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DATABASE APPLIANCE

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Oracle Database Appliance characterization with JD Edwards EnterpriseOne

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Executive Overview

The purpose of this white paper is to illustrate deployment of Oracle JD Edwards EnterpriseOne applications database on Oracle Database Appliance and characterize the performance of the combined, integrated Oracle stack.

Enterprise applications require robust, highly available, secure, high performance platforms. Oracle Database Appliance is a suitable platform to run enterprise class databases that typically require high availability and reliability.

Oracle Database Appliance is a pre-configured, highly available Oracle database system. It is a complete system that includes hardware, software, networking, and storage, all packaged in a single 4-U rack installable box. The hardware configuration provides complete redundancy and protects against all single points of failures in the system.

Figure 1 - Oracle Database Appliance System

The information presented in this white paper is the result of a project involving extensive testing of various Oracle JD Edwards EnterpriseOne application workloads against different Oracle Database Appliance configurations.

Introduction

Oracle Database Appliance

Oracle Database Appliance is a two node RAC cluster database system running Oracle Linux operating system, Oracle Database, Oracle Clusterware and Automatic Storage Management. These components provide the foundation for the highly available databases operating on Oracle Database Appliance.

Oracle Database Appliance comprises of two independent, but interconnected compute nodes and direct attached SAS and SSD storage. The storage provides about 4 TB of usable space in a highly available, fully redundant configuration. Oracle Database Appliance requires minimal configuration and almost no performance tuning. For performance intensive applications, minor tweaks may be required. Oracle Database

Appliance includes Oracle Appliance Manager software to manage and maintain the database system, including patching of the entire stack, upgrades of all stack components, as well as end to end troubleshooting.

JD Edwards EnterpriseOne

Oracle's JD Edwards EnterpriseOne is an integrated suite of comprehensive enterprise resource planning applications software that combines business value, standards-based technology, and deep industry experience into a business solution with a low total cost of ownership. EnterpriseOne ERP solution is designed to run on different platforms and database architectures. JD Edwards EnterpriseOne also delivers mobile applications. It is also the first ERP solution to run all applications on Apple iPad.

Project goals and architectural setup

The objective of this project is to validate installation and configuration of Oracle JD Edwards EnterpriseOne applications in an environment with Oracle Database Appliance serving as the database host. In addition, this project is to demonstrate the performance testing of Oracle JD Edwards EnterpriseOne applications involving a combination of interactive and batch workloads.

The interactive and batch workload was generated using HP LoadRunner tool version 9.52. A single controller running in a Microsoft Windows (2008) operating system environment was used for the testing. Batch processes were executed from the command line interface on the EnterpriseOne Logic Server running in an OVM (Oracle Virtual Machine) on a separate Oracle X4100 machine.

- Web Tier
  - Oracle Sun X4100, 4-way, 16 GB
  - OVM 3.0.3 (7 GB)
- Logic Tier
  - Oracle Sun X4100, 4-way, 16 GB
  - OVM 3.0.3 (6 GB)
  - JDEdwards EnterpriseOne Tools Version 8.98.4.9
  - JDEdwards EnterpriseOne Application Version 9.0
- Data Tier
  - Oracle Database Appliance (OAK 2.3)
  - Very Small and Medium RAC Configurations Only
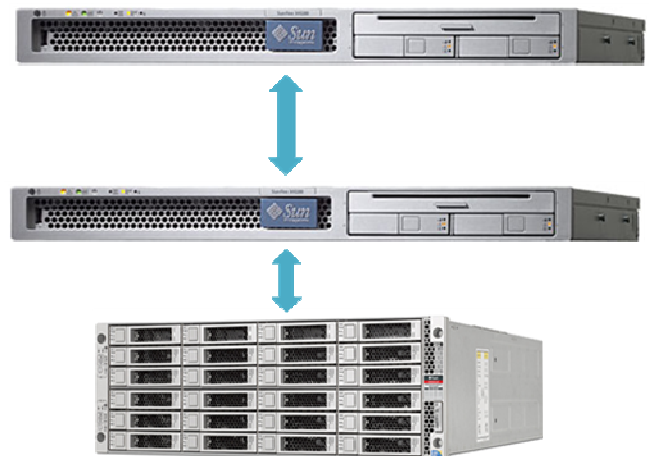 - Oracle RDBMS 11.2.0.3.0
  - Oracle Enterprise Linux 5, UEK

Figure 2 - Oracle JD Edwards EnterpriseOne and Oracle Database Appliance Testing Architecture

Performance measurements were collected from LoadRunner controller, the database, and the operating system. For operating system level performance measurements, the following standard tools were used.

