14,468 |
| 2 | 31,191 | 31,162 | 31,319 |
| 3 | 31,482 | 31,407 | 31,725 |
| 4 | 31,365 | 31,370 | 31,174 |
| 5 | 31,115 | 31,046 | 31,112 |
| 6 | 30,868 | 30,947 | 30,910 |
| 7 | 30,675 | 30,651 | 30,725 |
| 8 | 30,645 | 30,568 | 30,639 |
| **Score** | 31,346 | 31,313 | 31,406 |
| **Total Score** | **120,644** | **121,291** | **122,271** |

**Figure 5: SPECjbb2005 results for the dual-core AMD Opteron processor model 8220 SE-based server. Higher numbers are better.**

Figure 6 shows the results by warehouse for the Dual-Core Intel Xeon processor 7140M-based server for all three runs. Run 3 produced the median results.

| Dual-Core Intel Xeon processor 7140M-based server | | | |
|---|---|---|---|
| | **Run 1** | **Run 2** | **Run 3** |
| Warehouse | | **JVM 1** | |
| 1 | 15,229 | 15,379 | 14,923 |
| 2 | 32,738 | 32,960 | 32,417 |
| 3 | 39,085 | 39,610 | 38,849 |
| 4 | 44,304 | 44,832 | 44,546 |
| 5 | 44,175 | 44,741 | 44,375 |
| 6 | 43,698 | 44,586 | 43,902 |
| 7 | 43,576 | 44,375 | 43,936 |
| 8 | 43,214 | 43,963 | 43,363 |
| **Score** | **43,793** | **44,500** | **44,024** |
| Warehouse | | **JVM 2** | |
| 1 | 9,915 | 9,669 | 9,596 |
| 2 | 25,183 | 24,900 | 25,553 |
| 3 | 38,533 | 38,994 | 38,428 |
| 4 | 44,560 | 44,951 | 44,641 |
| 5 | 44,575 | 45,246 | 44,792 |
| 6 | 44,134 | 44,584 | 44,365 |
| 7 | 44,094 | 44,514 | 44,108 |
| 8 | 43,540 | 43,986 | 43,772 |
| **Score** | **44,181** | **44,656** | **44,336** |
| Warehouse | | **JVM 3** | |
| 1 | 9,809 | 9,606 | 10,006 |
| 2 | 26,215 | 24,571 | 26,577 |
| 3 | 38,302 | 38,611 | 37,908 |
| 4 | 44,785 | 44,634 | 44,691 |
| 5 | 44,878 | 44,534 | 44,663 |
| 6 | 44,244 | 44,195 | 44,342 |
| 7 | 44,319 | 44,089 | 44,370 |
| 8 | 43,737 | 43,565 | 43,860 |
| **Score** | **44,392** | **44,203** | **44,385** |
| Warehouse | | **JVM 4** | |
| 1 | 10,112 | 10,003 | 9,664 |
| 2 | 25,995 | 27,989 | 25,582 |
| 3 | 38,911 | 38,658 | 38,536 |
| 4 | 44,786 | 44,166 | 44,747 |
| 5 | 44,937 | 44,121 | 44,850 |
| 6 | 44,295 | 43,889 | 44,051 |
| 7 | 44,249 | 43,648 | 44,179 |
| 8 | 43,624 | 43,295 | 44,179 |
| **Score** | **44,378** | **43,824** | **44,292** |
| **Total Score** | **176,744** | **177,183** | **177,037** |

**Figure 6: SPECjbb2005 results for the Dual-Core Xeon processor 7140M-based server. Higher numbers are better.**

Figure 7 details the power consumption, in watts, of the test servers while idle and during the median peak runs of the benchmark.

| Server | Idle power (watts) | Average power (watts) |
|---|---|---|
| Dual-core AMD Opteron processor model 8220 SE-based | 411.2 | 732.4 |
| Dual-Core Intel Xeon processor 7140M-based server | 518.2 | 800.6 |

**Figure 7: Average power usage (in watts) of the test servers during the median peak runs of SPECjbb2005. Lower numbers are better.**

# Test methodology

Figure 8 summarizes some key aspects of the configurations of the server systems; Appendix A provides detailed configuration information.

| Server | Dual-core AMD Opteron processor model 8220 SE-based server | Dual-Core Intel Xeon processor 7140M-based server |
|---|---|---|
| Processor frequency (GHz) | 2.8 GHz | 3.4 GHz |
| Single/Dual-Core processors | Dual | Dual |
| Motherboard | IBM Server System x3755 | Intel SR4850HW4x Server |
| Chipset | IBM HT1000 Legacy / AMD | Intel E8501 Chipset |
| RAM (32GB in each) | 8 x 4GB PC2-5300 running at 667MHz | 8 x 4GB PC2-5300 running at 400MHz |
| Hard disk | 1 x Maxtor 8J073S0 10K RPM 73.5 GB 16MB buffer | 1 x Seagate ST3146854LC 15K RPM 146.8 GB 8MB buffer |

**Figure 8: Summary of some key aspects of the server configurations.**

Intel configured and provided both servers.

The difference in RAM speeds reflects the capabilities of the Front Side Bus (FSB) of the two systems and their current configurations. The Dual-Core Intel Xeon processor 7140M has a FSB of 800 MHz. The dual-core AMD Opteron processor model 8220 SE has a FSB of 2000 MHz HyperTransport Technology.

To make the best possible comparison we used the same physical memory in both systems. The speed of the memory dropped when installed in the system to correspond to the processor's FSB speed.

The hard disks differed, but hard disk performance typically plays at most a small role in SPECjbb2005 performance, so this configuration difference was unlikely to affect results.

