# TPC-W Benchmark for IBM @server xSeries Servers

*Leadership e-business Performance with IBM xSeries servers and DB2 Universal Database*

## Executive Summary

IBM, the leader in e-business solutions, is pleased to announce a compelling demonstration of its ability to implement an end-to-end business solution and achieve world-class performance.

This paper presents the results of a performance study using the Transaction Processing Performance Council (TPC) Benchmark™ W (TPC-W™). The TPC is a non-profit corporation founded to define transaction processing and database benchmarks and to disseminate objective, verifiable TPC performance data to the industry.[1] The details of the methodology used and the configuration of the benchmark are described, followed by an analysis of the benchmark results. These results demonstrate the advantages of powering an e-business site with hardware and software solutions from IBM.

This study demonstrates the performance of the IBM @server xSeries systems and the DB2® Universal Database™ in large-scale e-business solutions.

[1] This is the TPC's mission statement.

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## Benchmark Description

TPC-W is a Web benchmark that simulates the activities of a 24/7 online bookstore. The benchmark allows scale factors of 1,000, 10,000, 100,000, 1,000,000, or 10,000,000 items to model various bookstore sizes.

The benchmark defines 14 Web interactions where each demonstrates a different kind of user operation. Most of these interactions contain dynamic content. This means a Web page is generated with dynamic data retrieved from multiple sources.

The benchmark models two security components to represent a true e-business. These security components are resource-intensive but essential parts of an e-business. The first component involves securing data transmitted over the Internet by requiring that all communication between a user and the Web servers use 1024-bit Secure Sockets Layer (SSL). The second component models a credit card verification process where credit card information is authorized by a simulated payment gateway. This verification also uses SSL to secure the information transmitted.

The TPC requires that all software components used in the benchmark, except the TPC-W application logic, be commercially available and supported. This ensures that the software solutions used in the benchmark represent real-world deployments.

## Performance Metrics

TPC-W measures the number of successful Web Interactions per Second (WIPS™) for a given workload and response time constraints.

A Web interaction is defined as the complete transfer of a Web page from a Web server to a browser. A Web page is constructed of several objects, such as HTML, images, frames, or Java™ applets. The browser initially retrieves the main HTML page and parses it to find all object references. It sends out a request to the Web servers to request each object. TPC-W provides a more comprehensive measurement of performance than other industry-standard benchmarks that measure the total number of object requests serviced per second.

The benchmark divides the 14 interactions into two categories, browsing and ordering, to model different types of users. Browsing interactions include accessing the home page, searching for an item, viewing product details, viewing new products and viewing best sellers. Ordering interactions include more intensive operations such as buying items and reviewing order information. The benchmark measures three types of interaction mixes based on the ratio of these two types of interactions: Shopping mix (WIPS), Browsing mix (WIPSb™) and Ordering mix (WIPSo™).

The Shopping mix models an 80/20 ratio of browsing and ordering interactions that is intended to simulate a typical user's shopping activity. The Browsing mix models a 95/5 ratio that is intended to model window shoppers who spends most of their time browsing. The Ordering mix models a 50/50 ratio that is intended to model a power buyer or a business-to-business (B2B) workload.

These metrics are reported with the scale-factor used in the benchmark. For example, 1,234WIPS@100,000 means that 1,234 WIPS were achieved at the scale-factor of 100,000 items. The primary metrics of the benchmark are *WIPS@scale-factor* and *$/WIPS@scale-factor*. The latter metric is the total cost of the system divided by *WIPS@scale-factor*. *WIPSb@scale-factor* and *WIPSo@scale-factor* are secondary

metrics. TPC-W also measures the performance of the system under a constant overload state. This test demonstrates the system behavior when it is driven at a higher load than at the reported WIPS rate. The minimum, maximum, average and 90th percentile response time for each interaction is also reported for each mix.

## Benchmarked Configuration

The system under test (SUT) is implemented in a two-tier configuration. The TPC does not mandate any particular configuration; however, two-tier is used to gain a price/performance benefit.