➢ mpstat
➢ vmstat
➢ iostat
➢ free
➢ netstat

For transaction level performance measurements, LoadRunner results were used and for database level performance Automatic Workload Repository (AWR) reports were used.

Oracle Database Appliance sizing

Oracle Database Appliance comes pre-configured with standardized configuration templates. These templates can be used to rapidly deploy databases of various sizes, from a very small configuration that activates 2 cores on each server node to a very large configuration that uses all 12 cores on each server node. The database configured using these standard templates automatically includes Oracle recommended configuration best practices and creates a pre-tuned configuration. This greatly simplifies the deployment process and results in an optimal deployment.

The following matrix describes the database templates deployed on Oracle Database Appliance. This matrix is available in Oracle Database Appliance Getting Started Guide Release 2.4 (part number E22692-18)

System Component	Very Small	Small	Medium	Large	Very Large
CPU	2	4	8	12	12
Memory (GB)	8	16	32	48	96
Database Size (GB)	136	273	546	819	1638
Log File Size (GB)	1	1	2	4	4
Number of DBs	12	6	3	2	1
IOPS	300	600	1300	2000	4000
MBPS	250	500	1000	1500	3000
Log Generation (MB/Sec)	6.83	6.83	13.65	27.30	27.30

Table 1 - Oracle Database Appliance Database Sizing Matrix for RAC Configurations

Oracle Database Appliance supports pay-as-you-grow licensing model. CPU cores are activated based on customer needs according to the matrix above. For the VERY SMALL configuration, only 2 cores were activated on each server node within the Oracle Database

Appliance. For the MEDIUM configuration, 4 cores were activated on each server node within the Oracle Database Appliance, in accordance with the published sizing matrix.

Adjustments to standard Oracle Database Appliance templates

Oracle Database Appliance comes pre-configured with best practices. However, sometimes for specific workloads, minor adjustments to the configuration may be required. For the workload testing conducted during the course of writing this white paper, two specific changes were identified to increase the effective capacity of Oracle Database Appliance for Oracle JD Edwards EnterpriseOne ERP Applications workloads. Both these parameters belong to the database configuration and can be changed directly in the database.

- **PROCESSES** parameter – The PROCESSES database parameter was increased to 3000. The default setting of this parameter is 200 for the VERY SMALL template and 800 for MEDIUM template.

- **OPEN_CURSORS** parameter – The OPEN_CURSORS database parameter was increased to 5000. The default setting of this parameter is 1000.

Workload and test design

A single server managed instance process (i.e., a single JVM) was used for all tests conducted. The number of EnterpriseOne Call Object Kernel was adjusted during the tests to maintain a ratio of 10 users per Call Object Kernel.

The Day-in-the-Life (DIL) kit was used for generating database workload during testing. The Day-in-the-Life kit consisted of interactive and batch workload components as detailed below.

It may be noted that general system workload, was not taken into account during this testing. The general system workload may include, but is not limited to:

1. Database backups
2. Data loads and extracts
3. Data replication to external site, disaster recovery site, etc.
4. Local data validation and verification on local system, etc.

Interactive workload

Oracle JD Edwards EnterpriseOne DIL kit includes 16 interactive transactions and queries. These transactions and queries belong to 5 different modules as depicted in the table below.