We began by installing a fresh copy of Microsoft Windows 2003 Server, x64 Enterprise Edition Service Pack 1 on each server. 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:

- Windows Server 2003 Security Update for Windows Media Player 6.4 (KB925398)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB923689)
- Windows Server 2003 Cumulative Security Update for Outlook Express for Windows Server 2003 x64 Edition (KB923694)

- Windows Server 2003 Cumulative Security Update for Internet Explorer for Windows Server 2003 x64 Edition (KB925454)
- Windows Server 2003 Update for Windows Server 2003 x64 Edition (KB911897)
- Windows Server 2003 Windows Internet Explorer 7.0 for Windows Server 2003 (x64) and Windows XP 64-bit Edition Version 2003
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB920213)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB922819)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB924191)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB923191)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB924496)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB923414)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB925486)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB920685)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB921883)
- Windows Server 2003 Update for Windows Server 2003 x64 Edition (KB922582)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB921398)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB917422)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB922616)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB920683)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB920670)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB914388)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB911280)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB917953)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB918439)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB917344)
- Windows Server 2003 Update for Windows Server 2003 x64 Edition (KB914784)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB914389)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB917734)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB911562)
- Windows Server 2003 Security Update for Windows Media Player Plug-in (KB911564)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB911927)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB908519)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB912919)
- Windows Server 2003 Update for Windows Server 2003 x64 Edition (KB910437)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB896424)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB900725)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB902400)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB904706)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB901017)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB899587)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB899591)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB893756)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB899588)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB901214)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB896358)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB896428)
- Windows Server 2003 Update for Windows Server 2003 x64 Edition (KB898715)

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 did the following:

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

## Power measurement procedure

To record each server’s power consumption during each test, we used an Extech Instruments (www.extech.com) 380803 Power Analyzer / Datalogger. We connected the power cord from the server under test to the Power Analyzer’s output load power outlet. We then plugged the power cord from the Power Analyzer’s input voltage connection into a power outlet.

We used the Power Analyzer’s Data Acquisition Software (version 2.11) to capture all recordings. We installed the software on a separate Intel–processor-based PC, which we connected to the Power Analyzer via an RS-232 cable. We captured power consumption at one-second intervals.

To gauge the idle power usage, we recorded the power usage for two minutes while each server was running the operating system but otherwise idle.

We then recorded the power usage (in watts) for each server during the testing at one-second intervals. To compute the average power usage, we averaged the power usage during the time the server was running the benchmark. We call this time the power measurement interval. See Figures 3 (power consumption over time) and 7 (idle and average peak power) for the results of these measurements.

## SPECjbb2005 configuration

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.) We installed SPECjbb2005 by copying the contents of the SPECjbb2005 CD to the directory C:\Documents and Setting\Administrator\SPECjbb2005v1.07 on the server’s hard disk.

SPECjbb2005 requires a Java Virtual Machine (JVM) on the system under test. We used the BEA JRockit 5.0 (P26.4.1 build P26.4.1-5-64782-1.5.0_06-20060726-0014-win-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 four. This change allows a server to run four JVM instances during testing.

We created a batch file for each system, 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 9 shows the contents of the dual-core AMD Opteron processor model 8220 SE-based server batch file.

runit-affinity-ibm.bat

File Edit Format View Help

```
@echo off
set path="C:\Program Files\Java\jrockit-jdk1.5.0_06-P26.4.1\bin";%path%

set JVM=4
:: Set JAVA_HOME to Java.exe path.
set JAVA_HOME="C:\Program Files\Java\jrockit-jdk1.5.0_06-P26.4.1\bin"

:stage1
set PROPFILE=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 C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\bin\java.exe %JAVAOPTIONS% spec.jbb.Controller -propfile %PROPFILE%
@echo off

set I=1
set J=3
echo.
echo Starting JVM Number %I% with Affinity to CPU %J%
echo.
@echo on
start /AFFINITY %J% /B C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\bin\java.exe -Xms3700m -Xmx3700m -XXaggressive -XXthroughputCompaction
-XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize128k spec.jbb.JBBmain -propfile %PROPFILE% -id %I% >
multi.%I%
@echo off

set I=2
set J=C
echo.
echo Starting JVM Number %I% with Affinity to CPU %J%
echo.
@echo on
start /AFFINITY %J% /B C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\bin\java.exe -Xms3700m -Xmx3700m -XXaggressive -XXthroughputCompaction
-XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize128k spec.jbb.JBBmain -propfile %PROPFILE% -id %I% >
multi.%I%
@echo off

set I=3
set J=30
echo.
echo Starting JVM Number %I% with Affinity to CPU %J%
echo.
@echo on
start /AFFINITY %J% /B C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\bin\java.exe -Xms3700m -Xmx3700m -XXaggressive -XXthroughputCompaction
-XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize128k spec.jbb.JBBmain -propfile %PROPFILE% -id %I% >
multi.%I%
@echo off

set I=4
set J=C0
echo.
echo Starting JVM Number %I% with Affinity to CPU %J%
echo.
@echo on
start /AFFINITY %J% /B C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\bin\java.exe -Xms3700m -Xmx3700m -XXaggressive -XXthroughputCompaction
-XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize128k spec.jbb.JBBmain -propfile %PROPFILE% -id %I% >
multi.%I%
@echo off

:END

:egress
```

**Figure 9: The text of the batch file we used to execute the SPECjbb2005 benchmark on the dual-core AMD Opteron processor model 8220 SE-based server.**

Due to differences in the number of available execution units in the systems, we had to use a different batch file for each server to set processor affinity. Setting processor affinity maps an active process to an assigned execution unit. The dual-core AMD Opteron processor model 8220 SE-based server has 4 physical processors with 2 cores per processor, or 8 total execution units. The Dual-Core Intel Xeon processor 7140M-based server has 4 physical processors with 2 cores per processor and Hyper-Threading Technology (HT Technology) in each core, or 16 available execution units. Figure 10 shows the contents of the Dual-Core Intel Xeon processor 7140M-based server batch file.

