



# IBM Power 770 with IBM i 7.1 performance benchmark results for Oracle's JD Edwards EnterpriseOne

*Delivering outstanding performance  
for large configurations*



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## Table of contents

<b>Change history .....</b>	<b>3</b>
<b>Abstract.....</b>	<b>4</b>
<b>Introduction .....</b>	<b>4</b>
<b>POWER7 performance tests .....</b>	<b>4</b>
Test objectives .....	4
Test environment .....	5
Interactive test results .....	7
Interactive with batch test results.....	9
Batch test results .....	11
64-bit JVM tuning guidelines.....	11
<b>Summary .....</b>	<b>12</b>
<b>Resources .....</b>	<b>12</b>
<b>About the authors .....</b>	<b>13</b>
<b>Appendix 1: “Day in the Life” workload.....</b>	<b>14</b>
<b>Appendix 2: System and application tuning.....</b>	<b>16</b>
System configuration .....	16
IBM i tuning .....	16
WebSphere tuning .....	16
JD Edwards EnterpriseOne tuning .....	17
<b>Trademarks and special notices.....</b>	<b>19</b>



## Change history

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Version	Date	Editor	Editing description
1.0	06/15/2012	Patrick Moore	Original version

## Abstract

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*This paper describes the results of recent measurements which demonstrate the performance of Oracle's JD Edwards EnterpriseOne on an IBM Power® 770 server (model 9117-MMC) running IBM i. These latest measurements extend previous benchmark results to the high end of the product line, add a batch component to the results, and offer an example of using WebSphere® 64-bit JVMs.*

*These results for a POWER7® processor-based Power Systems™ server show scalability across measurements of 4000, 8000, 12000 and 15000 JD Edwards EnterpriseOne interactive web-based users on several IBM Power Systems hardware configurations from eight to 32 cores. They also validate that these servers continue to deliver excellent JD Edwards EnterpriseOne end user response times time including conditions of high levels of CPU utilization..*

*IBM and Oracle remain committed to providing customers with an integrated, scalable, and easy to manage environment based on the latest processor technology and a robust software solution including the use of IBM PowerVM™, DB2® for i, and WebSphere Application Server.*

## Introduction

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IBM and Oracle continue to work together closely to ensure customers have the application and platform solutions needed to maximize their business results. This paper contains new performance results which reflect some recent announcements from IBM and Oracle.

- In October 2011, IBM announced the Power 770 model MMC enterprise server targeting the high end of the product line. IBM hardware configurations supports anywhere from one to 32 processor cores, these new servers provide a broad range of processor options for large environments.

This paper provides performance results for the Power 770 server running JD Edwards EnterpriseOne application software 9.0.2 with Tools 8.98.4.5 in an "All on i" configuration with the entire application running on a single instance of IBM i. These results take advantage of the powerful integration capabilities of IBM i and IBM PowerVM virtualization technology.

## POWER7 performance tests

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### Test objectives

The objectives of these tests were as follows:

- Establish the performance benchmark of the POWER7 processor-based Power 770 server with IBM i for JD Edwards EnterpriseOne configurations by evaluating the maximum number of users the given processor configuration would support.
- Provide JD Edwards EnterpriseOne configuration guidelines for using the 64-bit version of the IBM Technology for Java™ Virtual Machine. The previous JVM process was written in 32-bit and so has limitations in the heap size and ability to handle larger HTML requests.
- Provide updated results for the new combined interactive and batch JD Edwards "EnterpriseOne Day-In-The-Life" (DIL) benchmark workload.

## Test environment

The hardware environments were defined to represent various configurations for the Power 770 server. Note that many other configurations are possible. Table 1 shows the configuration information for the environments used for the performance testing. The JD Edwards EnterpriseOne architecture, including the elements of logic, JAS, and database, were implemented in a single IBM i logical partition on the same server. Different logical partition definitions were used for this partition to provide different processor and memory resources for measurement. Two instances of the JD Edwards EnterpriseOne logic server were implemented in this partition to handle the interactive and batch scaling loads. These processor and memory resources are shown in the following tables. The number of processor cores indicates the number of processors which were licensed for IBM i and used for the tests. Note that the physical hardware may have additional processors which were not activated.

