



SPECjbb2005 performance and power consumption on Intel Xeon 51xx processor-based servers

Executive summary

Intel Corporation (Intel) commissioned Principled Technologies (PT) to measure the SPECjbb2005 performance of dual-processor servers using the following four processors:

- Dual-Core Intel Xeon processor 5110
- Dual-Core Intel Xeon processor 5130
- Dual-Core Intel Xeon processor 5150
- Dual-Core Intel Xeon processor 5160

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 utilizes 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

KEY FINDINGS

- The Dual-Core Intel Xeon processor 5160-based server delivered 55 percent higher peak performance than the Dual-Core Intel Xeon processor 5110-based server (see Figure 1).
- The Dual-Core Intel Xeon processor 5160-based server delivered almost 10 percent more performance/watt than the Dual-Core Intel Xeon processor 5110-based server (see Figure 2). (We calculated performance/watt using system-level power measurements.)

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.)

In this section, we discuss the best results for each server. For complete details of the performance of each server with varying thread counts, see the "Test results" section.

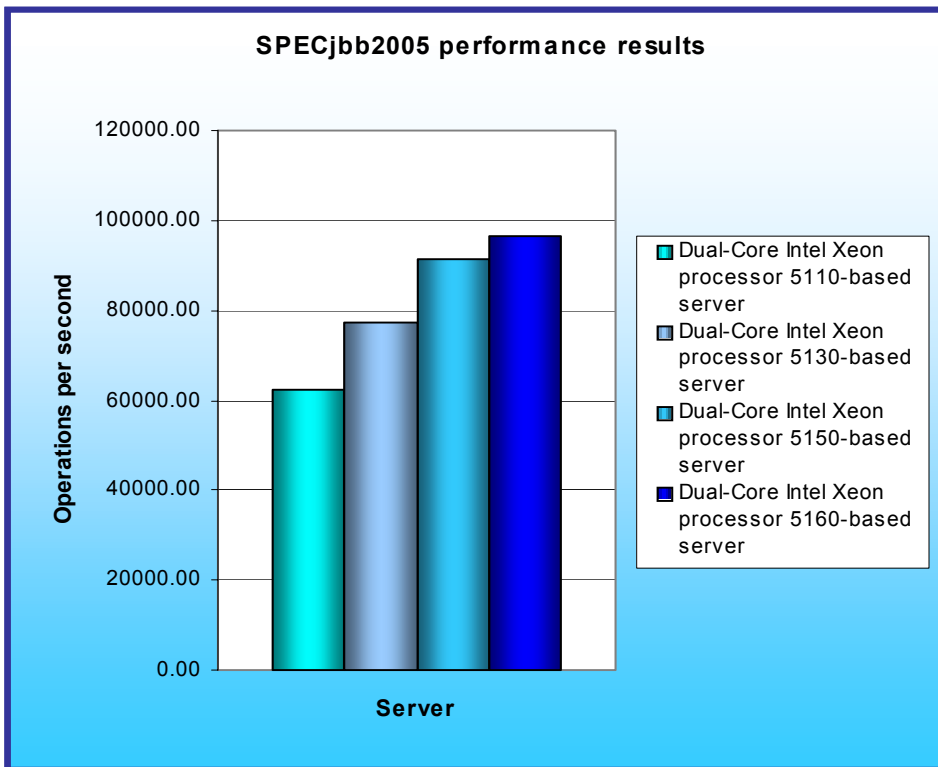


Figure 1: SPECjbb2005 business operations per second (dual-processor) results for the test servers. Higher numbers of operations per second are better.

Figure 1 shows the SPECjbb2005 results, in bops, of the four 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 5160-based server produced the highest result: 96,494 bops. The Dual-Core Intel Xeon processor 5150-based server achieved 91,315, while the Dual-Core Intel Xeon processor 5130-based server produced a score of 77,233 bops. The Dual-Core Intel Xeon processor 5110-based server produced a score of 62,174 bops. The Dual-Core Intel Xeon processor 5160-based server thus delivered a 55.2 percent performance increase over the Dual-Core Intel Xeon processor 5110-based server and a 24.9 percent increase over the Dual-Core Intel Xeon processor 5130-based server. The Dual-Core Intel Xeon processor 5160-based server produced 5.7 percent performance increase over the Dual-Core Intel Xeon processor 5150-based server.

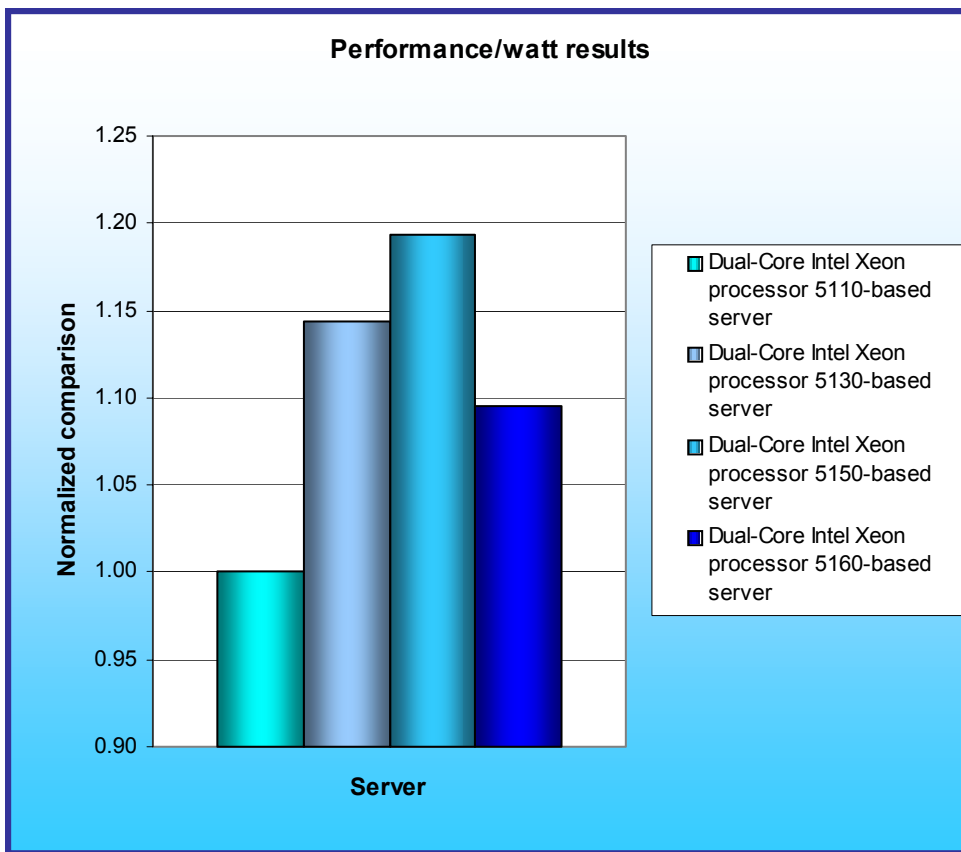


Figure 2 illustrates the performance/watt for each of the four servers. In this chart, we normalized the results for each system to the lowest performance/watt configuration. The lowest system’s performance/watt result is thus always 1.00. By normalizing, we make each data point in these charts a comparative 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: Performance/watt (dual-processor) results of the test servers running SPECjbb2005. Higher numbers indicate better performance/watt.

As Figure 2 illustrates, the Dual-Core Intel Xeon processor 5160-based server delivered over 9 percent more performance/watt than the Dual-Core Intel Xeon processor 5110-based server.

Figure 3 shows a plot of the power usage of the four 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.