Process	Application	Description
1	P03B102	Apply Receipts
2	P0411	Supplier Ledger Inquiry
3	P051191	Daily Time Entry
4	P31114	Work Order Completion
5	P3411	MRP Messages (WO Orders)
6	P3411	MRP Messages (OP Orders)
7	P3411	MRP Messages (OT Orders)
8	P4113	Inventory Transfer
9	P42101	Sales Order Entry - 10 line items
10	P42101	Sales Order Update
11	P4310	Purchase Order Entry - 25 line items
12	P4312	Purchase Order Receipts
13	P4314	Voucher Match
14	P4915	Ship Confirm - Approval only
15	P4915	Ship Confirm - Confirm/Ship only
16	P4915	Ship Confirm - Confirm and change entry

Table 2 - Interactive workload – EnterpriseOne DIL kit

Batch workload

The Day-in-the-Life kit includes 18 batch processes. These short and medium running batch processes (also known as, Universal Batch Engine or UBEs) are listed in the tables below.

Type	Process	Application	Description
SHORT	1	R0004P	UDC Records Types Print
SHORT	2	R0006P	Business Unit Report
SHORT	3	R00067	Business Unit Translation Report
SHORT	4	R0008P	Date Patterns Report
SHORT	5	R0010P	Company Constants Report
SHORT	6	R0012P1	AAI Report
SHORT	7	R0014	Payment Terms Report
SHORT	8	R0018P	Tax Detail Report
SHORT	9	R00425	Organization Structure Report
SHORT	10	R01402W	Who's Who Report
SHORT	11	R03B155	A/R Summary Analysis
SHORT	12	R03B31	Activity Log Report
SHORT	13	R41411	Select Items Cost Count
SHORT	14	R42072	Price Category Print
MEDIUM	1	R31410	Generate and Print Work Orders
MEDIUM	2	R3483	Multi-Facility MPS - Net Change
MEDIUM	3	R42565	Print Invoice
MEDIUM	4	R43500	Print Purchase Orders

Table3 - Batch workload – EnterpriseOne DIL Kit

Each of the LoadRunner scripts simulated a series of web interface actions, including:

- Logging into EnterpriseOne applications
- Performing a series of steps within an EnterpriseOne module
- Repeating these steps for a number of iterations
- Logging out of EnterpriseOne applications

The above actions simulate those of a typical user of JD Edwards EnterpriseOne applications. For example, during these test sessions, virtual users perform steps such as issuing a "find", pressing the "OK" button, pressing the "Submit" button, and performing other such functions. For each script, LoadRunner measures and records the time and duration of each of these actions. The average end user response time metric reported in this white paper is a composite average of the 16 LoadRunner script metrics (i.e., the interactive workload).

As stated previously, the workload executed during the tests consisted of both the interactive and the batch database workload elements. These processes running concurrently on Oracle Database Appliance, did not consume significant amount of computing resources. The computing resources referred here are the CPU and memory resources on the database server nodes. The maximum CPU utilization on Oracle Database Appliance server nodes during testing was less than 35%, while consumed and available memory was sufficient and remained fairly constant.

The resource consumption on the web and logic tiers was relatively very significant. On the EnterpriseOne Logic Server, the interactive workload was responsible for about 5% of resource consumption while the batch job resulted in 95% of the consumed CPU and memory resources. This was expected.

Test results

Before describing the test results it is important to note the following details as these details should help understanding of the test results.

Validation testing

The setup of Oracle JD Edwards EnterpriseOne was successfully performed using standard installation and configuration processes. Performance and stress testing was also successfully performed using the standard Day-in-the-Life (DIL) kit.

The standard installation and configuration process, as tested, included the following:

1. Verification of minimal technical requirements
    a. Oracle Database Server and Oracle Client software
    b. Java JRockit

   c. WebLogic Server software
   d. EnterpriseOne software
   e. EnterpriseOne Deployment Server
2. Installation and validation of the Deployment Server, Server Manager
3. Application of Planner ESU and upgrade of Deployment Server Tools version to 8.98.4.9
4. Performing EnterpriseOne PORTTEST
5. Upgrade of EnterpriseOne Tools version to 8.98.4.9 (Base installation is 9.0 with Tools Release 8.98.4) on the EnterpriseOne Logic Server using Server Manager
6. Installation and Configuration of Java JRockit and WebLogic Server
7. Implementation of EnterpriseOne Tools 8.98.4.2 on the WebLogic cluster configuration
8. Validation of web connectivity by accessing the EnterpriseOne application through the URL
9. Testing and validation of a number of EnterpriseOne interactive applications and completing the initiation of a batch process
10. Performing an EnterpriseOne update package build and deploy
11. Performing an EnterpriseOne full package build and deploy
12. Re-testing the EnterpriseOne interactive applications and batch case scenarios after the EnterpriseOne software upgrade