Commercial Processing Workload (CPW) is a relative measurement of performance of systems running the IBM i operating system. CPW was used to estimate the performance of measured configurations. CPW values for configurations other than 16 and 32 cores are estimates based on the published values (see: <http://www-03.ibm.com/systems/power/hardware/770/perfdata.html>) for the 16 and 32 core configurations. For example the 8 core CPW value was calculated as 50% of the 16 core CPW value (93000) and the 24 core as 75% of the 32 core (162000).

Model 9117-MMC	
<b>Processor</b>	<b>32 core</b>
<b>Technology</b>	<b>POWER7</b>
<b>Clock rate</b>	<b>3.3 Ghz</b>
<b>Memory</b>	<b>1024 GB</b>
<b>Disk arms</b>	<b>48 arms</b>
<b>Software</b>	
<b>Operating system</b>	<b>i 7.1</b>
<b>WebSphere Express</b>	<b>7.0.0.19</b>
<b>EnterpriseOne</b>	<b>9.0 Update 2 / 8.98.4</b>

Table 1 – Summary of POWER7 test configuration



*Figure 1. Power 770 server*

The Power 770 is a modular enterprise server which can run with from one to four nodes. Each node has two 8-core POWER7 chips running at 3.3 GHz. The test system ran with two nodes (32 cores), while a fully populated 770 supports four nodes (64 cores).

The DDR3 memory in the Power 770 operates at 1066 MHz, and each node in the test system held 512 GB. The maximum system memory for the Power 770 is 4 TB.

The test system was configured with two drawers of disk drives. Each drawer held 24 drives, and each drive was 139 GB in size. The drives in each drawer were controlled by a pair of large cache SAS adapters (#5913). The drives were setup with a mirrored configuration for optimal performance. The Power 770 is capable of supporting a total of 1,344 drives directly attached.



## Interactive test results

Table 2 shows the results of the interactive-only measurements.

Partition resources CPU/Memory	JVMs	HTTP Servers	JDE Instances	CPW	Number of Web-based users	Average Transaction Response Time (Seconds)	CPU Utilization %
8 / 256 GB	4	1	1	46500 <sup>1</sup>	4000	0.160	70
16 / 512 GB	8	2	1	93000	8000	0.081	72
24 / 768 GB	12	3	2	142000 <sup>1</sup>	12000	0.200	87
32 / 1024 GB	15	3	2	162000	15000	0.211	91
32 / 2014 GB	15	3	2	162000	16000	0.347	92

Table 2 - Performance results from the POWER7 measurements

<sup>1</sup>Values calculated from published CPW numbers

Some observations of these results:

- The results match previously published benchmarks demonstrating the ability of POWER7 processor-based servers to run more than 400 and as many as 500 users per core.
- The LoadRunner metrics of combined weighted interactive response times remained consistent across the configurations, even with heavy batch workloads as the system approached maximum utilization, showing the strong work management capabilities of the IBM i operating system.
- The WebSphere Application Server 64-bit JVM was configured and run with as many as 1066 users per JVM. High end benchmark testing demonstrated that fewer WebSphere Application Server instances are required for a large total user concurrency load when user loads are in the thousands of users.
- The ability of the system to provide end users with a response time less than 0.5 seconds with configurations of 500 users per processor across the range of available processors is shown, demonstrating the value of vertical scalability for IBM Power Systems. 16,000 interactive users was achieved with acceptable end user response times of 0.35 seconds. This value is far below the required threshold of 0.5 seconds for the DIL kit. Higher values of interactive users could be attained, the limiting factor was the CPU consumption reaching 92% at 16,000 users with 32 processor cores. Testing was stopped at 16,000 users.