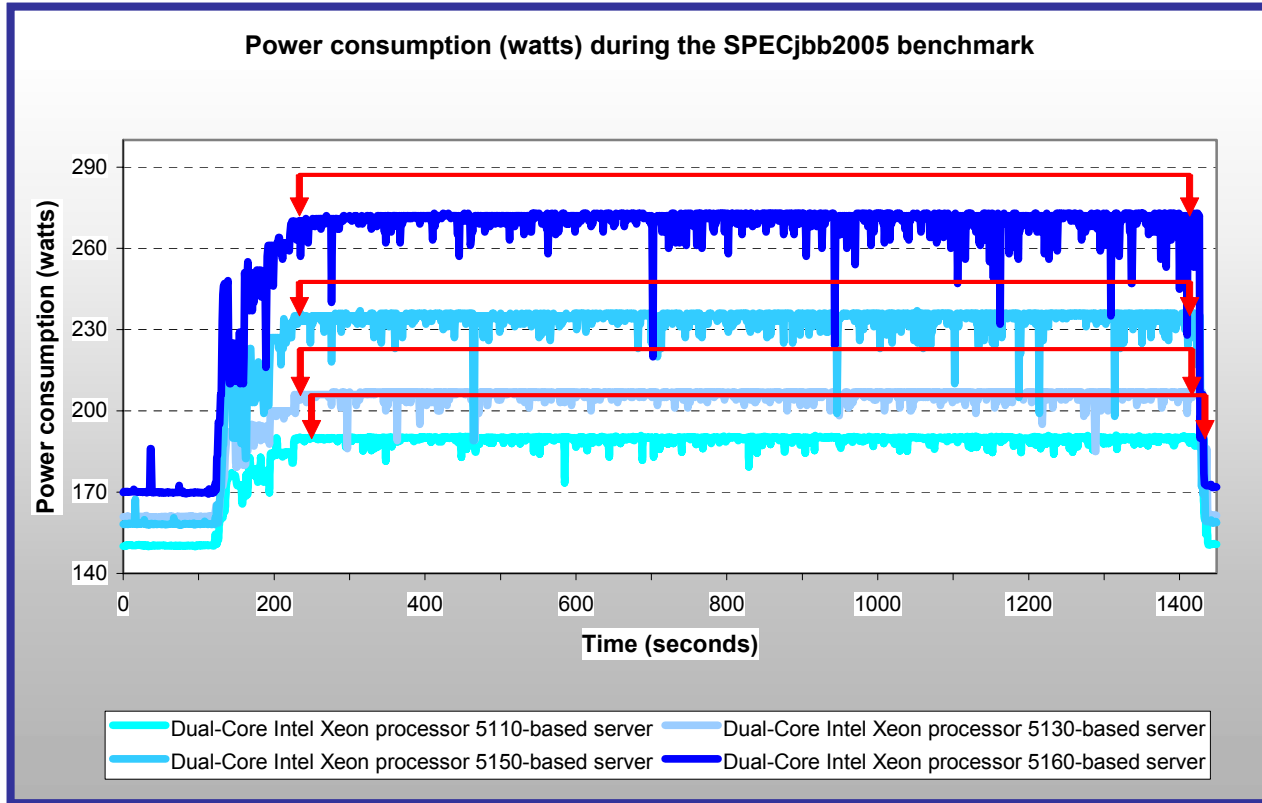


Figure 3: Power consumption (in watts) of each of the servers throughout the course of executing the SPECjbb2005 benchmark. Lower power consumption is better.

Test results

Figure 4 shows the median SPECjbb2005 results for all four servers. SPECjbb2005 computes its score 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 SPEC required files. We do present here all the data necessary to reproduce these results.)

Operations per second				
Warehouse	Dual-Core Intel Xeon processor 5110-based server	Dual-Core Intel Xeon processor 5130-based server	Dual-Core Intel Xeon processor 5150-based server	Dual-Core Intel Xeon processor 5160-based server
1	15401	19417	24806	26701
2	34609	42599	51794	56513
3	49983	61597	74405	79017
4	63018	78017	93227	98110
5	62395	78446	92653	98743
6	62610	77324	91301	97383
7	61636	76673	90419	94631
8	61210	75704	88971	93605
Score	62174	77233	91315	96494

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

Figure 5 shows the results by warehouse for the Dual-Core Intel Xeon processor 5110-based server for all three runs. Run 3 produced the median results.

Dual-Core Intel Xeon processor 5110-based server			
Warehouse	Run 1	Run 2	Run 3
1	14894	14594	15401
2	33621	34110	34609
3	49932	50292	49983
4	62721	63965	63018
5	62400	64324	62395
6	62234	63789	62610
7	60832	62591	61636
8	59775	62039	61210
Score	61593	63342	62174

Figure 5: SPECjbb2005 results for the Dual-Core Intel Xeon processor 5110-based server. Higher numbers are better.

Figure 6 shows the results by warehouse for the Dual-Core Intel Xeon processor 5130-based server for all three runs. Run 1 produced the median results.

Dual-Core Intel Xeon processor 5130-based server			
Warehouse	Run 1	Run 2	Run 3
1	19417	19020	18969
2	42599	42456	43526
3	61597	61408	62439
4	78017	77131	78174
5	78446	78186	78515
6	77324	75414	77898
7	76673	75080	76569
8	75704	73542	75330
Score	77233	75870	77297

Figure 6: SPECjbb2005 results for the Dual-Core Intel Xeon processor 5130-based server. Higher numbers are better.

Figure 7 shows the results by warehouse for the Dual-Core Intel Xeon processor 5150-based server for all three runs. Run 3 produced the median results.

Dual-Core Intel Xeon processor 5150-based server			
Warehouse	Run 1	Run 2	Run 3
1	23481	24932	24806
2	51140	51569	51794
3	74334	74812	74405
4	92035	93921	93227
5	91848	93582	92653
6	90985	92002	91301
7	89717	90836	90419
8	88657	89992	88971
Score	90649	92067	91315

Figure 7: SPECjbb2005 results for the Dual-Core Intel Xeon processor 5150-based server. Higher numbers are better.

Figure 8 shows the results by warehouse for the Dual-Core Intel Xeon processor 5160-based server for all three runs. Run 3 produced the median results.

Dual-Core Intel Xeon processor 5160-based server			
Warehouse	Run 1	Run 2	Run 3
1	25893	26249	26701
2	55397	54467	56513
3	79840	79680	79017
4	99904	98349	98110
5	98722	98108	98743
6	97770	96730	97383
7	95963	95463	94631
8	94672	93493	93605
Score	97406	96429	96494

Figure 8: SPECjbb2005 results for the Dual-Core Intel Xeon processor 5160-based server. Higher numbers are better.

Figure 9 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 Intel Xeon processor 5110-based server	150.3	188.4
Dual-Core Intel Xeon processor 5130-based server	160.9	204.7
Dual-Core Intel Xeon processor 5150-based server	158.3	231.9
Dual-Core Intel Xeon processor 5160-based server	170.3	266.9

Figure 9: Average power usage (in watts) of the test servers during the median peak runs of SPECjbb2005. Lower numbers are better.

Test methodology

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 Server 2003 x64 Edition (KB921398)
- Windows Server 2003 Security Update for Outlook Express for Windows Server 2003 x64 Edition (KB920214)
- 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 Cumulative Security Update for Internet Explorer for Windows Server 2003 x64 Edition (KB918899)
- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB921883)

- Windows Server 2003 Security Update for Windows Server 2003 x64 Edition (KB917159)
- 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 Cumulative Security Update for Outlook Express for Windows Server 2003 x64 Edition (KB911567)
- 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 (KB890046)
- 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 producing its peak performance results. We call this time the power measurement interval. See Figures 3 (power consumption over time) and 8 (idle and average peak power) for the results of these measurements.