The Oracle database was expanded to simulate a real-world customer database. The database configuration was modified to ensure both the interactive and batch processes functioned as expected. Two hundred different unique users were created and used during the interactive user tests to simulate the environment of an average EnterpriseOne customer.

Performance metrics

The key metrics collected during testing were *average end-user response time* as well as *average CPU* and *average memory* resource consumption at operating system level on all tiers.

Average end-user response time – LoadRunner

The average end-user response time was the main performance metric collected by the LoadRunner controller to measure changes in workload execution efficiency. The 16 LoadRunner scripts driven by the controller simulated five of the major modules in the EnterpriseOne application.

The average end user response time metric reported in this white paper is a composite average of the 16 LoadRunner metrics (interactive workload). This metric were used to characterize the EnterpriseOne applications' performance on the Oracle Database Appliance.

Operating System CPU and memory metrics

The operating system metrics, CPU utilization, memory utilization, disk I/O, and network statistics, typically provide other valuable measures of system performance. Operating systems metrics reported in this document are the operating system resource utilizations. They help gauge the utilization of resources across the deployed architecture and the capacity to execute additional work.

The primary operating system metrics used for EnterpriseOne applications characterization were CPU and Memory utilization. Additional metrics such as disk I/O, network I/O, etc. were collected but these did not present a bottleneck or concern and were not considered key to overall performance and operational characterization.

Load testing

Please note that, in the workload mix documented in this white paper, "users" represent interactive users and "UBE" (universal batch engine) represent batch jobs.

Terminology Reference	Workload Type
Users	Interactive Workload
UBE (Universal Batch Engine)	Batch Workload

Table 4 - Interactive and batch workloads - terminology

Load testing was performed to characterize the performance of Oracle Database Appliance system over an increasing user workload. Two different Oracle Database Appliance configurations were used for different rounds of testing. These were the configurations corresponding to the "VERY SMALL" and "MEDIUM" database sizing templates available with Oracle Database Appliance.

Load testing was performed in a single instance database configuration environment as well as the clustered database environment. The single database instance environment consisted of the database instance running on only one of the two server nodes available within the Oracle Database Appliance. The clustered database environment consisted of Oracle Real Application Clusters (RAC) database instances running concurrently on each of the two server nodes within the Oracle Database Appliance.

Database Template (Size)	Attributes
VERY SMALL (RAC)	2 CPU Cores per Node, 8GB Memory, 136GB Database
MEDIUM (RAC)	4 CPU Cores per Node, 32GB Memory, 546GB Database
VERY SMALL (Single Instance)	2 CPU Cores total, 8GB Memory, 136GB Database
MEDIUM (Single Instance)	4 CPU Cores total, 32GB Memory, 546GB Database

Table 5 - Oracle Database Appliance – configurations used for testing

The configuration of how the interactive users processed transactions was consistent across all tests performed with different user volumes. The configuration of how the UBEs processed batch jobs was consistent across all tests performed with different user volumes. The difference in performance and resource consumption measurements across different tests is thus a result of the server's ability to process the given workload and perform the necessary work and not due to inefficiencies introduced by differences in configuration.

The duration of each performance test was 30 minutes. The workload ramp up time was taken into account when starting the window of measurement. The operating system statistics collection and EnterpriseOne statistics gathering corresponds to the window when all users were running and all UBEs were fully submitted.

Tests were run in two database configurations, namely - one RAC node and two RAC nodes. The tests were performed with using a single node of Oracle Database Appliance and then the same test was repeated with both server nodes up in a clustered (RAC) configuration. The results refer to these two configurations as "one RAC node" and "two RAC nodes" configurations.