Figure 2 shows the number of web-based users, the measured response times, and the processor utilization in graphical form for interactive workloads.

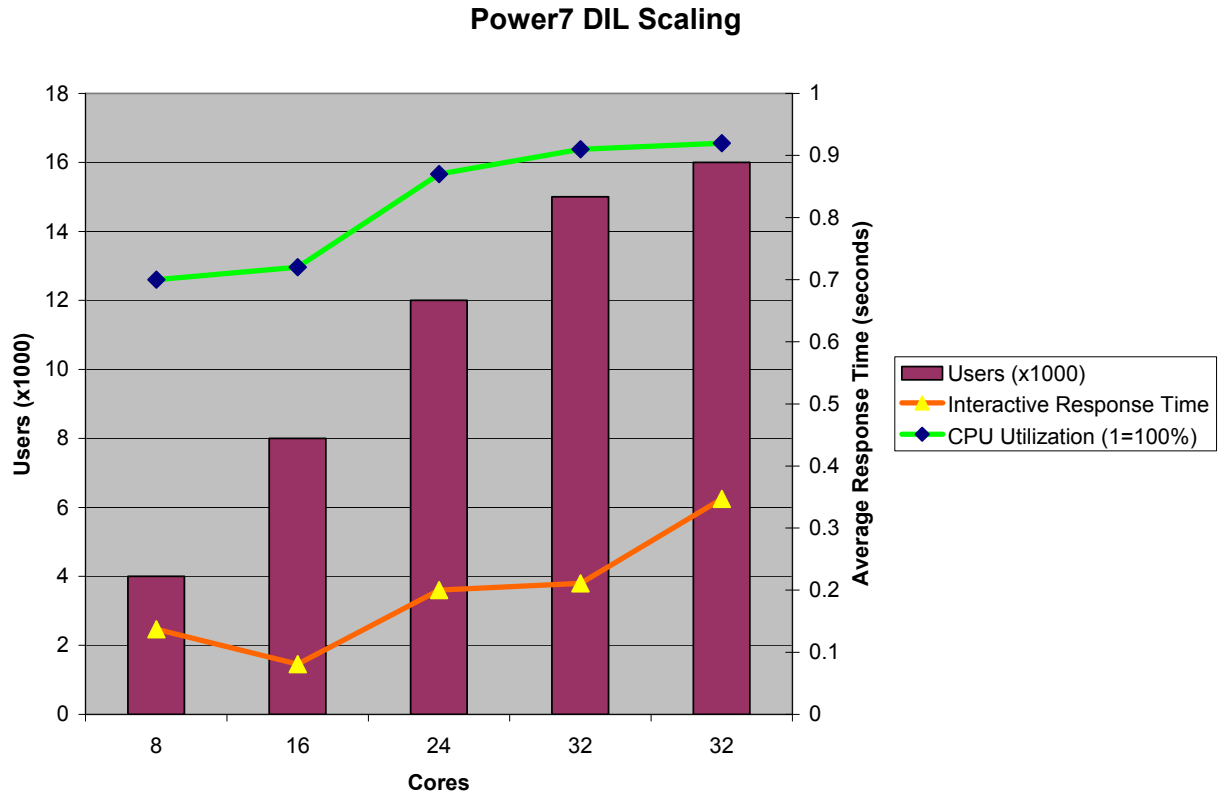


Figure 2- POWER7 interactive workload scaling measurements

Another JD Edwards EnterpriseOne instance was added at the 12000 user run causing an increase in utilization which affected the response time. CPU utilization above 90% also affects response time. This can be seen as CPU utilization reached 90% at approximately 15000 users. Response time began to be impacted at 16000 users and 92% CPU utilization. The response time in both cases is still well within the standards of acceptable performance at less than 0.35 seconds.