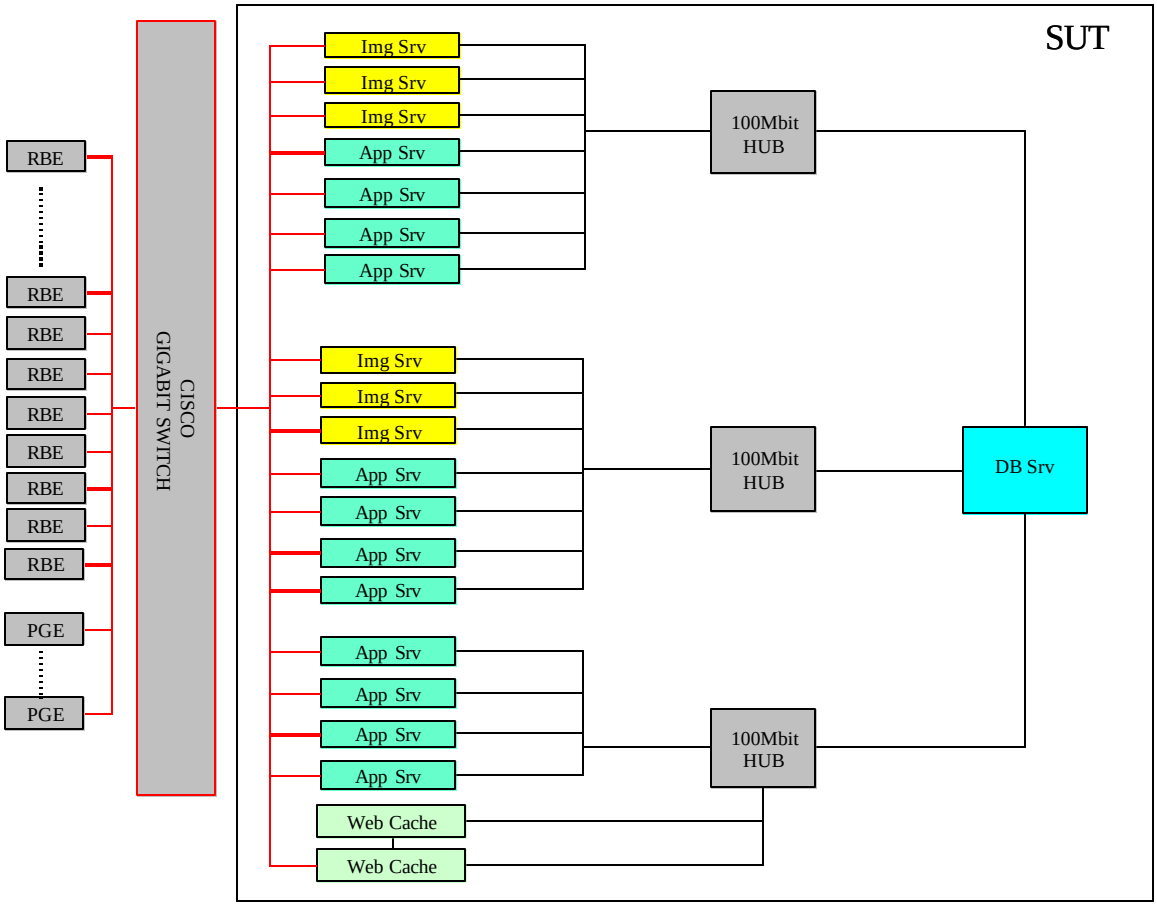


**Figure 1:** *Benchmarked Configuration*

The SUT includes a total of 21 systems. These systems were divided into four functional categories: 12 application servers, 6 image servers, 2 Web caches and 1 database server.

The 12 application servers run a copy of the TPC-W application code, which is executed with Microsoft® Internet Information Server (IIS). IIS is also responsible for servicing HTML and GIF images.

The six image servers are responsible for serving JPEG images associated with the 100,000 items in the database. This results in 100,000 5KB thumbnail-sized images and 100,000 full-sized images that range from 5KB to 250KB.

The two Web caches are responsible for caching the dynamic content permitted by the specification. The cacheable content includes parts of the New Products, Best Sellers, Search Results and Product Details interactions. Dynamic content cannot be cached for longer than 30 seconds, except for searches by title or author, which can be cached indefinitely.

The application servers and the Web cache interface with the database server. This is required to handle the business logic of the e-business, including credit card authorizations and security.