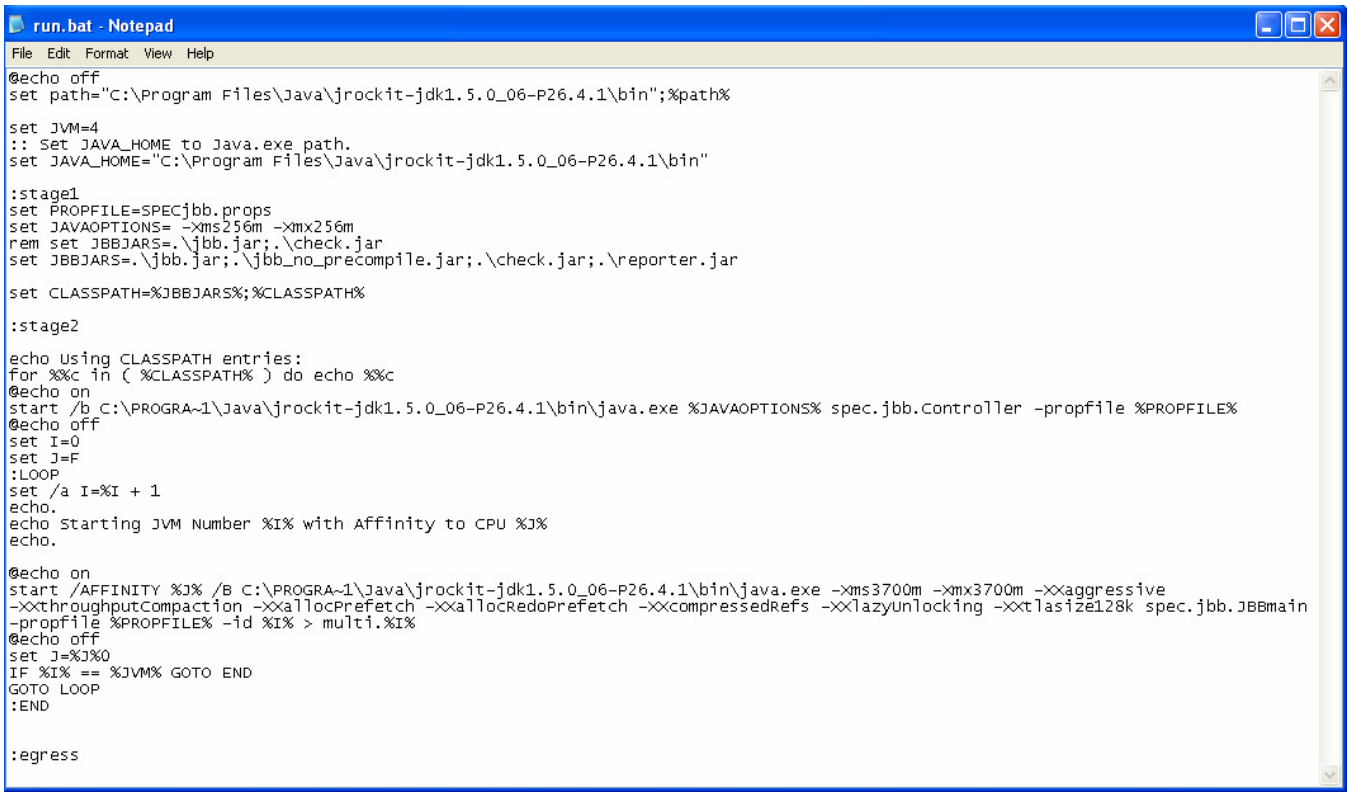



**Figure 10: The text of the batch file we used to execute the SPECjbb2005 benchmark on the Dual-Core Intel Xeon processor 7140M-based server.**

In both batch files we set the same Java options to control the performance of the JVM. Intel specified the following Java option settings:

- *-Xms3700m* 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 3700MB.
- *-Xmx3700m* This option sets the maximum heap size.
- *-XXaggressive* This option basically tells the JVM to perform at maximum speed.
- *-XXthroughputCompaction* This option adjusts the compaction ratio dynamically based on live data in the heap.
- *-XXallocPrefetch* This option tells the JVM to prefetch a chunk of data when it uses a related, earlier bit of data.
- *-XXallocRedoPrefetch* This option also affects JVM prefetch behavior.
- *-XXcompressedRefs* This option turns on compressed references.
- *-XXlazyUnlocking* This option affects when the JVM releases locks.
- *-XXtlasize128k* This option sets the thread-local area size the JVM uses.

# Appendix A – Test server configuration information

This appendix provides detailed configuration information about each of the test server systems, which we list in alphabetical order.

| System | Dual-core AMD Opteron processor model 8220 SE-based server | Dual-Core Intel Xeon processor 7140M-based server |
|---|---|---|
| **System configuration information** | | |
| **General** | | |
| Processor and OS kernel: (physical, core, logical) | 4P8C8L | 4P8C16L |
| Number of physical processors | 4 | 4 |
| Single/Dual-Core processors | Dual | Dual |
| System Power Management Policy | Always On | Always On |
| **CPU** | | |
| Vendor | AMD | Intel |
| Name | dual-core AMD Opteron processor model 8220 SE | Dual-Core Intel Xeon processor 7140M |
| Stepping | 2 | 8 |
| Socket type | F | LGA 771 |
| Core frequency (GHz) | 2.8 GHz | 3.4 GHz |
| Front-side bus frequency (MHz) | 2000 MHz HyperTransport Technology | 800 MHz |
| L1 Cache | 64 KB + 64 KB (per core) | 12 KB + 16 KB (per core) |
| L2 Cache | 1 MB (per core) | 1 MB (per core) |
| L3 Cache | None | 16MB |
| **Platform** | | |
| Vendor and model number | Dual-core AMD Opteron processor model 8220 SE-based server | Dual-Core Intel Xeon processor 7140M-based server |
| Motherboard model number | IBM Server System x3755 | Intel SR4850HW4x Server |
| Motherboard chipset | IBM HT1000 Legacy / AMD | Intel E8501 Chipset |
| Motherboard revision number | 1.01 | 11 |
| Motherboard serial number | 11S42C9489YK10A469C05Z | QSHM61700171 |
| BIOS name and version | IBM ZYE123AUS-1.01, 08/15/2006 | Intel Corporation SHW40.86B.P.09.00.0060, 07/06/2006 |
| BIOS settings | Default | Default |
| Chipset INF driver | NA | Microsoft Version 5.2.3790.1830 |
| **Memory module(s)** | | |
| Vendor and model number | Samsung M393T5166AZA-CE6 | Samsung M393T5166AZA-CE6 |
| Type | PC2-5300 | PC2-5300 |
| Speed (MHz) | 667 | 667 |
| Speed in the system currently running @ (MHz) | 667 | 400 |
| Timing/Latency (tCL-tRCD-tRP-tRASmin) | 5-5-5-13 | 3-3-3-8 |
| Size | 32768 MB | 32768 MB |
| Number of RAM modules | 8 | 8 |
| Chip organization | Double-sided | Double-sided |
| **Hard disk** | | |