## Interactive with batch test results

The Oracle JD Edwards development team has recently added a batch component to the DIL benchmark test workload. This batch workload consists of long-running and short running UBEs (Universal Batch Engines). A mixture of these UBEs can be chosen to represent typical batch activity on a system. For our tests, four long-running UBEs ran for the entire duration of the test, while seven job queue entries submitted short-running UBEs. This means 11 UBEs were running concurrently and measurements showed approximately 61 short UBEs per minute being completed. The 61 short UBEs per minute combined with the four long-running UBEs gives a total of 65 UBEs processed per minute. Varying numbers of interactive processes were initiated concurrently with the batch processes to simulate actual customer batch and user interaction with EnterpriseOne. Table 3 shows the results of the interactive and batch test measurements.

Partition Resources CPU/Memory	JVMs	HTTP Servers	JDE Instances	CPW	Number of Web-based users	Average Transaction Response Time (Seconds)	CPU Utilization %
12 / 375 GB	8	1	1	70000 <sup>1</sup>	4000	0.205	90
24 / 512 GB	9	3	2	121500 <sup>1</sup>	8000	0.170	81
32 / 1024 GB	15	3	2	162000	12000	0.165	85

Table 3 - Performance results from the POWER7 measurements

<sup>1</sup>Values calculated from published CPW numbers

The following are some additional observations regarding these results:

- These values as illustrated in Figure 3 represent near linear scaling from 12 to 32 processors.
- The UBE load required a fairly constant 4 CPUs to process. The same UBE workload was run for each test. The number of interactive users was varied to increase the workload as the configuration CPU and memory resources increased.
- CPU utilization increases slightly as the numbers of users and processor cores increases due to additional system overhead. An acceptable response time for the test reported above met the criteria of 0.5 seconds as is reported in Table 3.
- The number of IBM i storage disk arms used and I/O response time was not a significant factor in overall system performance. The highest average service time reported by a disk unit in the 16,000 user measurement was 0.0016 seconds and the average time per I/O was 0.0004 seconds. The JD Edwards EnterpriseOne DIL benchmark testing for interactive and batch processing is CPU-intensive. Memory and disk contention were not deemed as critical factors in evaluating JD Edwards EnterpriseOne performance.

Figure 3 shows the number of web-based users and the processor utilization in graphical form for a combined interactive and batch workload test.