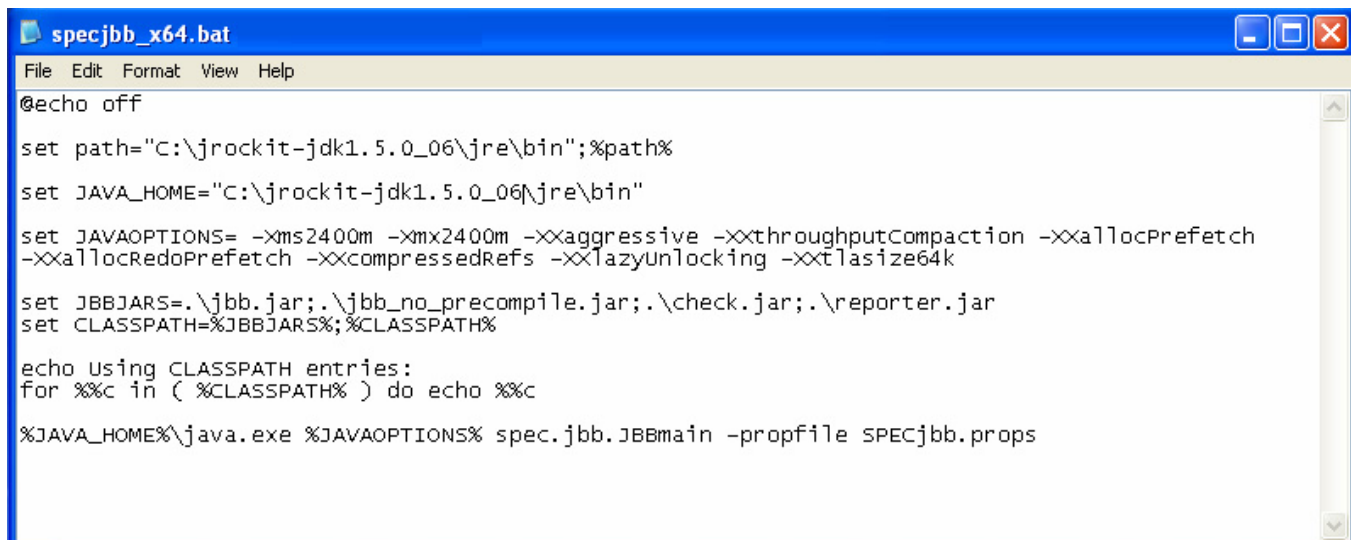
SPECjbb2005 configuration

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 Settings\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 (P26.4.0-10-62459-1.5.0_06-20060529-2101-win-x86_64 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 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 10 shows the contents of this file.



```
@echo off

set path="C:\jrockit-jdk1.5.0_06\jre\bin";%path%
set JAVA_HOME="C:\jrockit-jdk1.5.0_06\jre\bin"

set JAVA_OPTIONS=-Xms2400m -Xmx2400m -XXaggressive -XXthroughputCompaction -XXallocPrefetch
-XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlsize64k

set JBBJARS=.\jbb.jar;.\jbb_no_precompile.jar;.\check.jar;.\reporter.jar
set CLASSPATH=%JBBJARS%;%CLASSPATH%

echo Using CLASSPATH entries:
for %%c in ( %CLASSPATH% ) do echo %%c

%JAVA_HOME%\java.exe %JAVA_OPTIONS% spec.jbb.JBBmain -propfile SPECjbb.props
```

Figure 10: The text of the batch file we used to execute the SPECjbb2005 benchmark on all servers.

In the batch file we used the “set JAVA_OPTIONS” command to set the Java options that control the performance of the JVM. Intel specified the following Java option settings:

- *-Xms2400m* 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 2400MB.
- *-Xmx2400m* 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.
- *-XXtlasize64k* 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 four test server systems, which we list in alphabetical order.

Processors	Dual-Core Intel Xeon processor 5110-based server	Dual-Core Intel Xeon processor 5130-based server	Dual-Core Intel Xeon processor 5150-based server	Dual-Core Intel Xeon processor 5160-based server
System configuration information				
General				
Processor and OS kernel: (physical, core, logical) / (UP, MP)	2P4C4L/ MP	2P4C4L/ MP	2P4C4L/ MP	2P4C4L/ MP
Number of physical processors	2	2	2	2
Single/Dual-Core processors	Dual	Dual	Dual	Dual
System Power Management Policy	Always On	Always On	Always On	Always On
CPU				
Vendor	Intel	Intel	Intel	Intel
Name	Dual-Core Intel Xeon processor 5110	Dual-Core Intel Xeon processor 5130	Dual-Core Intel Xeon processor 5150	Dual-Core Intel Xeon processor 5160
Stepping	6	6	6	6
Socket type	LGA 771	LGA 771	LGA 771	LGA 771
Core frequency (GHz)	1.60 GHz	2.00 GHz	2.67 GHz	3.00 GHz
Front-side bus frequency (MHz)	1066MHz Dual Independent Busses (DIB)	1333MHz Dual Independent Busses (DIB)	1333MHz Dual Independent Busses (DIB)	1333MHz Dual Independent Busses (DIB)
L1 Cache	32 KB +32 KB	32 KB +32 KB	32 KB +32 KB	32 KB +32 KB
L2 Cache	4 MB (Shared)	4 MB (Shared)	4 MB (Shared)	4 MB (Shared)
Platform				
Vendor and model number	Dual-Core Intel Xeon processor 5110-based server	Dual-Core Intel Xeon processor 5130-based server	Dual-Core Intel Xeon processor 5150-based server	Dual-Core Intel Xeon processor 5160-based server
Motherboard model number	Intel Server Board S5000PSL	Intel Server Board S5000PSL	Intel Server Board S5000PSL	Intel Server Board S5000PSL
Motherboard chipset	Intel 5000P Chipset	Intel 5000P Chipset	Intel 5000P Chipset	Intel 5000P Chipset
Motherboard revision number	92	92	92	92
Motherboard serial number	QTFMHN62500 173	QTFMHN62500 173	QTFMHN62500 173	QTFMHN62500 173
BIOS name and version	Intel Corporation S5000.86B.02.0 0.0054.0615200 62205	Intel Corporation S5000.86B.02.0 0.0054.0615200 62205	Intel Corporation S5000.86B.02.0 0.0054.0615200 62205	Intel Corporation S5000.86B.02.0 0.0054.0615200 62205
BIOS settings	HW Prefetcher and Adjacent Cache Line Prefetcher Disabled	HW Prefetcher and Adjacent Cache Line Prefetcher Disabled	HW Prefetcher and Adjacent Cache Line Prefetcher Disabled	HW Prefetcher and Adjacent Cache Line Prefetcher Disabled
Chipset INF driver	8.1.1.1001	8.1.1.1001	8.1.1.1001	8.1.1.1001