| | | |
|---|---|---|
| Vendor and model number | Maxtor 8J073S0 | Seagate ST3146854LC |
| Number of disks in system | 1 | 1 |
| Size | 73.5 GB | 146.8 GB |
| Buffer Size | 16 MB | 8 MB |
| RPM | 10,000 | 15,000 |
| Type | SAS | SCSI |
| Controller | IBM ServeRAID 8k/8k-l SCSI | LSI Logic PCI-X Ultra320 SCSI |
| Controller Driver | Adaptec 5.1.0.9206 | Microsoft 5.2.3790.1830 (LSI Logic) |
| **Operating system** | | |
| Name | Microsoft Windows Server 2003 R2 Enterprise x64 Edition | Microsoft Windows Server 2003 R2 Enterprise x64 Edition |
| Build number | 3790 | 3790 |
| Service Pack | SP1 | SP1 |
| Microsoft Windows update date | 12/28/2006 | 12/28/2006 |
| File system | NTFS | NTFS |
| Kernel | ACPI Multiprocessor x64-based PC | ACPI Multiprocessor x64-based PC |
| Language | English | English |
| Microsoft DirectX version | DirectX 9.0c | DirectX 9.0c |
| **Graphics** | | |
| Vendor and model number | ATI ES1000 | ATI Radeon 7000 |
| Chipset | ATI ES1000 | ATI Radeon 7000 PCI |
| BIOS version | BK-ATI VER008.005.028.000 | BK-ATI VER008.004.037.001 |
| Type | Integrated | Integrated |
| Memory size | 16 MB | 16 MB |
| Resolution | 1024 x 768 | 1024 x 768 |
| Driver | ATI 8.19.4.0 | ATI 6.14.10.6508 |
| **Network card/subsystem** | | |
| Vendor and model number | Broadcom dual BCM5708C NetXtreme GigE | Broadcom dual NetXtreme Gigabit |
| Type | Integrated | Integrated |
| Driver | Broadcom 2.6.14.0 | Microsoft 7.98.0.0 |
| **Optical drive** | | |
| Vendor and model number | Matshita UJDA770 | Philips SDR089 |
| Type | DVD-ROM / CD-RW | DVD-ROM |
| Interface | IDE | Internal |
| **USB ports** | | |
| Number | 3 (2 front. 1 back) | 5 (3 front, 2 back) |
| Type | USB 2.0 | USB 2.0 |
| **Power-supply** | | |
| Number of power supplies | 2 x Delta Electronics DPS-1400AB A | 2 x LITEON PS-2142-1D1 |
| Rating of each | 1400 W | 1470 W |
| Number of case fans | 6 | 4 |

**Figure 11: Detailed configuration information for the test servers.**

# Appendix B – SPECjbb2005 output

This appendix provides the output of the benchmark for each of the test servers.

### Dual-core AMD Opteron processor model 8220 SE-based server

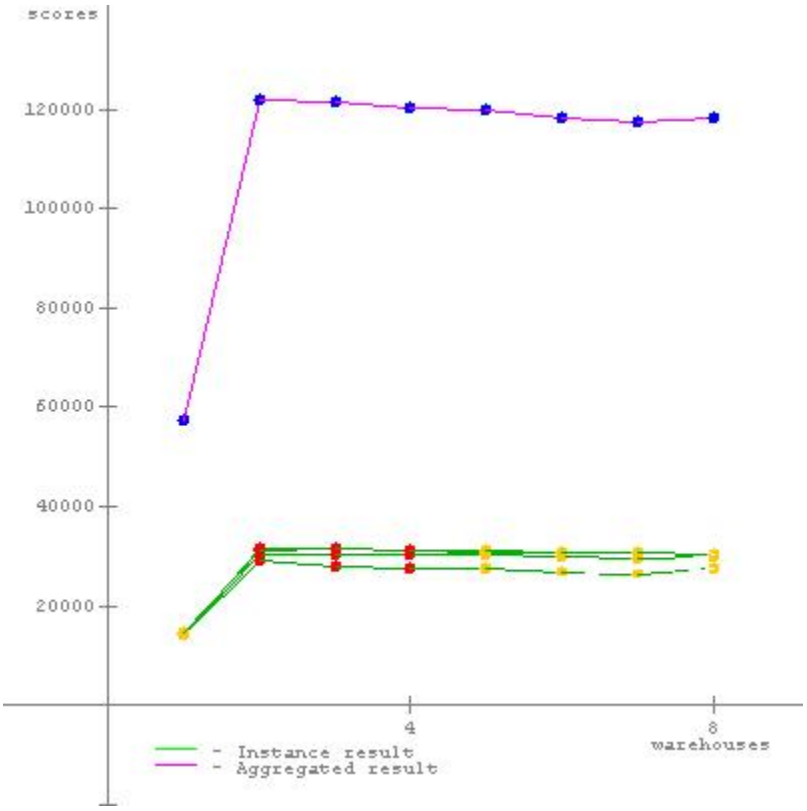
SPECjbb2005

**SPECjbb2005 bops = 121291, SPECjbb2005 bops/JVM = 30323**

IBM x3755 Server

BEA JRockit(R) 5.0 P26.4.1 (build P26.4.1-5-64782-1.5.0_06-20060726-0014-win-x86_64,)

| JVM run | JVM Scores |
|---|---|
| 1 | 28145 |
| 2 | 30363 |
| 3 | 31470 |
| 4 | 31313 |
| **SPECjbb2005 bops = 121291, SPECjbb2005 bops/JVM = 30323** | |




| Hardware | |
|---|---|
| **Hardware Vendor** | IBM |
| **Vendor URL** | http://www.ibm.com |
| **Model** | IBM x3755 Server |
| **Processor** | dual-core AMD Opteron processor model 8220 SE |
| **MHz** | 2800 |
| **# of Chips** | 4 |
| **# of Cores** | 8 |
| **# of Cores/Chip** | 2 |

| Software | |
|---|---|
| **Software Vendor** | BEA |
| **Vendor URL** | http://www.bea.com |
| **JVM Version** | JRockit(R) 5.0 P26.4.1 (build P26.4.1-5-64782-1.5.0_06-20060726-0014-win-x86_64,) |
| **JVM Command Line** | start /AFFINITY %J% /B java -Xms3700m -Xmx3700m -XXaggressive -XXthroughputCompaction -XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize128k spec.jbb.JBBmain -propfile SPECjbb.props |

| | |
|---|---|
| **HW Threading Enabled?** | No |
| **Procs Avail to Java** | 8 |
| **Memory (MB)** | 32768 |
| **Memory Details** | 8 x 4GB DDR2-5300 |
| **Primary cache** | 64 KB+64 KB |
| **Secondary cache** | 1 MB |
| **Other cache** | |
| **Filesystem** | NTFS |
| **Disks** | 1 x 73.5GB SAS 10krpm |
| **Other hardware** | none |

