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# Understanding the SPECjbb2000 Benchmark on the IBM eServer pSeries System

## Introduction

Java applications are becoming a standard for Web-based commercial environments; therefore Java application performance becomes essential.

## Highlights

This brief details how the SPECjbb2000 benchmark measures Java server performance and reviews its process and significance.

IBM® @server pSeries 690 Turbo provides the highest throughput per processor in the industry in SPECjbb2000 benchmark results.

IBM® @server pSeries server is based on advanced technologies from IBM that provide additional benefit for customers, such as flexibility and reliability features.

# What is the SPECjbb2000 benchmark

Java server performance for business applications can be evaluated and compared by using a benchmark offered by the Standard Performance Evaluation Corporation (SPEC). The SPECjbb2000 (Java business benchmark) is helpful in predicting the performance and scalability of Java-based business solutions. It illustrates the Java engine effectiveness and how efficiently each processor is performing.

The SPECjbb2000 benchmark models a wholesale company, with warehouses that serve various districts. It emulates this processing with a three-tier client/server model:

- Customers initiate information requests or orders. These requests are simulated by random input from terminal processes. It assumes that each warehouse has one terminal input.
- These requests are processed using the business logic instructions programmed into the Java application.
- Finally, a database is accessed to obtain the information needed to fulfill the customer's request. This database is represented by data stored in a tree-like structure held in memory. Each warehouse contains roughly 25 MB of data stored in the database.

The SPECjbb2000 process illustrated in Figure 1 shows benchmarks for 3 and 5 warehouses, respectively.

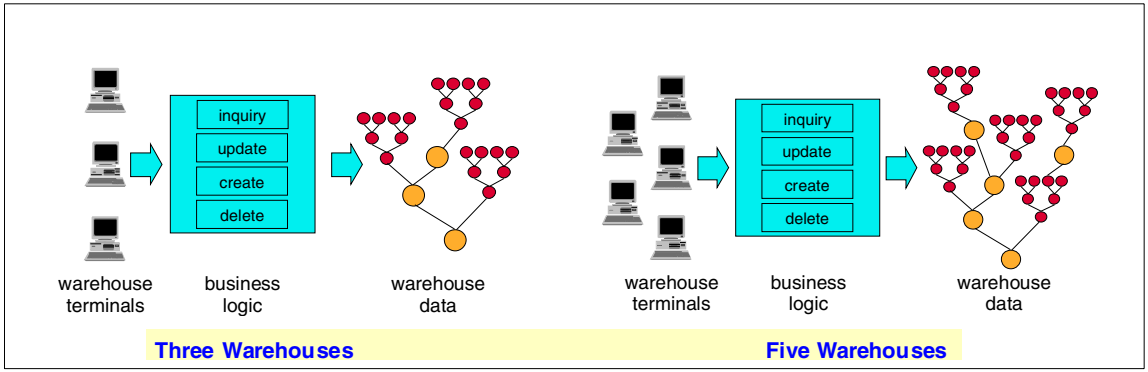


*Figure 1 SPECjbb2000 benchmark process*

The processes for each benchmark run are performed in a single Java environment. When running the benchmark, as the number of warehouses increase, the number of lightweight processes or threads increase, and so does the size of the database.

A measurement is taken on the middle tier and captures the rate at which business operations are performed per second. The SPECjbb2000 metric is an average number for peak performance throughputs. The throughput numbers are measured when warehouses are added one at a time until there are twice as many warehouses active as when the peak throughput was obtained.

SPECjbb2000 performs a functional and performance test for Java platforms. It exercises the implementations of the Java Virtual Machine (JVM), Just-In-Time (JIT) compiler, threads, and some aspects of the operating system. Also, it measures the performance of CPUs, caches, memory hierarchy, and the scalability of processors and servers.

## Limitations of SPECjbb2000

The SPECjbb2000 benchmark only measures performance using a single Java environment. It is also totally self-contained, as it stores all the data in memory. Therefore the benchmark does not take disk and network I/O into consideration. A "real-world" application will need to address these additional performance parameters.

SPECjbb2000 dispatches units of work against each processor. No interaction between processors for shared data takes place and no network/disk I/O is required. Each processor completes its unit of work and the result is accumulated and reported. This means that each additional processor that is added both adds to the accumulated total of the result and causes absolutely no overhead to the other processors. SPECjbb2000 is not a "real world" benchmark and should be considered along with other benchmarks that reflect real-world workloads.

Additionally, most of the 64-bit JVM implementations support very large memory, so garbage collection does not occur during the benchmark. The value of the benchmark is as a measure of JVM effectiveness and what a single processor is capable of delivering.