Memory module(s)				
Vendor and model number	Kingston KVR667D2D8F 5/1G	Kingston KVR667D2D8F 5/1G	Kingston KVR667D2D8F 5/1G	Kingston KVR667D2D8F 5/1G
Type	FB-DIMM/ PC2- 5300	FB-DIMM/ PC2- 5300	FB-DIMM/ PC2- 5300	FB-DIMM/ PC2- 5300
Speed (MHz)	667 MHz	667 MHz	667 MHz	667 MHz
Speed in the system currently running @ (MHz)	533 MHz	667 MHz	667 MHz	667 MHz
Timing/Latency (tCL-tRCD-iRP- tRASmin)	4-4-4-12	5-5-5-15	5-5-5-15	5-5-5-15
Size	4096 MB	4096 MB	4096 MB	4096 MB
Number of RAM modules	4	4	4	4
Chip organization	Double-Sided	Double-Sided	Double-Sided	Double-Sided
Channel	Dual	Dual	Dual	Dual
Hard disk				
Vendor and model number	Seagate ST3808110AS	Seagate ST3808110AS	Seagate ST3808110AS	Seagate ST3808110AS
Number of disks in system	1	1	1	1
Size	80 GB	80 GB	80 GB	80 GB
Buffer Size	8 MB	8 MB	8 MB	8 MB
RPM	7200	7200	7200	7200
Type	SATA-II	SATA-II	SATA-II	SATA-II
Controller	Intel 631xESB/6321 ESB/3100 Chipset ATA Storage Controller – 2680	Intel 631xESB/6321 ESB/3100 Chipset ATA Storage Controller – 2680	Intel 631xESB/6321 ESB/3100 Chipset ATA Storage Controller – 2680	Intel 631xESB/6321 ESB/3100 Chipset ATA Storage Controller – 2680
Controller driver	Intel 7.4.0.1005	Intel 7.4.0.1005	Intel 7.4.0.1005	Intel 7.4.0.1005
Operating system				
Name	Microsoft Windows Server 2003, x64 Enterprise Edition	Microsoft Windows Server 2003, x64 Enterprise Edition	Microsoft Windows Server 2003, x64 Enterprise Edition	Microsoft Windows Server 2003, x64 Enterprise Edition
Build number	3790	3790	3790	3790
Service Pack	SP1	SP1	SP1	SP1
Microsoft Windows update date	8/17/06	8/17/06	8/17/06	8/17/06
File system	NTFS	NTFS	NTFS	NTFS
Kernel	ACPI Multiprocessor x64- based PC	ACPI Multiprocessor x64- based PC	ACPI Multiprocessor x64- based PC	ACPI Multiprocessor x64- based PC
Language	English	English	English	English
Microsoft DirectX version	DirectX 9.0c	DirectX 9.0c	DirectX 9.0c	DirectX 9.0c
Graphics				
Vendor and model number	ATI ES1000	ATI ES1000	ATI ES1000	ATI ES1000
Chipset	ATI ES1000 PCI	ATI ES1000 PCI	ATI ES1000 PCI	ATI ES1000 PCI
BIOS version	BK-ATI VER008.005.02 3.000	BK-ATI VER008.005.02 3.000	BK-ATI VER008.005.02 3.000	BK-ATI VER008.005.02 3.000

Type	Integrated	Integrated	Integrated	Integrated
Memory size	16 MB	16 MB	16 MB	16 MB
Resolution	1024 x 768	1024 x 768	1024 x 768	1024 x 768
Driver	ATI 8.24.3.0	ATI 8.24.3.0	ATI 8.24.3.0	ATI 8.24.3.0
Network card/subsystem				
Vendor and model number	Intel PRO/1000 EB Network Dual Port Network Connection	Intel PRO/1000 EB Network Dual Port Network Connection	Intel PRO/1000 EB Network Dual Port Network Connection	Intel PRO/1000 EB Network Dual Port Network Connection
Type	Integrated	Integrated	Integrated	Integrated
Driver	Intel 9.3.39.0	Intel 9.3.39.0	Intel 9.3.39.0	Intel 9.3.39.0
Optical drive				
Vendor and model number	Toshiba- Samsung TS- H552B	Toshiba- Samsung TS- H552B	Toshiba- Samsung TS- H552B	Toshiba- Samsung TS- H552B
Type	CD/DVDW	CD/DVDW	CD/DVDW	CD/DVDW
Interface	Internal	Internal	Internal	Internal
Dual/Single layer	Dual	Dual	Dual	Dual
USB ports				
# of ports	6	6	6	6
Type of ports (USB 1.1, USB 2.0)	USB 2.0	USB 2.0	USB 2.0	USB 2.0

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

Appendix B – SPECjbb2005 output

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

Dual-Core Intel Xeon processor 5110-based server

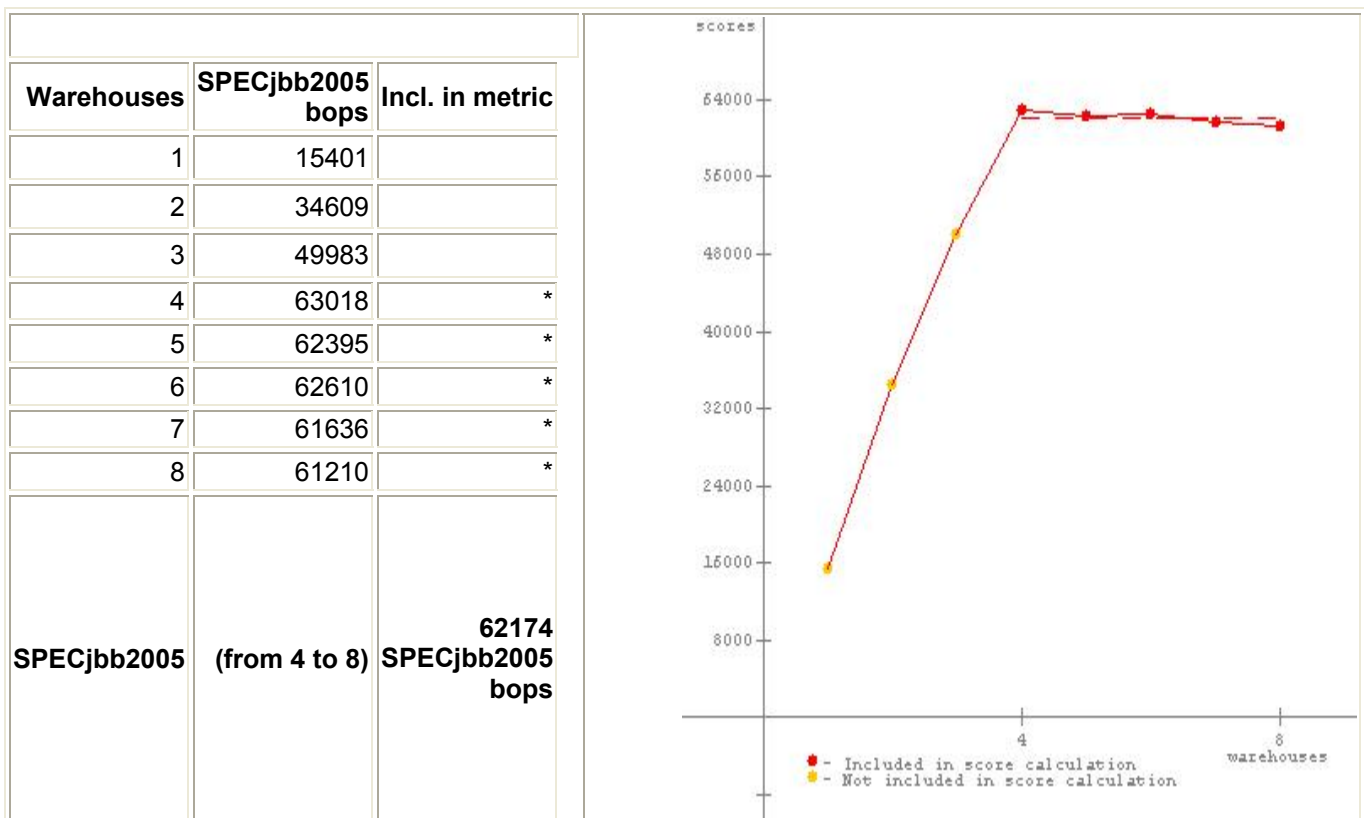
SPECjbb2005

**SPECjbb2005 bops = 62174,
SPECjbb2005 bops/JVM = 62174**

Intel Server board S5000PSL(1.6 GHz, Dual-Core Intel 5110 processor)

BEA Jrockit 5.0, jrockit-P26.4.0-1062459-1.5.0_06-20060529-2101-win-x86_64

No errors. Valid run.