| | |
|---|---|
| **JVM Initial Heap Memory (MB)** | 3700 |
| **JVM Maximum Heap Memory (MB)** | 3700 |
| **JVM Address bits** | 64 |
| **JVM CLASSPATH** | .\jbb.jar;<br>.\jbb_no_precompile.jar;<br>.\check.jar;<br>.\reporter.jar; |
| **JVM BOOTCLASSPATH** | C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\bin\jrockit\jrockit.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\bin\jrockit\managementapi.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\managementapi.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\rt.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\i18n.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\sunrsasign.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\jsse.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\jce.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\charsets.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\classes |
| **OS Version** | Microsoft Server 2003 R2 Enterprise x64 Edition, Service Pack 1 |
| **Other software** | None |

| **Test Information** | |
|---|---|
| **Tested by** | Principled Technologies, Inc. |
| **SPEC license #** | 3184 |
| **Test location** | Durham, NC |
| **Test date** | Jan 2, 2007 |
| **H/w available** | Aug-2006 |
| **JVM available** | Nov-2006 |
| **OS available** | Dec-2005 |
| **Other s/w available** | none |

| **AOT Compilation** |
|---|
| |

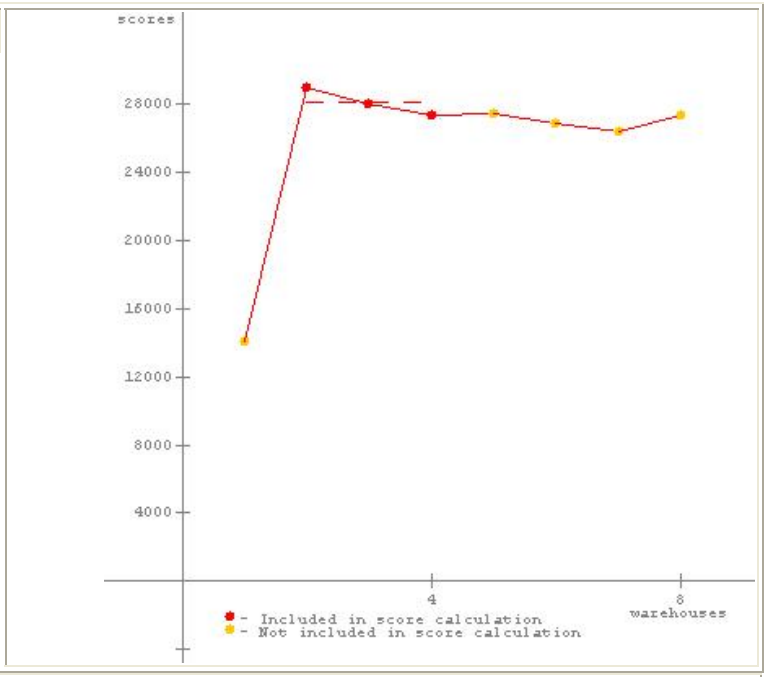
| **Tuning** |
|---|
| "lock pages in memory" was enabled for the user running the benchmark. Each JVM instance was bound to a single CPU node |

| **Notes** |
|---|
| |

# JVM 1 Scores:

## No errors. Valid run.

| Warehouses | SPECjbb2005 bops | Incl. in metric |
|---|---|---|
| 1 | 14076 | |
| 2 | 29011 | * |
| 3 | 28038 | * |
| 4 | 27386 | * |
| 5 | 27433 | |
| 6 | 26901 | |
| 7 | 26367 | |
| 8 | 27386 | |
| **SPECjbb2005** | **(from 2 to 4)** | **28145 SPECjbb2005 bops** |

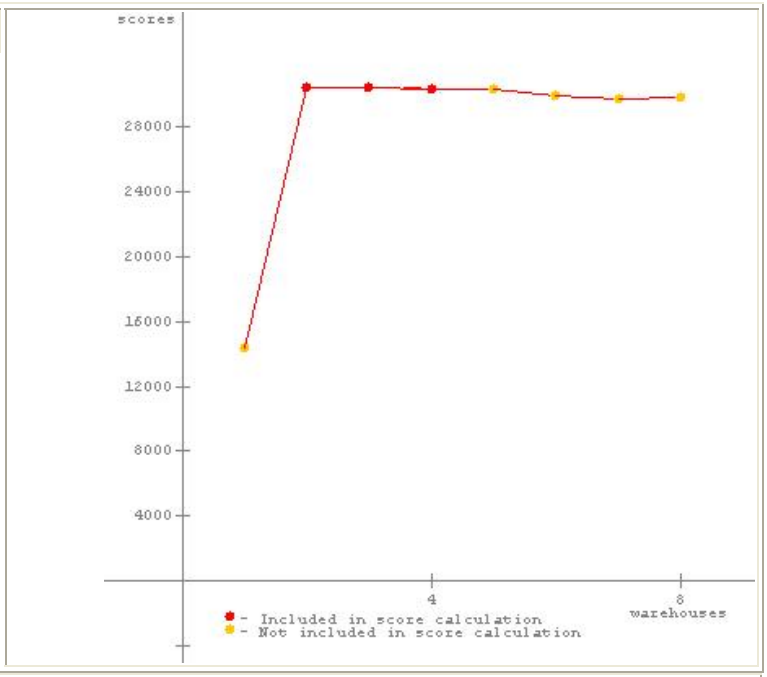



| SPEC license # 3184 | Tested by: Principled Technologies, Inc. | Test date: Jan 2, 2007 |
|---|---|---|

# JVM 2 Scores:

## No errors. Valid run.

| Warehouses | SPECjbb2005 bops | Incl. in metric |
|---|---|---|
| 1 | 14341 | |
| 2 | 30358 | * |
| 3 | 30432 | * |
| 4 | 30300 | * |
| 5 | 30261 | |
| 6 | 29909 | |
| 7 | 29676 | |
| 8 | 29779 | |
| **SPECjbb2005** | **(from 2 to 4)** | **30363 SPECjbb2005 bops** |