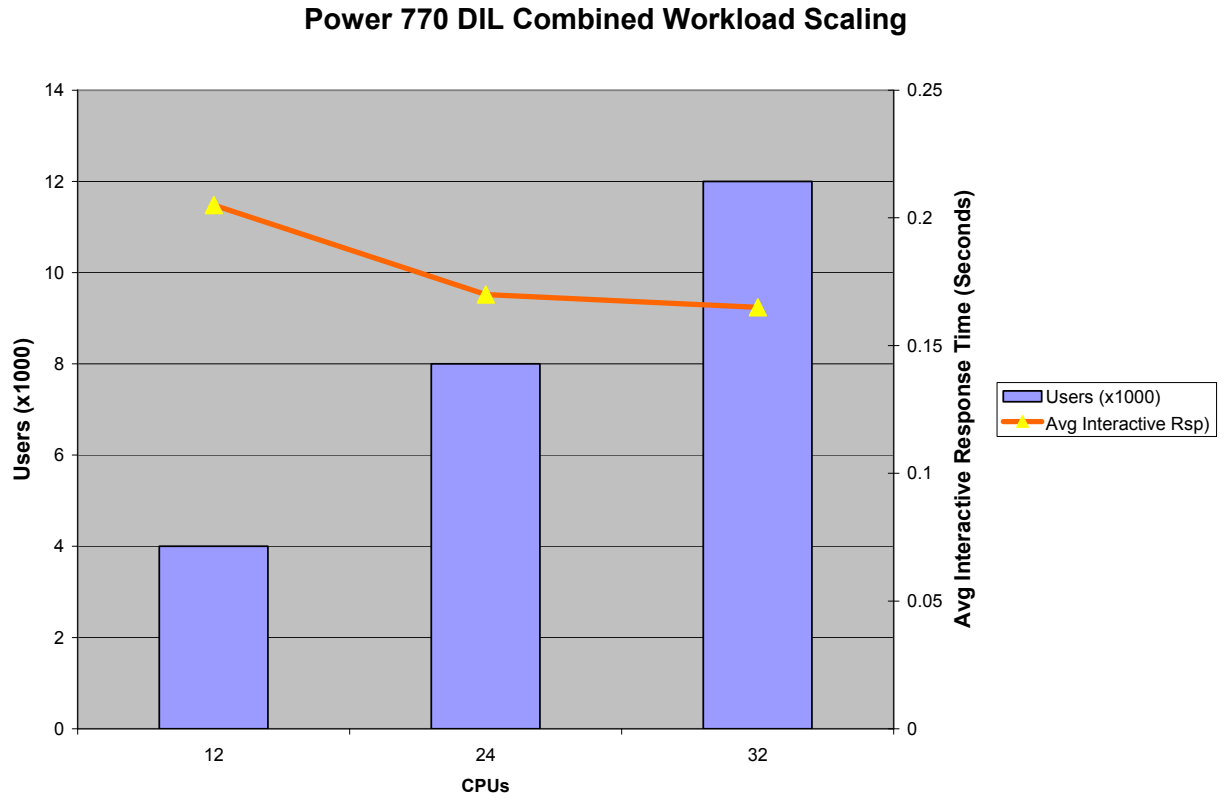


Figure 3 - POWER7 interactive and batch workload scaling measurements

Figure 3 shows the effect of running the batch workloads at a lower priority than the interactive. In the purely interactive scenario with all jobs competing equally for resources, the interactive response time for the 32 CPU, 15000 user test decreased slightly. In this mixed scenario, only 12000 interactive users are running with 32 CPUs, so their response time is similar to the 12000 user purely interactive scenario. Any reduction in service occurs in the lower-priority batch jobs. This demonstrates the sophisticated workload management capabilities of the IBM i operating system.



## Batch test results

Table 4 shows the results of the batch measurements.

Partition resources CPU/Memory	Short-running UBEs per minute <sup>2</sup>	Records processed per hour <sup>2</sup>	Concurrent Long Running Batch Processes	Disk I/O per Second	CPU Utilization	CPW
16 / 512 GB	340	48 million	9	7,500	93%	93000
24 / 768 GB	477	75 million	13	8,600	93%	122000 <sup>1</sup>
32 /1024 GB	643	99 million	17	12,000	89%	162000

Table 4 - Performance results from the POWER7 measurements for a batch workload

<sup>1</sup>Values calculated from published CPW numbers

<sup>2</sup>Number of records processed is determined by using the Auditing Information Data Repository table (F986114) column JCPWPRCD.

Some observations of these results:

- Short running UBEs ran at priority 50, long-running UBEs ran at priority 60.
- Short-running UBEs ran in their own shared pool. This resulted in significant gains over running them in the same pool as the long running UBEs.
- Disk performance at all data points averaged between 150 and 250 I/Os per second for each disk arm.

## 64-bit JVM tuning guidelines

The 64-bit JVM allowed fewer HTML servers to be allocated for a given user workload. There are two major benefits of the 64-bit JVM compared to the 32-bit JVM:

- Reduced risk of JVM out-of-memory errors. In previous benchmark testing we used a maximum heap size of 1744 MB for the 32-bit JVM. In some cases Java “Out-Of-Memory” errors were observed. The 64-bit JVM removes this limitation on heap size.
- Reduction in administration. If using Websphere ND clusters to support large numbers of users, fewer Websphere Application Server instances need to be configured in the cluster for a given number of users.