The 12-processor database server is an Intel® processor-based xSeries 430 server running IBM DB2 Universal Database. This system is the powerhouse of the SUT and provides all dynamic data. The database schema consists of eight tables with an overall size of approximately 300GB. This data includes 100,000 unique items, 158.4 million customers and is stored on IBM Fibre Array Storage Technology (FAStT) products.

Table 1 lists the types and configuration details for all systems used in the SUT.

| | Application Servers | Image Servers | Web Cache | Database Server |
|---|---|---|---|---|
| **System Type** | Netfinity 4500R | Netfinity 4500R | Netfinity 4500R | xSeries 430 |
| **Number of Processors** | 2 | 2 | 1 | 12 |
| **Memory (MB)** | 512 | 2304 | 1152 | 9216 |
| **Network** | 1Gbit/100Mbit | 1Gbit | 1Gbit/100Mbit | 100Mbit |
| **Operation System** | Windows 2000 Server | Windows 2000 Server | Windows 2000 Server | ptx |

**Table 1:** *System Configuration*

## Benchmark Results

The performance results achieved provides compelling evidence that IBM xSeries servers combined with IBM DB2 Universal Database Version 7 Enterprise Edition is the solution of choice for the e-business marketplace. Table 2 summarizes the results of the primary and secondary metrics.[2]

| Primary Metrics | |
|---|---|
| **WIPS@100,000** | 7554.7 |
| **$/WIPS@100,000** | 136.8 |

| Secondary Metrics | |
|---|---|
| **WIPSb@100,000** | 6104.9 |
| **WIPSo@100,000** | 2777.3 |

**Table 2:** *Benchmark Metrics*

We show that our solution is capable of servicing almost 6 billion requests a day by extrapolating the reported *WIPS@100,000* over a 24-hour period. This is a larger workload compared to most of today's largest e-businesses. The benchmarked system is

[2] Data is current as of May 1, 2001. This configuration is available as of June 8, 2001.

run at the rated WIPS rate for a continuous 8-hour period as part of an independent auditor test.

Fifty-five thousands users are simulated for the Shopping measurement interval. This number is derived from the targeted WIPS rate and equations presented in the benchmark specification. Forty-five thousand and 25,000 users are simulated for the Browsing and Ordering measurement intervals, respectively, since the capacity of the resources is determined for the Shopping interval. The benchmark does not allow hardware changes between measurement intervals. This results in a lower WIPS rates for the secondary metrics.

## *Overload Run*

The system is able to sustain a WIPS rate of 8809.9 when subjected to a load approximately four times greater than the reported *WIPS@scale-factor* rate.

This test demonstrates the robustness and efficient operation of the IBM xSeries servers and IBM DB2 Universal Database under extreme load conditions.

## *Response Time Behavior*

The 90th percentile response times for all 14 Web interaction measured are displayed in the following figure.