SPEC license # 3184

Tested by: Principled Technologies

Test date: Sep 13, 2006

Hardware		Software	
Hardware Vendor	Intel	Software Vendor	BEA
Vendor URL	http://www.intel.com	Vendor URL	http://www.bea.com
Model	Intel Server board S5000PSL(1.6 GHz, Dual-Core Intel 5110 processor)	JVM Version	Jrockit 5.0, jrockit-P26.4.0-1062459-1.5.0_06-20060529-2101-win-x86_64
Processor	Dual Core Intel Xeon processor 5110 (1.6 GHz,	JVM Command Line	java -Xms2400m -Xmx2400m -XXaggressive -XXthroughputCompaction -XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize64k

	1066 MHz bus)	JVM Initial Heap Memory (MB)	2400
MHz	1600	JVM Maximum Heap Memory (MB)	2400
# of Chips	2	JVM Address bits	64
# of Cores	4	JVM CLASSPATH	.\jbb.jar; .\jbb_no_precompile.jar; .\check.jar; .\reporter.jar;
# of Cores/Chip	2	JVM BOOTCLASSPATH	C:\jrockit-jdk1.5.0_06\jre\bin\jrockit\jrockit.jar; C:\jrockit-jdk1.5.0_06\jre\bin\jrockit\managementapi.jar; C:\jrockit-jdk1.5.0_06\jre\lib\managementapi.jar; C:\jrockit-jdk1.5.0_06\jre\lib\rt.jar; C:\jrockit-jdk1.5.0_06\jre\lib\i18n.jar; C:\jrockit-jdk1.5.0_06\jre\lib\sunrsasign.jar; C:\jrockit-jdk1.5.0_06\jre\lib\jsse.jar; C:\jrockit-jdk1.5.0_06\jre\lib\jce.jar; C:\jrockit-jdk1.5.0_06\jre\lib\charsets.jar; C:\jrockit-jdk1.5.0_06\jre\classes
HW Threading Enabled?	Yes	OS Version	Microsoft Windows Server 2003 Enterprise x64 Edition, Service Pack 1
Procs Avail to Java	4	Other software	
Memory (MB)	4096		
Memory Details	4 x 1GB DDR2-FBDIMM PC2-5300 ECC registered		
Primary cache	32KB + 32KB		
Secondary cache	2 x 2MB		
Other cache	NA		
Filesystem	NTFS		
Disks	1 x 80GB SATA		
Other hardware			

Test Information	
Tested by	Principled Technologies
SPEC license #	3184
Test location	Durham, NC
Test date	Sep 13, 2006
H/w available	
JVM available	
OS available	April-2005 (for Service pack 1)
Other s/w available	

AOT Compilation	
Tuning	
In the local security settings, "lock pages in memory" was enabled	
Notes	

No errors. Valid run.

Details of Runs

Warehouses	Thrput	Total heap (MB)		Thread spread %	% > 120s	transaction type	Count	Time (in seconds)	
		Size	Used					total	max
1	15401	2400	2344	<0.01%	<0.01	new_order	203316	13.2	.078
						payment	140151	4.76	.016
						order_status	14015	.636	.016
						delivery	14015	5.12	.016

						stock_level	14015	.594	.016
						cust_report	76983	4.72	.016
2	34609	2400	1385	2.87%	<0.01	new_order	456349	25.6	.266
						payment	314796	9.96	.266
						order_status	31480	.847	.016
						delivery	31478	11.3	.016
						stock_level	31479	1.36	.016
						cust_report	173234	9.62	.250
3	49983	2400	490	3.05%	<0.01	new_order	661545	36.4	.235
						payment	456059	14.7	.235
						order_status	45606	1.74	.156
						delivery	45603	18.9	.140
						stock_level	45606	1.58	.016
						cust_report	250572	14.7	.235
4	63018	2400	1699	4.07%	.033	new_order	6647540	375	.500
						payment	4584631	140	.500
						order_status	458464	16.6	.172
						delivery	458464	231	.469
						stock_level	458464	22.7	.453
						cust_report	2521736	152	.500
5	62395	2400	2400	25.8%	.078	new_order	6583984	467	.656
						payment	4541365	187	.656
						order_status	454137	19.9	.484
						delivery	454136	281	.656
						stock_level	454138	31.6	.594
						cust_report	2498745	185	.718
6	62610	2400	1207	29.2%	.078	new_order	6607744	556	.797
						payment	4557002	226	.766
						order_status	455700	26.7	.734
						delivery	455698	341	.922
						stock_level	455701	34.1	1.03
						cust_report	2506261	227	.750
7	61636	2400	1653	25.5%	.013	new_order	6500376	659	1.50
						payment	4483232	277	1.70
						order_status	448324	28.3	2.05
						delivery	448323	365	3.14
						stock_level	448322	37.8	1.02
						cust_report	2466090	273	3.00
8	61210	2400	1136	19.7%	.039	new_order	6457803	751	1.25

						payment	4453388	331	1.14
						order_status	445338	38.1	2.25
						delivery	445339	415	4.84
						stock_level	445337	44.3	.953
						cust_report	2448970	304	5.06