SPECjbb2000 does not use many Java software functions including Enterprise Java Beans (EJBs), Servlets, or Java Server Pages (JSPs).

## SPECjbb200 benchmark results

IBM tested the high-end IBM @server pSeries systems with the configurations shown in Table 1 on page 4.

The results of the IBM benchmark are shown in Table 2. In that table, we show the average peak throughput for each system and also the average number of operations per second per processor.

*Table 1 System configurations for IBM @server pSeries in SPECjbb2000 benchmark*

| | **IBM @server pSeries** | | |
|---|---|---|---|
| | **690 HPC** | **690 Turbo** | **670** |
| Processor | 16-way 1.3 GHz | 32-way 1.3 GHz | 16-way 1.1 GHz |
| L1 Cache | 64 KB (instruction) 32 KB (data) | 64 KB (instruction) 32 KB (data) | 64 KB (instruction) 32 KB (data) |
| L2 Cache | 1440 KB | 1440 KB | 1440 KB |
| L3 Cache | 4 x 128 MB | 4 x 128 MB | 4 x 128 MB |
| Memory | 64 GB | 128 GB | 64 GB |
| Disk | 18.2 GB SCSI | 18.2 SCSI | 18.2 SCSI |
| Operating Systems | AIX 5L Version 5.1 | | |
| Java Virtual Machine | IBM AIX 5L for PowerPC 64-bit JVM | | |

*Table 2 SPECjbb2000 result for IBM @server pSeries*

| **System** | **# of processors** | **SPECjbb2000 operations/second** | **Operations/second/ processor** |
|---|---|---|---|
| IBM p690 Turbo 1.3 GHz | 32 | 339,484 | 10,608 |
| IBM p690 HPC 1.3 GHz | 16 | 202,081 | 12,630 |
| IBM p670 1.1 GHz | 16 | 161,904 | 10,119 |

These performance benchmark results are current as of the publication of this paper. However, new performance benchmarks are added occasionally. The latest performance benchmark data is available on the SPEC Web site at http://www.spec.org.

# IBM eServer advantages

Good SPECjbb2000 performance is dependent on system characteristics (both hardware and software) which are supportive of typical Java business applications.

Several important performance enhancements in the AIX 5L Version 5.1, IBM 64-bit Java virtual machine were instrumental in achieving the SPECjbb2000 results. Improvements to object allocation reduced the instruction path length and more effectively used the hardware's memory hierarchy. Additional enhancements in the JIT and JVM improved large system scaling and allowed for more efficient CPU utilization.

The IBM @server pSeries utilizes the POWER4 processors. The POWER4 processor, recently awarded the Microprocessor Report Analysts' Choice Award for Best Workstation/Server Processor of 2001, is the key to the outstanding number of operations per second per processor achieved by the IBM @server pSeries 690 and the IBM @server pSeries 670 servers.

Compared to competing servers, both the IBM @server pSeries 690 and 670 deliver greater performance per processor and, at the same time, offer outstanding reliability features. Fewer processors translates into a lower cost of ownership through lower electricity costs, lower maintenance expenses, and software acquisition cost saving for applications using processor based pricing.

There is more than just performance in selecting a server. The IBM @server pSeries (Figure 2) also offers additional features that help ensure its flexibility and reliability as an enterprise level solution.