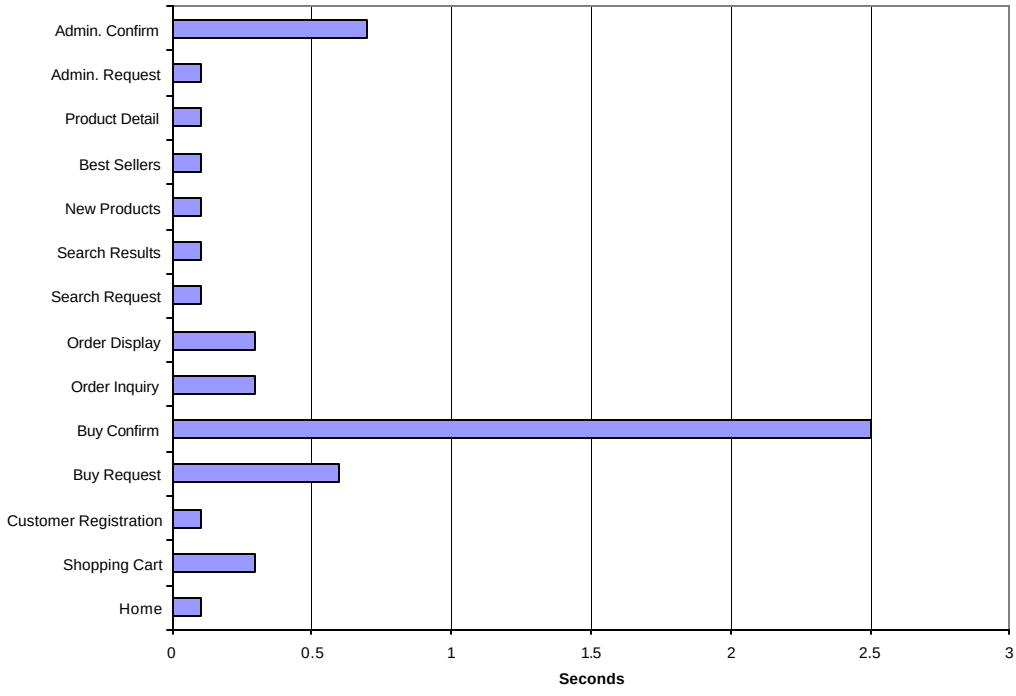


**Figure 2:** *Shopping Interval 90th Percentile Response Times*

Thirteen of these interactions have a 90th percentile response time of 1 second or less. For all practical purposes, these are considered instantaneous responses. The higher 90th percentile response times for the Admin Confirm and Buy Request interactions are due to the complex nature of the administrative database transactions they perform. The 90th percentile response time for the Buy Confirm interaction includes a minimum two-

second processing time for credit card authorizations. These response times are dramatically better than those observed at some of the fastest e-businesses.

### *Resource Utilization*

Table 3 summarizes the average resource utilization for some of the key resources. These resource measurements are taken during the Shopping measurement interval. This shows that the processor is not a bottleneck and there is plenty of processing power available in the system.

| | Web Cache | Application Server | Image Server | Database Server |
|---|---|---|---|---|
| **Processor Utilization (%)** | 44 | 84 | 57 | 83 |
| **Physical Memory, Available (MB)** | 271 | 122 | 610 | 1511 |
| **Average Disk Utilization (%)** | 2 | 4 | 14 | 63 |

**Table 3:** *System Resource Utilizations*

The available memory in each system shows that an adequate amount of memory is installed in each system. This allows for most of the data to be cached in memory resulting in negligible disk usage.

The benchmarked system serviced a total of almost 70,000 HTTP requests per second. This enormous load of HTTP requests results in an overall network bandwidth of more than 4 gigabits per second.

## Competitive Performance

The published IBM TPC-W result stands in a class of its own. To this day, IBM has the only results in the 100,000 item scale-factor category.

Other published results by IBM, Unisys and Dell are in the smaller 10,000 item scale-factor.[3] According to TPC guidelines, results in different scale-factors cannot be compared. The currently published results are displayed side-by-side in the following figure.

[3] Data on competitive products is obtained from publicly available information. Contact the manufacturer directly for the most current information.