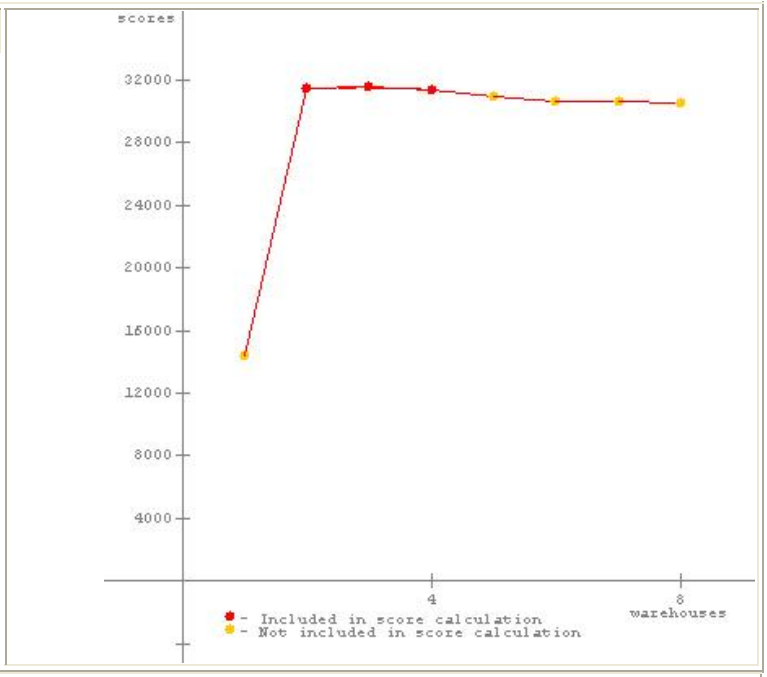



| SPEC license # 3184 | Tested by: Principled Technologies, Inc. | Test date: Jan 2, 2007 |
|---|---|---|

## JVM 3 Scores:

## No errors. Valid run.

| Warehouses | SPECjbb2005 bops | Incl. in metric |
|---|---|---|
| 1 | 14418 | |
| 2 | 31486 | * |
| 3 | 31604 | * |
| 4 | 31319 | * |
| 5 | 30934 | |
| 6 | 30670 | |
| 7 | 30606 | |
| 8 | 30497 | |
| **SPECjbb2005** | **(from 2 to 4)** | **31470 SPECjbb2005 bops** |

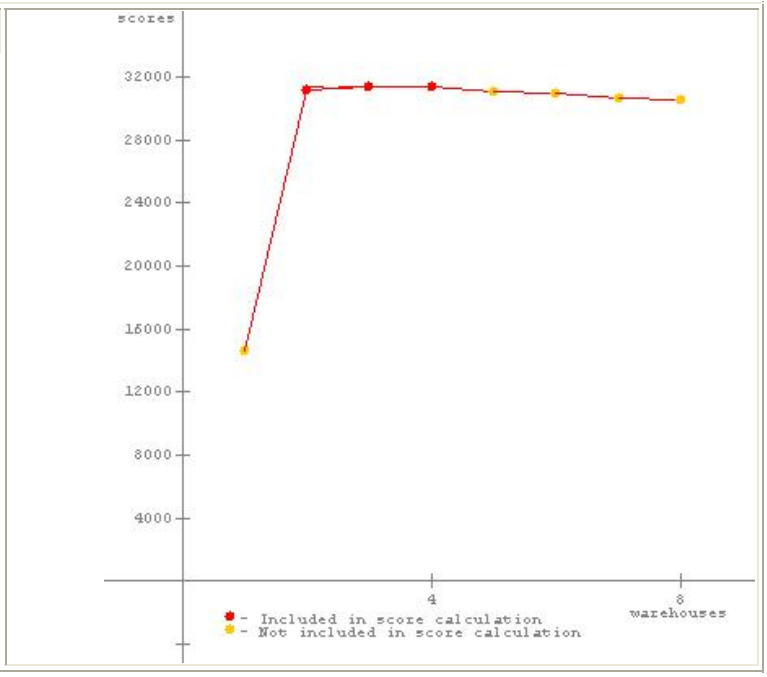



**SPEC license #** 3184 | **Tested by:** Principled Technologies, Inc. | **Test date:** Jan 2, 2007

## JVM 4 Scores:

## No errors. Valid run.

| Warehouses | SPECjbb2005 bops | Incl. in metric |
|---|---|---|
| 1 | 14617 | |
| 2 | 31162 | * |
| 3 | 31407 | * |
| 4 | 31370 | * |
| 5 | 31046 | |
| 6 | 30947 | |
| 7 | 30651 | |
| 8 | 30568 | |
| **SPECjbb2005** | **(from 2 to 4)** | **31313 SPECjbb2005 bops** |



| SPEC license # 3184 | Tested by: Principled Technologies, Inc. | Test date: Jan 2, 2007 |
|---|---|---|

SPECjbb2005 Version: [SPECjbb2005 1.07, March 15, 2006]
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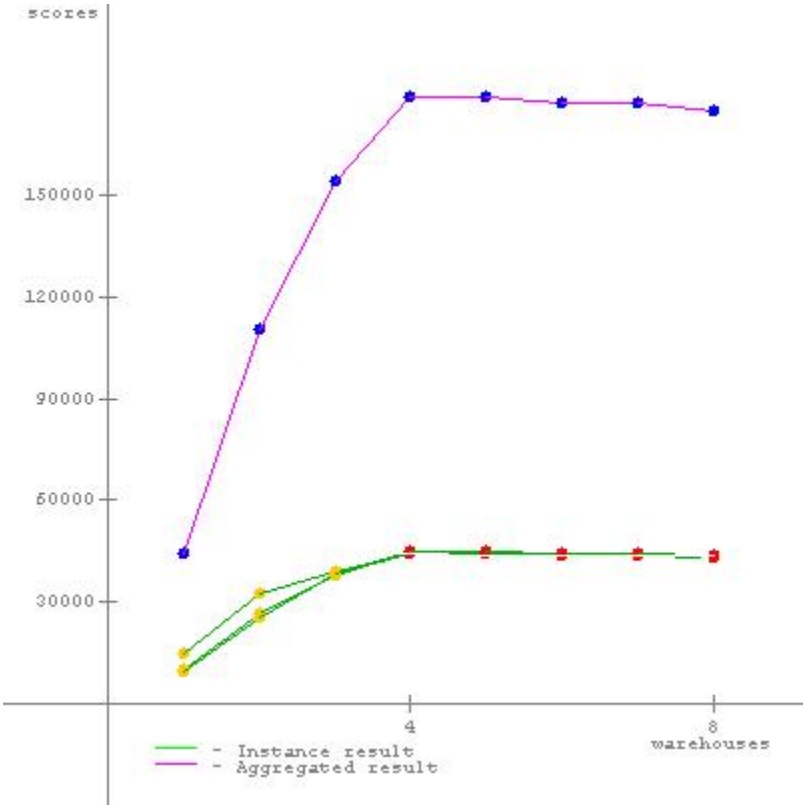
**Dual-Core Intel Xeon processor 7140M-based server**