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

Dual-Core Intel Xeon processor 5130-based server

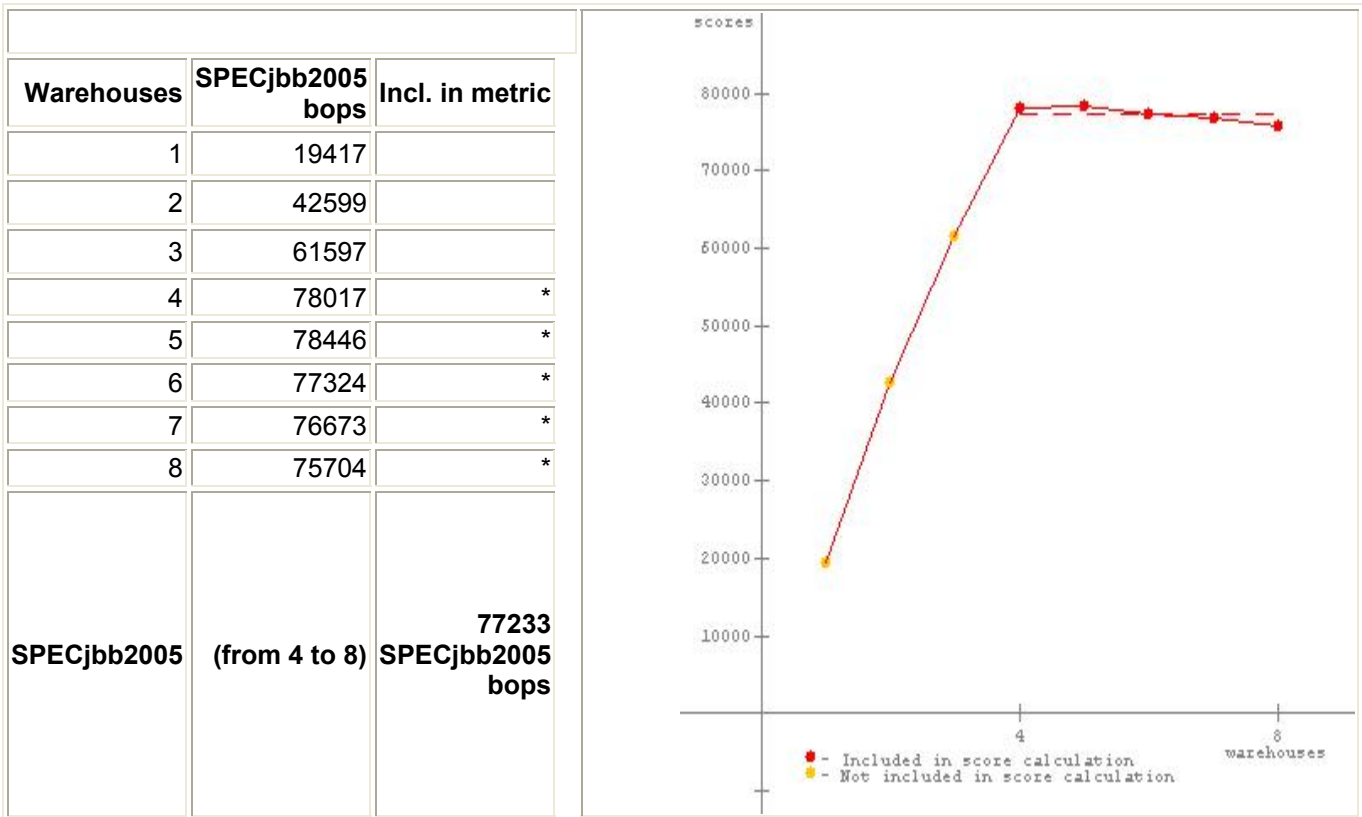
SPECjbb2005

**SPECjbb2005 bops = 77233,
 SPECjbb2005 bops/JVM = 77233**

Intel Server board S5000PSL(2.0 GHz, Dual-Core
 Intel 5130 processor)

BEA Jrockit 5.0, jrockit-P26.4.0-1062459-1.5.0_06-
 20060529-2101-win-x86_64

No errors. Valid run.



SPEC license # 3184 Tested by: Principled Technologies Test date: Sep 14, 2006

Hardware Software

Hardware Vendor	Intel
Vendor URL	http://www.intel.com
Model	Intel Server board S5000PSL(2.0 GHz, Dual-Core Intel 5130 processor)
Processor	Dual Core Intel Xeon processor 5130 (2.0 GHz, 1333 MHz bus)
MHz	2000
# of Chips	2
# of Cores	4
# of Cores/Chip	2
HW Threading Enabled?	Yes
Procs Avail to Java	4
Memory (MB)	4096
Memory Details	4 x 1GB DDR2-FBDIMM PC2-5300 ECC registered
Primary cache	32KB + 32KB
Secondary cache	2 x 2MB
Other cache	NA
Filesystem	NTFS
Disks	1 x 80GB SATA
Other hardware	

Software Vendor	BEA
Vendor URL	http://www.bea.com
JVM Version	Jrockit 5.0, jrockit-P26.4.0-1062459-1.5.0_06-20060529-2101-win-x86_64
JVM Command Line	java -Xms2400m -Xmx2400m -XXaggressive -XXthroughputCompaction -XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize64k
JVM Initial Heap Memory (MB)	2400
JVM Maximum Heap Memory (MB)	2400
JVM Address bits	64
JVM CLASSPATH	.\jbb.jar; .\jbb_no_precompile.jar; .\check.jar; .\reporter.jar;
JVM BOOTCLASSPATH	C:\jrockit-jdk1.5.0_06\jre\bin\jrockit\jrockit.jar; C:\jrockit-jdk1.5.0_06\jre\bin\jrockit\managementapi.jar; C:\jrockit-jdk1.5.0_06\jre\lib\managementapi.jar; C:\jrockit-jdk1.5.0_06\jre\lib\rt.jar; C:\jrockit-jdk1.5.0_06\jre\lib\i18n.jar; C:\jrockit-jdk1.5.0_06\jre\lib\sunrsasign.jar; C:\jrockit-jdk1.5.0_06\jre\lib\jsse.jar; C:\jrockit-jdk1.5.0_06\jre\lib\jce.jar; C:\jrockit-jdk1.5.0_06\jre\lib\charsets.jar; C:\jrockit-jdk1.5.0_06\jre\classes
OS Version	Microsoft Windows Server 2003 Enterprise x64 Edition, Service Pack 1
Other software	

Test Information	
Tested by	Principled Technologies
SPEC license #	3184
Test location	Durham, NC
Test date	Sep 14, 2006
H/w available	
JVM available	
OS available	April-2005 (for Service pack 1)
Other s/w available	

AOT Compilation	
Tuning	
In the local security settings, "lock pages in memory" was enabled	
Notes	

No errors. Valid run.

Details of Runs

Warehouses	Thrput	Total heap (MB)		Thread spread %	% > 120s	transaction type	Count	Time (in seconds)	
		Size	Used					total	max
1	19417	2400	1385	<0.01%	<0.01	new_order	256035	13.6	.203
						payment	176611	4.84	.016
						order_status	17662	.421	.016
						delivery	17661	4.92	.172
						stock_level	17662	.780	.016
						cust_report	97185	4.76	.016
2	42599	2400	2246	3.51%	<0.01	new_order	561846	25.6	.219
						payment	387466	10.6	.219
						order_status	38747	1.18	.078
						delivery	38746	11.0	.109
						stock_level	38747	1.23	.094
						cust_report	213087	8.57	.032
3	61597	2400	448	3.23%	<0.01	new_order	814878	37.0	.187
						payment	562008	14.7	.187
						order_status	56202	1.29	.016
						delivery	56199	19.0	.187
						stock_level	56201	2.06	.125
						cust_report	309143	13.8	.156
4	78017	2400	1153	5.20%	.078	new_order	8234826	384	.734
						payment	5678394	148	.562
						order_status	567841	16.0	.187
						delivery	567838	216	.547
						stock_level	567839	22.2	.140
						cust_report	3121956	150	.547
5	78446	2400	2072	30.0%	.098	new_order	8279764	485	.859
						payment	5710761	185	.485
						order_status	571077	19.4	.297
						delivery	571077	267	.703
						stock_level	571075	27.5	.687
						cust_report	3141760	190	.984
6	77324	2400	2000	24.7%	.065	new_order	8159542	583	.938
						payment	5627232	234	.688
						order_status	562723	22.1	.391

						delivery	562725	314	.938
						stock_level	562724	29.9	.594
						cust_report	3094928	225	.766
7	76673	2400	868	23.4%	.013	new_order	8084740	674	1.16
						payment	5576957	275	.954
						order_status	557693	29.2	.891
						delivery	557697	366	.984
						stock_level	557697	36.4	1.14
						cust_report	3069167	262	.938
8	75704	2400	2010	9.05%	.013	new_order	7983643	765	1.48
						payment	5506451	332	1.16
						order_status	550643	32.3	1.17
						delivery	550648	396	1.67
						stock_level	550644	44.3	.953
						cust_report	3029250	309	1.42