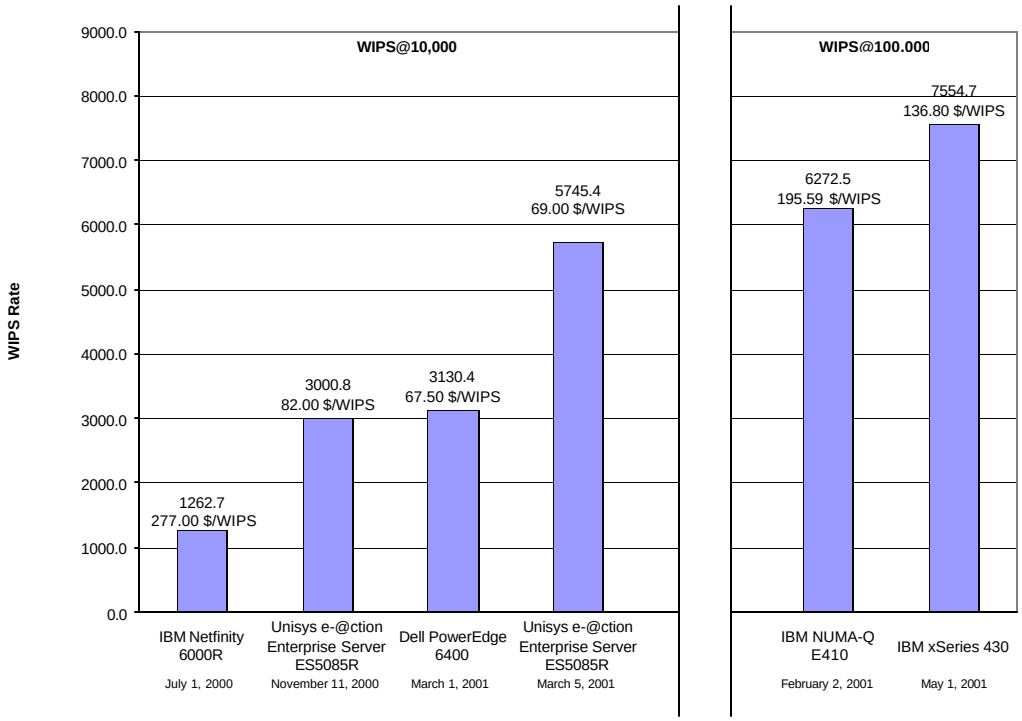


**Figure 3:** *Competitive Performance Results*

It is worth mentioning that the relationship between the size of an e-business site and the complexity of the system bears a nonlinear relationship. The larger an e-business grows, the more complex the solution becomes. Solutions that work well for smaller e-businesses do not necessarily work, if at all, for large e-businesses. As the e-business grows, it becomes increasingly difficult to get a well-balanced, robust and efficient configuration. The IBM xSeries servers and IBM DB2 Universal Database are perfectly suited to handle large and complex e-business solutions.

# Conclusion

As the size of the e-business grows, adding more systems to the configuration eventually results in diminishing returns because of the scalability limitations in most of today's solutions. To provide a smooth growth path, it is key to select a solution that is proven to scale well beyond the current demands.

The industry-leading result of 7554.7 WIPS@100,000 demonstrates the strength of IBM xSeries servers in the high-end e-business market. The benchmarked configuration is capable of servicing almost 6 billion user requests a day. This also demonstrates how IBM DB2 Universal Database enables e-businesses to manage and leverage information in all its forms. DB2 efficiently handles the combined transactional and query workload simulated by the TPC-W at a scale-factor 10 times larger than on any other vendor's database.

While not many of today's e-businesses demand the level of performance demonstrated in this benchmark, the modular organization of the benchmarked configuration allows it to be easily scaled down for smaller workloads.

These are compelling demonstrations of the outstanding performance from IBM xSeries and IBM DB2 Universal Database in an e-business environment.

## *Additional Information*

Visit our Web site at **ibm.com**/eserver/xseries for more information on IBM xSeries servers direction, products and services. From the xSeries home page, select **Library** for a list of the types of documents available.

## *About DB2*

Visit our Web site at **www.software.ibm.com**/data/db2. DB2 Universal Database (UDB) is the first multimedia, Web-ready relational database management system that is strong enough to meet the demands of large corporations and flexible enough to serve small and medium-sized businesses. With DB2 UDB Version 7, IBM continues its role as the database innovator in:

- e-business
  DB2 UDB powers the most demanding e-business applications, such as electronic commerce, enterprise resource planning, customer relationship management, supply-chain management, Web self-service, and business intelligence. It is about a scalable, industrial-strength database that can be the data management foundation for your evolution into e-business.

- Business Intelligence
  DB2 UDB means using data assets to make better business decisions. It is about data access, data analysis, and decisions that help control costs, uncover new opportunities, boost market share, and increase customer loyalty.

- Data Management
  DB2 UDB data management is more than simply running queries and applications. It is about where to store data, how to access it quickly, how to protect it against loss, and how to administer databases for optimum performance on your hardware and for your mix of applications.

- DB2 Family
  DB2 UDB continues to meet the demands of today's heterogeneous computing environments. It is about open solutions that can access and integrate data from multiple, geographically separated sources on different platforms. The new offering, DB2 Life Sciences Data Connect, is another excellent example demonstrating DB2's ongoing commitment.



IBM Server Group

Department LO6A

Research Triangle Park NC 27709

Produced in the USA

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IBM xSeries servers are assembled in the U.S., Great Britain, Japan, Australia and Brazil and are composed of U.S. and non-U.S. parts.

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