# SPECjbb2005

## SPECjbb2005 bops = 177037, SPECjbb2005 bops/JVM = 44259

Intel Intel SR4850HW4x Server

BEA JRockit(R) 5.0 P26.4.1 (build P26.4.1-5-64782-1.5.0_06-20060726-0014-win-x86_64,)




| JVM run | JVM Scores |
|---|---|
| 1 | 44024 |
| 2 | 44336 |
| 3 | 44385 |
| 4 | 44292 |
| **SPECjbb2005 bops = 177037, SPECjbb2005 bops/JVM = 44259** | |

| Hardware | |
|---|---|
| **Hardware Vendor** | Intel |
| **Vendor URL** | http://www.intel.com |
| **Model** | Intel SR4850HW4x Server |
| **Processor** | Dual-Core Intel Xeon processor 7140M |
| **MHz** | 3400 |
| **# of Chips** | 4 |

| Software | |
|---|---|
| **Software Vendor** | BEA |
| **Vendor URL** | http://www.bea.com |
| **JVM Version** | JRockit(R) 5.0 P26.4.1 (build P26.4.1-5-64782-1.5.0_06-20060726-0014-win-x86_64,) |
| **JVM Command Line** | start /AFFINITY %J% /B java -Xms3700m -Xmx3700m -XXaggressive -XXthroughputCompaction -XXallocPrefetch -XXallocRedoPrefetch - |

| | |
|---|---|
| **# of Cores** | 8 |
| **# of Cores/Chip** | 2 |
| **HW Threading Enabled?** | Yes |
| **Procs Avail to Java** | 16 |
| **Memory (MB)** | 32768 |
| **Memory Details** | 8 x 4GB DDR2-5300 |
| **Primary cache** | 12 KB+16 KB |
| **Secondary cache** | 1 MB |
| **Other cache** | 16 MB |
| **Filesystem** | NTFS |
| **Disks** | 1 x 146.8GB SCSI 15krpm |
| **Other hardware** | none |

| | |
|---|---|
| | XXcompressedRefs -XXlazyUnlocking -XXtlasize128k spec.jbb.JBBmain -propfile SPECjbb.props |
| **JVM Initial Heap Memory (MB)** | 3700 |
| **JVM Maximum Heap Memory (MB)** | 3700 |
| **JVM Address bits** | 64 |
| **JVM CLASSPATH** | .\jbb.jar;<br>.\jbb_no_precompile.jar;<br>.\check.jar;<br>.\reporter.jar; |
| **JVM BOOTCLASSPATH** | C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\bin\jrockit\jrockit.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\bin\jrockit\managementapi.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\managementapi.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\rt.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\i18n.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\sunrsasign.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\jsse.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\jce.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\lib\charsets.jar;<br>C:\PROGRA~1\Java\jrockit-jdk1.5.0_06-P26.4.1\jre\classes |
| **OS Version** | Microsoft Server 2003 R2 Enterprise x64 Edition, Service Pack 1 |
| **Other software** | None |

| **Test Information** | |
|---|---|
| **Tested by** | Principled Technologies, Inc. |
| **SPEC license #** | 3184 |
| **Test location** | Durham, NC |
| **Test date** | Jan 3, 2007 |
| **H/w available** | Aug-2006 |
| **JVM available** | Nov-2006 |
| **OS available** | Dec-2005 |
| **Other s/w available** | none |

| **AOT Compilation** |
|---|
| |

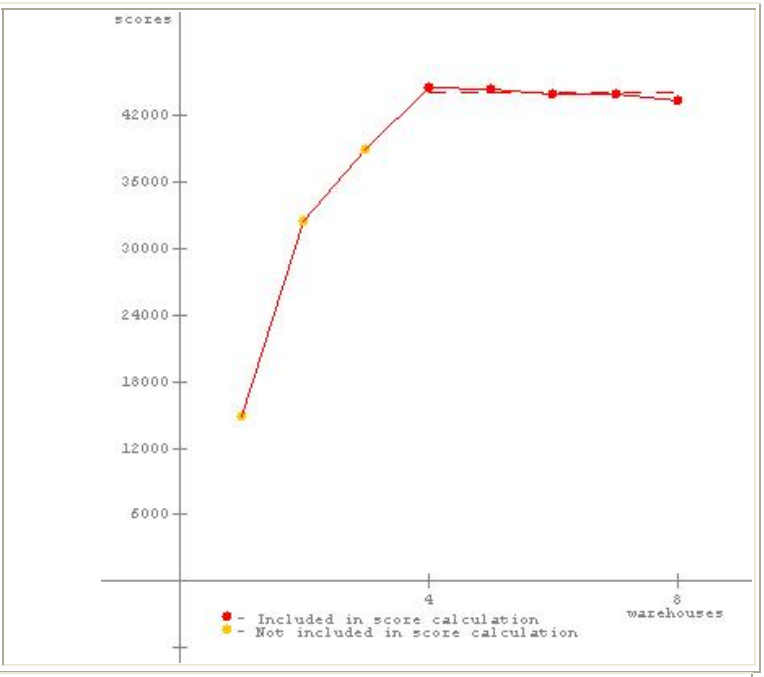
| **Tuning** |
|---|
| "lock pages in memory" was enabled for the user running the benchmark. Each JVM instance was bound to a single CPU node |

| **Notes** |
|---|
| Disabled Adjacent Cache Line Prefetch and HW Prefetcher |

## JVM 1 Scores:

## No errors. Valid run.

| Warehouses | SPECjbb2005 bops | Incl. in metric |
|---|---|---|
| 1 | 14923 | |
| 2 | 32417 | |
| 3 | 38849 | |
| 4 | 44546 | * |
| 5 | 44375 | * |
| 6 | 43902 | * |
| 7 | 43936 | * |
| 8 | 43363 | * |
| **SPECjbb2005** | **(from 4 to 8)** | **44024 SPECjbb2005 bops** |