Increasing user workload – OS metrics

The purpose of interactive user load testing was to determine the base scalability and stability of Oracle Database Appliance configuration with increasing EnterpriseOne applications interactive user workload. Due to middle tier server limitations testing was performed up to 400 users only. It is likely that the EnterpriseOne applications workload would continue to scale on Oracle Database Appliance, if this external resource limitation was removed.

The data shown on the following charts represents the data collected during the testing runs of the DIL kit workload with increasing user loads on the Oracle Database Appliance configuration.

End-user response time

For almost all of the tests conducted, Oracle Database Appliance provided, on average, sub-second response time in terms of end user experience.

Concurrent Users →	50	100	200	400
User Load with UBEs				
Very Small - One Node	0.234	0.260	0.402	2.060
Very Small - Two Nodes	0.224	0.265	0.340	0.478
Medium - One Node	0.259	0.252	0.401	1.846
Medium - Two Nodes	0.280	0.241	0.363	1.111
User Load Only				
Very Small - One Node	0.098	0.081	0.104	0.283
Very Small - Two Nodes	0.114	0.1	0.117	0.278

Medium - One Node	0.094	0.094	0.105	0.214
Medium - Two Nodes	0.106	0.104	0.129	0.195

Table 6 - End-user average response time for increasing concurrent users

The above metrics show that as concurrent user volume increase, in both interactive only and interactive plus batch workload execution scenarios, the end-user response time increased. However, the end-user response time remained within an acceptable limit (sub-second) for all but one 400 user scenario. For the 400 user scenario, the response time exceeded the 1 second range.

There was an anomaly in this end-user response time observations. For the VERY SMALL database configuration the end-user response time was better than the MEDIUM database configuration. This was found to be due to a high level of resource consumption (and periodic saturation) at the LOGIC tier of the deployed test architecture.

Transactions per minute

Transactions per minute were measured for concurrent interactive user workload running by itself as well as for concurrent execution of interactive user workload and batch workload (UBEs). The following data illustrates that transactions per minute increased linearly (while maintaining reported performance levels) as workload increased.

Concurrent Users	50	100	200	400
User				
Very Small - One Node	38	73	138	251
Very Small - Two Nodes	39	76	140	260
User & UBE				
Very Small - One Node	37	72	135	218
Very Small - Two Nodes	36	75	136	219
User				
Medium - One Node	39	76	142	269
Medium - Two Nodes	39	76	143	274
User & UBE				
Medium - One Node	38	75	142	220
Medium - Two Nodes	36	72	135	233

Table 7 - Transactions per minute

Total UBEs (batch) processed

Batch jobs processing rate was measured as user volume was increased in both single node and two node configurations. As interactive workload increased fewer UBE batch

jobs were processed, while maintaining acceptable execution time. In these sets of observations also, an anomaly was observed where more UBE batch jobs were processed in the VERY SMALL configuration than in the MEDIUM configuration.

Concurrent Users	50	100	200	400
Very Small - One Node	1624	1500	1262	1022
Very Small - Two Nodes	1501	1428	1162	1008
Medium - One Node	1620	1512	1218	940
Medium - Two Nodes	1477	1386	1162	845

Figure 8 - Total UBEs processed (with concurrent users)

Oracle Database Appliance resource utilization

Average CPU consumption on Oracle Database Appliance

The CPU consumption levels on Oracle Database Appliance were, in general, observed to be relatively low during the workload testing. The maximum CPU utilization rate observed was less than 35% when using the VERY SMALL configuration and below 15% when using the MEDIUM configuration.

Concurrent Users	50	100	200	400
Very Small Template				
User-One Node	13.990	14.330	17.530	18.990
User-Two Nodes	10.930	11.670	13.970	16.310
User & UBE-One Node	33.080	34.000	32.610	32.410
User & UBE-Two Nodes	23.200	22.185	22.040	22.895
Medium Template				
User-One Node	6.140	6.870	7.950	10.020
User-Two Nodes	5.575	5.830	6.630	7.870
User & UBE-One Node	15.450	14.940	15.450	15.230
User & UBE-Two Nodes	10.300	10.210	10.440	10.575

Figure 9 - Average CPU consumption on Oracle Database Appliance during DIL Kit Execution

Average memory consumption on Oracle Database Appliance

The average memory consumption on Oracle Database Appliance was observed to be as follows. Note that, the memory consumption is not variant, as expected.