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

Dual-Core Intel Xeon processor 5150-based server

SPECjbb2005

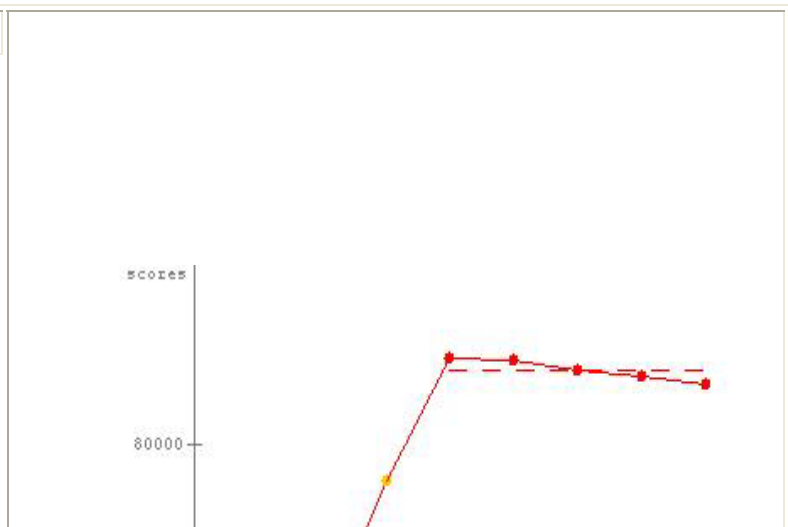
SPECjbb2005 bops = 91315,
SPECjbb2005 bops/JVM = 91315

Intel Server board S5000PSL(2.66 GHz, Dual-Core
Intel 5150 processor)

BEA Jrockit 5.0, jrockit-P26.4.0-1062459-1.5.0_06-
20060529-2101-win-x86_64

No errors. Valid run.

Warehouses	SPECjbb2005 bops	Incl. in metric
1	24806	
2	51794	
3	74405	
4	93227	*
5	92653	*
6	91301	*
7	90419	*
8	88971	*
SPECjbb2005	(from 4 to 8)	91315



Principled Technologies, Inc.: SPECjbb2005 performance and power consumption on Intel Xeon 51xx processor-based servers

		SPECjbb2005 bops	
--	--	-----------------------------	--

SPEC license # 3184	Tested by: Principled Technologies	Test date: Sep 14, 2006
----------------------------	---	--------------------------------

Hardware		Software	
Hardware Vendor	Intel	Software Vendor	BEA
Vendor URL	http://www.Intel.com	Vendor URL	http://www.bea.com
Model	Intel Server board S5000PSL(2.66 GHz, Dual-Core Intel 5150 processor)	JVM Version	Jrockit 5.0, jrockit-P26.4.0-1062459-1.5.0_06-20060529-2101-win-x86_64
Processor	Dual Core Intel Xeon processor 5150 (2.66 GHz, 1333 MHz bus)	JVM Command Line	java -Xms2400m -Xmx2400m -XXaggressive -XXthroughputCompaction -XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize64k
MHz	2660	JVM Initial Heap Memory (MB)	2400
# of Chips	2	JVM Maximum Heap Memory (MB)	2400
# of Cores	4	JVM Address bits	64
# of Cores/Chip	2	JVM CLASSPATH	.\jbb.jar; .\jbb_no_precompile.jar; .\check.jar; .\reporter.jar;
HW Threading Enabled?	Yes	JVM BOOTCLASSPATH	C:\jrockit-jdk1.5.0_06\jre\bin\jrockit\jrockit.jar; C:\jrockit-jdk1.5.0_06\jre\bin\jrockit\managementapi.jar; C:\jrockit-jdk1.5.0_06\jre\lib\managementapi.jar; C:\jrockit-jdk1.5.0_06\jre\lib\rt.jar; C:\jrockit-jdk1.5.0_06\jre\lib\i18n.jar; C:\jrockit-jdk1.5.0_06\jre\lib\sunrsasign.jar; C:\jrockit-jdk1.5.0_06\jre\lib\jse.jar; C:\jrockit-jdk1.5.0_06\jre\lib\jce.jar; C:\jrockit-jdk1.5.0_06\jre\lib\charsets.jar; C:\jrockit-jdk1.5.0_06\jre\classes
Procs Avail to Java	4	OS Version	Microsoft Windows Server 2003 Enterprise x64 Edition, Service Pack 1
Memory (MB)	4096	Other software	
Memory Details	4 x 1GB DDR2-FBDIMM PC2-5300 ECC registered		
Primary cache	32KB + 32KB		
Secondary cache	2 x 2MB		
Other cache	NA		
Filesystem	NTFS		
Disks	1 x 80GB SATA		
Other hardware			

Test Information		AOT Compilation	
Tested by	Principled Technologies		
SPEC license #	3184		
Test location	Durham, NC		
Test date	Sep 14, 2006		
H/w available			
JVM available			
OS available	April-2005 (for Service pack 1)		
Other s/w			
		Tuning	
		In the local security settings, "lock pages in memory" was enabled	
		Notes	

available	
-----------	--

No errors. Valid run.

Details of Runs

Warehouses	Thrput	Total heap (MB)		Thread spread %	% > 120s	transaction type	Count	Time (in seconds)	
		Size	Used					total	max
1	24806	2400	623	<0.01%	<0.01	new_order	327499	14.0	.187
						payment	225736	4.50	.016
						order_status	22574	.451	.016
						delivery	22574	4.66	.047
						stock_level	22573	.699	.016
						cust_report	123980	5.04	.016
2	51794	2400	2006	3.96%	<0.01	new_order	683646	25.3	.203
						payment	471092	9.96	.188
						order_status	47110	1.06	.016
						delivery	47111	11.8	.203
						stock_level	47109	1.39	.016
						cust_report	258535	9.06	.031
3	74405	2400	1116	3.55%	<0.01	new_order	981906	38.0	.250
						payment	677132	12.7	.250
						order_status	67714	1.51	.016
						delivery	67713	19.5	.141
						stock_level	67713	1.86	.016
						cust_report	372358	14.5	.141
4	93227	2400	2227	3.49%	.052	new_order	9837318	395	.391
						payment	6783711	140	.375
						order_status	678372	16.1	.203
						delivery	678371	223	.312
						stock_level	678370	22.1	.141
						cust_report	3730111	141	.235
5	92653	2400	2179	24.2%	.013	new_order	9772341	495	.469
						payment	6739308	172	.391
						order_status	673930	19.7	.390
						delivery	673932	279	.422
						stock_level	673932	25.0	.375
						cust_report	3706267	182	.391
6	91301	2400	1768	21.1%	.013	new_order	9628902	579	.766
						payment	6640962	220	.797

						order_status	664098	24.8	.593
						delivery	664096	324	.828
						stock_level	664097	35.5	.594
						cust_report	3653021	223	.750
7	90419	2400	961	29.6%	.013	new_order	9537079	673	1.19
						payment	6576800	273	.954
						order_status	657679	30.2	1.24
						delivery	657681	373	5.64
						stock_level	657679	34.7	.766
						cust_report	3616542	257	1.13
8	88971	2400	2313	16.7%	.013	new_order	9383661	787	1.14
						payment	6471455	313	1.11
						order_status	647145	33.4	1.17
						delivery	647144	421	1.14
						stock_level	647147	44.8	.812
						cust_report	3559259	281	1.81