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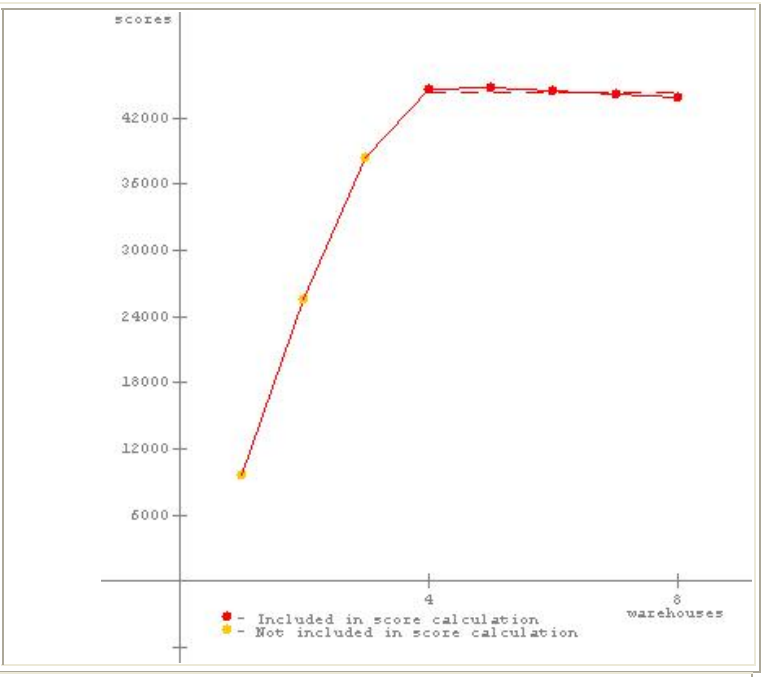
## JVM 2 Scores:

## No errors. Valid run.

| Warehouses | SPECjbb2005 bops | Incl. in metric |
|---|---|---|
| 1 | 9596 | |
| 2 | 25553 | |
| 3 | 38428 | |
| 4 | 44641 | * |
| 5 | 44792 | * |
| 6 | 44365 | * |
| 7 | 44108 | * |
| 8 | 43772 | * |
| **SPECjbb2005** | **(from 4 to 8)** | **44336 SPECjbb2005 bops** |

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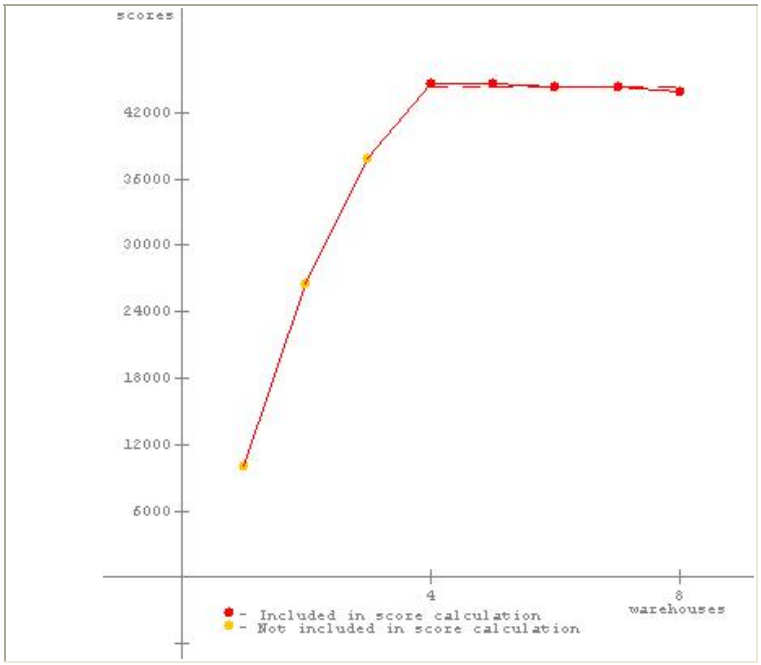
# JVM 3 Scores:

## No errors. Valid run.

| Warehouses | SPECjbb2005 bops | Incl. in metric |
|---|---|---|
| 1 | 10006 | |
| 2 | 26577 | |
| 3 | 37908 | |
| 4 | 44691 | * |
| 5 | 44663 | * |
| 6 | 44342 | * |
| 7 | 44370 | * |
| 8 | 43860 | * |
| **SPECjbb2005** | **(from 4 to 8)** | **44385 SPECjbb2005 bops** |

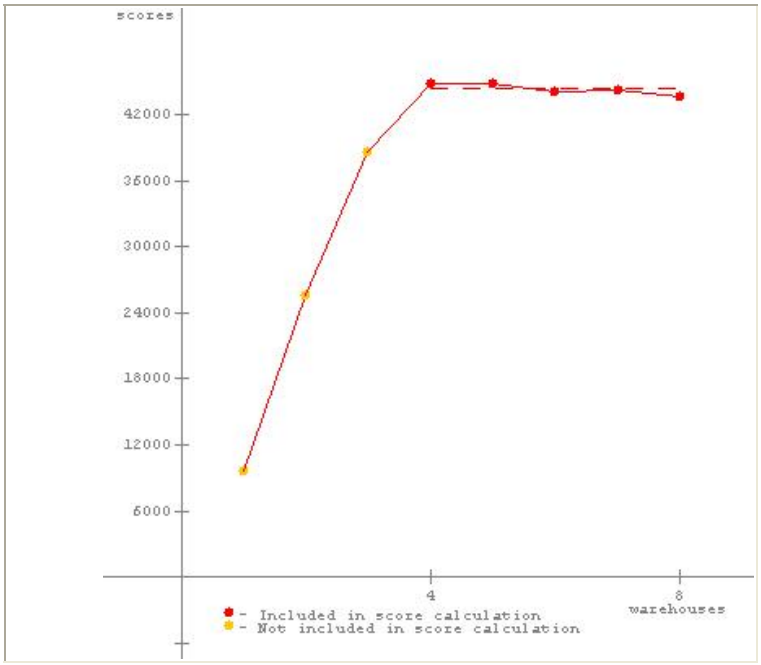



| | | |
|---|---|---|
| **SPEC license #** 3184 | **Tested by:** Principled Technologies, Inc. | **Test date:** Jan 3, 2007 |

# JVM 4 Scores:

## No errors. Valid run.

| Warehouses | SPECjbb2005 bops | Incl. in metric |
|---|---|---|
| 1 | 9664 | |
| 2 | 25582 | |
| 3 | 38536 | |
| 4 | 44747 | * |
| 5 | 44850 | * |
| 6 | 44051 | * |
| 7 | 44179 | * |
| 8 | 43634 | * |
| **SPECjbb2005** | **(from 4 to 8)** | **44292 SPECjbb2005 bops** |




| | | |
|---|---|---|
| **SPEC license #** 3184 | **Tested by:** Principled Technologies, Inc. | **Test date:** Jan 3, 2007 |

SPECjbb2005 Version: [SPECjbb2005 1.07, March 15, 2006]
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