These tests began at a previous benchmark’s 32-bit JVM configuration of 500 users per JVM. Eventually runs were made with as many as 1000 users per JVM with no observed degrading of performance. However, this is a controlled benchmark environment and it is difficult to extrapolate to a production environment. Customers migrating to a 64-bit JVM should consider their current 32-bit configuration a starting point and then tune for their unique environment.



The attributes having the most effect on performance were the amount of heap memory and the size of the web container thread pool. The nursery heap size was increased to improve garbage collection performance. The number of garbage collection threads were fixed with the `'gctthreads'` option set to a lower number than the default, which both reduced CPU utilization and reduced garbage collection cycle times.

Specific definition details of the JVM options are provided in Appendix 2.

## Summary

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These results demonstrate IBM's continued commitment to improving the performance of customer environments running JD Edwards EnterpriseOne software on Power Systems servers with IBM i. The results reflect the following:

- These results demonstrate interactive response time performance from IBM Power Systems POWER7 processor-based servers when running in both interactive-only and mixed workloads. Small sub second response times were reported for interactive workloads of up to 16k users and for mixed workloads of up to 12,000 interactive users and 11 batch processes completing 65 UBEs per minute.
- The results demonstrate purely batch workload capability of processing up to 99 million records per hour while running 643 short-running UBEs per minute and 17 long-running batch processes.
- The results show near linear scalability as environments progress in size toward the largest environments configurable on the Power 770 server.
- The results also demonstrate the performance and functionality of the IBM Technology for the WebSphere Java 64-bit JVM. Greater numbers of interactive users (1000 users per JVM) can now be supported as opposed to the 32-bit previous results of 500 users per JVM.

## Resources

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The following resources contain additional information which supplements the content of this paper.

- System i JD Edwards Solutions from Oracle  
<http://www.ibm.com/systems/i/advantages/oracle/>
- IBM i Solution Edition for Oracle's JD Edwards EnterpriseOne performance benchmark results  
<http://www.ibm.com/support/techdocs/atmastr.nsf/WebIndex/WP101731>
- Oracle's JD Edwards EnterpriseOne Scaling with IBM POWER6, POWER7, and IBM i  
<http://www-03.ibm.com/support/techdocs/atmastr.nsf/WebIndex/WP101555>
- IBM Power Systems with IBM i Performance and Tuning Tips for Oracle's JD Edwards EnterpriseOne WebSphere-based HTML Servers  
<http://www.ibm.com/support/techdocs/atmastr.nsf/WebIndex/WP101777>



- IBM Power Systems with IBM i Performance and Tuning Tips for Oracle's JD Edwards EnterpriseOne 9.0  
<http://www.ibm.com/support/techdocs/atmastr.nsf/WebIndex/WP101504>
- Using JD Edwards EnterpriseOne Server Manager to create an HTML server vertical cluster on WebSphere ND and IBM i  
<http://www-03.ibm.com/support/techdocs/atmastr.nsf/WebIndex/WP101647>
- IBM Power 770 Performance Data  
<http://www-03.ibm.com/systems/power/hardware/770/perfdata.html>

## About the authors

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John Brock is a Senior Software Engineer in the IBM Rochester development lab, and is the IBM i interface with Oracle's JD Edwards development. Diane Webster is a former JD Edwards employee and currently a consultant in the IBM JD Edwards Competency Center in Denver.

Questions or comments on this paper can be sent to [jcbrock@us.ibm.com](mailto:jcbrock@us.ibm.com).

## Appendix 1: “Day in the Life” workload

Table 5 contains the list of the web-based transactions used in the “Day in the Life” workload. The table reflects the transaction mix defined by Oracle for use with JD Edwards EnterpriseOne application release 9.0.