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

Dual-Core Intel Xeon processor 5160-based server

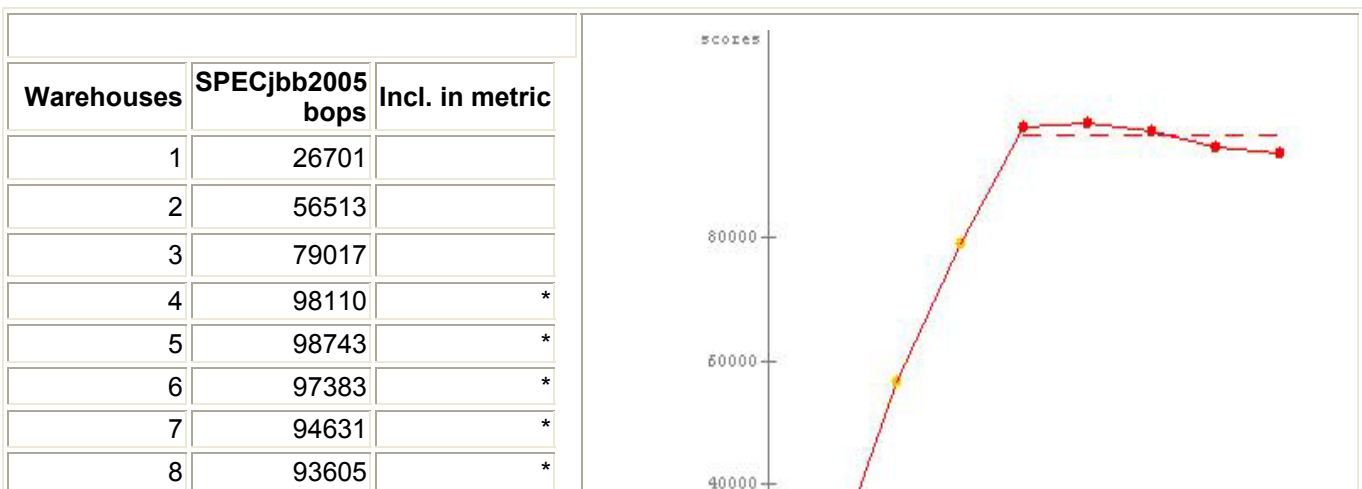
SPECjbb2005

SPECjbb2005 bops = 96494,
SPECjbb2005 bops/JVM = 96494

Intel Server board S5000PSL(3.0 GHz, Dual-Core
 Intel 5160 processor)

BEA Jrockit 5.0, jrockit-P26.4.0-1062459-1.5.0_06-
 20060529-2101-win-x86_64

No errors. Valid run.



SPECjbb2005	(from 4 to 8)	96494 SPECjbb2005 bops	
-------------	---------------	------------------------------	--

SPEC license # 3184	Tested by: Principled Technologies	Test date: Sep 14, 2006
---------------------	------------------------------------	-------------------------

Hardware		Software	
Hardware Vendor	Intel	Software Vendor	BEA
Vendor URL	http://www.intel.com	Vendor URL	http://www.bea.com
Model	Intel Server board S5000PSL(3.0 GHz, Dual-Core Intel 5160 processor)	JVM Version	Jrockit 5.0, jrockit-P26.4.0-1062459-1.5.0_06-20060529-2101-win-x86_64
Processor	Dual Core Intel Xeon processor 5160 (3.0 GHz, 1333 MHz bus)	JVM Command Line	java -Xms2400m -Xmx2400m -XXaggressive -XXthroughputCompaction -XXallocPrefetch -XXallocRedoPrefetch -XXcompressedRefs -XXlazyUnlocking -XXtlasize64k
MHz	3000	JVM Initial Heap Memory (MB)	2400
# of Chips	2	JVM Maximum Heap Memory (MB)	2400
# of Cores	4	JVM Address bits	64
# of Cores/Chip	2	JVM CLASSPATH	.\jbb.jar; .\jbb_no_precompile.jar; .\check.jar; .\reporter.jar;
HW Threading Enabled?	Yes	JVM BOOTCLASSPATH	C:\jrockit-jdk1.5.0_06\jre\bin\jrockit\jrockit.jar; C:\jrockit-jdk1.5.0_06\jre\bin\jrockit\managementapi.jar; C:\jrockit-jdk1.5.0_06\jre\lib\managementapi.jar; C:\jrockit-jdk1.5.0_06\jre\lib\rt.jar; C:\jrockit-jdk1.5.0_06\jre\lib\i18n.jar; C:\jrockit-jdk1.5.0_06\jre\lib\sunrsasign.jar; C:\jrockit-jdk1.5.0_06\jre\lib\jse.jar; C:\jrockit-jdk1.5.0_06\jre\lib\jce.jar; C:\jrockit-jdk1.5.0_06\jre\lib\charsets.jar; C:\jrockit-jdk1.5.0_06\jre\classes
Procs Avail to Java	4	OS Version	Microsoft Windows Server 2003 Enterprise x64 Edition, Service Pack 1
Memory (MB)	4096	Other software	
Memory Details	4 x 1GB DDR2-FBDIMM PC2-5300 ECC registered		
Primary cache	32KB + 32KB		
Secondary cache	2 x 2MB		
Other cache	NA		
Filesystem	NTFS		
Disks	1 x 80GB SATA		
Other hardware			

Test Information		AOT Compilation	
Tested by	Principled Technologies		
SPEC license #	3184		
Test location	Durham, NC		
Test date	Sep 14, 2006		
H/w available			
JVM available			
OS available	April-2005 (for Service pack 1)		
		Tuning	
		In the local security settings, "lock pages in memory" was enabled	
		Notes	

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

No errors. Valid run.

Details of Runs

Warehouses	Thrput	Total heap (MB)		Thread spread %	% > 120s	transaction type	Count	Time (in seconds)	
		Size	Used					total	max
1	26701	2400	1251	<0.01%	<0.01	new_order	352421	13.4	.203
						payment	242984	4.50	.062
						order_status	24298	.565	.016
						delivery	24299	5.10	.016
						stock_level	24299	.752	.094
						cust_report	133546	4.68	.016
2	56513	2400	1693	3.98%	<0.01	new_order	745502	26.1	.172
						payment	514023	10.1	.110
						order_status	51402	1.01	.140
						delivery	51403	11.0	.125
						stock_level	51402	1.20	.016
						cust_report	282548	9.18	.172
3	79017	2400	1943	3.62%	<0.01	new_order	1042619	38.9	.140
						payment	719084	13.2	.140
						order_status	71908	1.36	.016
						delivery	71907	19.3	.125
						stock_level	71908	2.11	.016
						cust_report	395543	13.3	.140
4	98110	2400	988	4.92%	.091	new_order	10355330	398	.532
						payment	7141761	131	.532
						order_status	714177	17.1	.172
						delivery	714174	233	.547
						stock_level	714176	22.3	.218
						cust_report	3928188	137	.344
5	98743	2400	698	22.2%	.045	new_order	10418515	491	.485
						payment	7184541	172	.500
						order_status	718455	18.9	.391
						delivery	718455	293	.563
						stock_level	718454	27.8	.391
						cust_report	3950570	172	.485
6	97383	2400	1062	15.8%	.091	new_order	10278931	585	.985

						payment	7088808	215	1.28
						order_status	708881	23.7	.578
						delivery	708882	342	1.14
						stock_level	708882	32.3	.391
						cust_report	3898685	211	.844
7	94631	2400	1448	27.1%	.215	new_order	10000396	686	1.20
						payment	6897089	264	.969
						order_status	689708	25.1	.578
						delivery	689708	399	1.31
						stock_level	689709	37.2	.719
						cust_report	3793771	239	1.16
8	93605	2400	1571	16.6%	.039	new_order	9874784	777	1.16
						payment	6810310	306	1.16
						order_status	681031	31.4	.781
						delivery	681028	448	1.73
						stock_level	681031	50.5	1.33
						cust_report	3745826	277	1.70

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



Principled Technologies, Inc.
4813 Emperor Blvd., Suite 100
Durham, NC 27703
www.principledtechnologies.com
info@principledtechnologies.com

Principled Technologies is a registered trademark of Principled Technologies, Inc.
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.