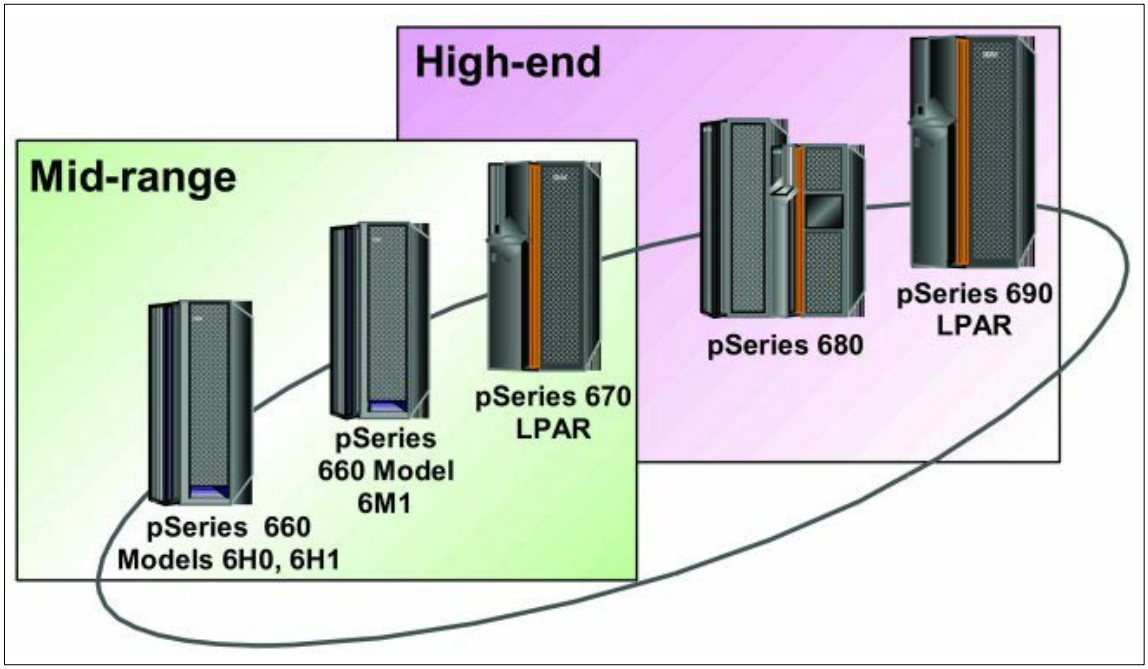


*Figure 2 Mid range and high end IBM @server pSeries systems*

## Self-managing technologies

IBM @server pSeries 690 and 670 incorporate technologies that are designed to be self-managing.

These technologies are designed to provide systems that can minimize downtime, suppress operating costs, and reduce administrative requirements. The following items show these self-managing features of the IBM @server pSeries:

- The self-optimizing feature, which uses the logical partitioning (LPAR) technology, enables customers to efficiently consolidate smaller servers into a single server. The logical partition has an inherent flexibility that can be adjusted easily and can eliminate wasted resources. A partition can be allocated to consist of a single processor. This gives customers the maximum flexibility when making server consolidation decisions.
- Self-configuring features automatically take failing or potentially failing components out-of-service without the need to reboot. Most hardware-caused application outages are avoided by employing these features, such as Error correcting code (ECC) memory, Redundant Bit Steering, Dynamic Processor deallocation, and Repeat Guard.
- Self-healing uses redundant features that allow the servers to recover from power related failures. Built-in redundancy includes the power supplies, power distribution cables, internal battery, and system cooling. Other self-healing features include Chipkill memory, which stripes data across physical memory, and PCI Bus Parity Error Retry, which allows an operation to be retried even when an error occurs.
- Self-protecting features detect possible threats to the system and initiate an action to avert the consequences of the threat. First Failure Data Capture (FFDC) is designed to prevent a single component failure from leading to a partition or system failure. FFDC includes extra registers that collect data about processors, I/O, memory, and cache.

## Conclusion

The SPECjbb2000 benchmark provides a strong indicator of processing throughput for Java application servers.

The IBM @server pSeries delivers peak performance for running mission-critical Java applications as indicated by the SPECjbb2000 benchmark results. The IBM @server pSeries systems occupy the top 3 positions for the highest operations per-processor per-second throughput by using the award winning POWER4 processors.

The IBM @server pSeries also provides features that allow the server to be self-managed. These features help ensure the highest availability and reliability for mission-critical applications.

## Notes on benchmarks and values

The benchmarks and values shown here were derived using particular, well configured, development-level computer systems. Unless otherwise indicated for a system, the values were derived using 32-bit applications and external cache, if external cache is supported on the system. All benchmark values are provided "AS IS" and no warranties or guarantees are expressed or implied by IBM. Actual system performance may vary and is dependent upon many factors including system hardware configuration and software design and configuration. Buyers should consult other sources of information to evaluate the performance of systems they are considering buying and should consider conducting application oriented testing. For additional information about the benchmarks, values and systems tested, contact your local IBM office or IBM authorized reseller or access the following on the Web:

http://www.spec.org

Unless otherwise indicated for a system, the performance benchmarks were conducted using AIX Version 5.1 and IBM AIX 5L for PowerPC 64-bit JVM with optimization where the compilers were used in the benchmark tests. The preprocessors used in the benchmark tests include KAP 3.2 for FORTRAN and KAP/C 1.4.2 from Kuck & Associates and VAST-2 v4.01X8 from Pacific-Sierra Research. The preprocessors were purchased separately from these vendors.

The benchmark results were based on the benchmark report obtained from SPEC web-site at http://www.spec.org/osg/jbb2000/results/jbb2000.html on July 2002.

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