Transaction	Description	Percent of Users
P03B102	Apply Receipts	10
P04111	Supplier Ledger Inquiry	10
P051141	Daily Time Entry	2
P17500	Case Management Add	5
P31114	Work Order Completion	3
P3411	MRP Messages (WO Orders)	2
P3411	MRP Messages (OP Orders)	2
P3411	MRP Messages (OT Orders)	2
P4113	Inventory Transfer	5
P42101	Sales Order Entry – 10 Line Items	25
P42101	Sales Order Update	5
P4310	Purchase Order Entry – 25 Line Items	20
P4312	Purchase Order Receipts	3
P4314	Voucher Match	1
P4915	Ship Confirmation – Approval only	1
P4915	Ship Confirmation – Confirm/Ship only	1
P4915	Ship Confirmation – Confirm and Change Entry	1

Table 5 - Day in the Life interactive benchmark transactions run

Table 6 contains the list of UBE transactions used in the “Day in the Life” workload for the batch component of this benchmark.

Transaction	Description	Class
R42520	Print Pick Slips	Long
R09801	General Ledger Post	Long
R31410	Work Order Processing	Long
R31802A	Manufacturing Account Journal	Long
R03B155	A/R Summary Analysis	Short
R0012P1	AAI Report	Short
R04413	Open A/R Summary Report	Short
R04602	Supplier Analysis Report	Short
R0008P	Date Patterns Report	Short
R0018P	Tax Detail Report	Short
R0006P	Business Unit Report	Short
R41543	Item Ledger/Account Integrity	Short
R00425	Organization Structure Report	Short
R0004P	UDC Records Type Print	Short
R03B31	Activity Log Report	Short
R0909P	Chart of Accounts Report	Short
R09017	Account Translation Report	Short
R0014	Payment Terms Report	Short
R42072	Price Category Print	Short



R0010P	Company Constants Report	Short
R03B461	Collection Report	Short
R46990	Warehouse Location Integrity	Short

*Table 6 - Day in the Life UBE benchmark transactions run*

The "Day in the Life" benchmark definition was designed to be more representative of customer environments and more realistic. It has been the standard for performance evaluations since the release of JD Edwards EnterpriseOne 8.12. It has several changes from the previous classic 17 benchmark definition:

- It uses a larger database, about 100GB in size.
- It includes both interactive user web-based and UBE based operations.
- It has a broad application coverage including options for turning on Advance Pricing and Advanced Transportation. It includes Customer Relationship Management (CRM), Human Capital Management (HCM), Supplier Relationship Management (SRM), and Financial Management Service (FMS). It also uses Powerforms.
- It is process oriented rather than inquiry oriented.
- It integrates the use of Verity and Vertex.

The tests initiated in this benchmark are part of a "Day in the Life" benchmark kit provided by Oracle. Oracle has reviewed IBM's testing methodology and results and has found them to be sound and consistent with industry standard practices.

## Appendix 2: System and application tuning

The following describes how IBM i, WebSphere Application Server, and JD Edwards EnterpriseOne were tuned for the measurements in this whitepaper.

### System configuration

The POWER7 processor-based system used was an IBM Power 770 Model 9117-MMC with varying partition configurations as described above. All tests were run on the same system using the “All on i” configuration in which the Database, Enterprise, and HTML servers are all run in a single instance..

The number of HTTP servers, HTML servers and JD Edwards EnterpriseOne instances increased as the number of interactive users increased. The configuration settled upon as optimal was:

- 1 HTTP server per 4000 interactive users.
- 4 HTML servers per 4000 interactive users.
- 2 JD Edwards EnterpriseOne instances, one handling 8000 interactive users and the other 4000 interactive users and the UBE workload.

### IBM i tuning

- Activity levels were set to sufficiently large values to preclude job transitions to ineligible.
- Separate memory pools were used for the Websphere Application Servers, HTML Servers, each JD Edwards EnterpriseOne instance, and the short-running UBEs. The database server and long-running UBE jobs ran in the base pool.
- The job priority of the UBEs was set lower than the job priority of the jobs servicing the interactive users.
- The memory pools were configured to minimize faulting in the machine pool.

Table 7 is an example memory pool allocation from the 24 processor, 512 GB test of 8000 interactive users and the UBE workload:

Pool	Size (Mb)
Machine	30788
Base	206828
Websphere	90000
JDE instance 1	90000
JDE instance 2	42000
HTTP	30000
Short-running UBEs	30000

Table 7- Sample Pool Allocation of 512 Gb

### WebSphere tuning

- Websphere was installed at the latest level currently supported by Oracle, 7.0.0.19 (fixpack 19).
- Up to fifteen HTML servers were used as indicated previously.
- Initial and maximum heap size for the HTML server JVMs were both set to 2048 MB.
- Separate shared class caches were used for each JVM. The shared class maximum cache size was set to 50 Mb (-Xscmx50M).



- All JVMs were configured for a garbage collection policy of gencon which more effectively manages the needs of both short lived temporary (nursery) and tenured heap objects.
- The size of the nursery heap was set to 1536 MB (-Xmn1536m).
- The 'gctthreads' were set to 24 (-Xgctthreads24). The recommendation is to set this value to equal the number of processing CPUs allocated to the partition. What was observed was the default number of garbage collection threads appeared to be the CPUs multiplied by 4.
- Web container threads were set to an initial value of 75 and a maximum value of 301 for runs with both interactive and UBE workloads. For interactive only workloads, a value of 100 was used for both the initial and the maximum value.
- Portlet fragment cache was enabled.
- Web container servlet caching was enabled.
- The default dynamic cache size was increased to 20000.
- The HTTP FRCA cache was enabled to cache EnterpriseOne static web content.

### JD Edwards EnterpriseOne tuning

- JD Edwards EnterpriseOne release 9.0.2 and Tools Release 8.98.4.5 were used.
- All application users run using the same user profile.
- Kernels were configured based on previously published guidance. The number of Call Object Kernels was based on a value of one kernel for 25 users (for example 480 Call Object Kernels for 12,000 users) except for the 15,000 and 16,000 user runs, which also used 480 kernels.

Settings of interest in ini files. Values omitted can be assumed to have been typical or default values.

- jdbj.ini
  - JDBj-CONNECTION POOL
    - minConnection=110
    - maxConnection=300
    - initialConnection=110
  - JDBj-RUNTIME PROPERTIES
    - as400PackageLibrary=QRECOVERY
    - as400ExtendedDynamic=true
    - as400Package=JDBj
- jas.ini
  - OWWEB
    - MAXUser=2000
    - EnableCompression=false
    - OWVirtualThreadPoolSize=550
  - JDENET
    - maxPoolSize=700
- jde.ini (values for 12000 to 16000 user tests, two JD Edwards EnterpriseOne instances)
 

Kernels	Instance1/Instance2
▪ Call Object	320/160
▪ Security	60/30
▪ Metadata	1/1



- UBE 1/7
- UBE Subsystem 1/1
- Workflow 1/1
- JDENET
  - maxNetProcesses 40/20
  - maxNetConnections 8500/4500
  - maxKernelProcesses 1000/1000
  - enterpriseServerTimeout 12000/60000
  - useKeepAlive 1/1
  - HandleKrnSignals 1/1
  - maxNumSocketMsgQueue 400/400
  - maxIPCQueueMsgs 200/200
  - maxLenInlineData 4096/4096
  - maxLenFixedData 16384/16384
  - maxFixedDataPackets 2000/2000
- JDEIPC
  - maxNumberOfResources 3000/2000
  - maxNumberOfSemaphores 1000/1000
  - startIPCKeyValue 2101/8301
  - avgResourceNameLength 40/40
  - maxMsgqEntries 1024/1024
  - maxMsgqBytes 65536/65536
  - msgQueueDelayTimeMillis 40/50



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