Concurrent Users	50	100	200	400
Very Small Template				
User-One Node	58.170	58.680	59.700	61.650
User-Two Nodes	57.600	57.880	58.360	59.280
User & UBE-One Node	59.520	59.730	60.760	62.460
User & UBE-Two Nodes	58.140	58.460	58.900	60.200
Medium Template				
User-One Node	57.930	58.570	59.670	61.590
User-Two Nodes	57.900	58.280	58.490	59.515
User & UBE-One Node	58.990	59.650	60.560	62.850
User & UBE-Two Nodes	57.890	58.085	58.835	59.840

Figure 10 - Average memory consumption on Oracle Database Appliance server nodes

EnterpriseOne server resource utilization

EnterpriseOne server average CPU consumption

The EnterpriseOne server performance showed that it was a constraining factor in the testing architecture. As the data below illustrates, execution of UBEs caused an immediate escalation in CPU consumption at the EnterpriseOne server layer, while the interactive user workload had minimal impact on CPU consumption at this layer.

Concurrent Users	50	100	200	400
Very Small Template				
User-One Node	3.100	5.630	12.140	27.180
User-Two Nodes	2.810	5.290	11.560	33.780
User & UBE-One Node	96.700	96.720	96.730	96.740
User & UBE-Two Nodes	96.400	96.570	96.700	96.730
Medium Template				

User-One Node	3.081	5.450	11.730	33.990
User-Two Nodes	2.850	5.420	11.960	33.720
User & UBE-One Node	96.760	96.760	96.760	96.780
User & UBE-Two Nodes	95.980	96.260	96.370	96.760

Figure 11 - Average CPU consumption on EnterpriseOne server

EnterpriseOne Server average memory consumption

Memory consumption at the EnterpriseOne server was significant during the testing, although it was not a limiting factor.

Concurrent Users	50	100	200	400
Very Small Template				
User-One Node	45.660	54.160	60.900	74.930
User-Two Nodes	38.220	45.440	53.410	73.140
User & UBE-One Node	47.960	54.810	63.670	79.760
User & UBE-Two Nodes	61.570	66.340	75.520	92.560
Medium Template				
User-One Node	44.670	51.680	63.180	81.780
User-Two Nodes	51.610	60.070	63.270	86.000
User & UBE-One Node	64.420	69.800	77.930	91.750
User & UBE-Two Nodes	61.060	65.370	80.170	92.440

Figure 12 - Average memory consumption on EnterpriseOne server

Web Server resource utilization

Web server CPU utilization

CPU utilization at the web server layer was relatively low and was not a limiting factor.

Concurrent Users	50	100	200	400
Very Small Template				
User-One Node	10.060	14.140	24.570	34.250
User-Two Nodes	10.610	13.700	25.540	54.900
User & UBE-One Node	9.310	16.290	23.350	39.130
User & UBE-Two Nodes	11.120	16.110	24.080	36.700
Medium Template				
User-One Node	10.030	15.340	24.400	51.410

User-Two Nodes	9.620	17.840	25.810	51.080
User & UBE-One Node	9.420	12.700	16.180	35.610
User & UBE-Two Nodes	10.310	11.640	23.360	43.370

Figure 13 - Average CPU Consumption on web server

Web Server average memory utilization

Memory consumption at the web server layer was significant. However, it was not a limiting factor.

Concurrent Users	50	100	200	400
Very Small Template				
User-One Node	56.020	73.050	74.370	78.920
User-Two Nodes	56.230	72.710	74.320	78.600
User & UBE-One Node	58.830	65.570	75.520	78.730
User & UBE-Two Nodes	57.370	65.830	78.340	78.710
Medium Template				
User-One Node	56.440	66.520	77.300	78.830
User-Two Nodes	74.190	62.220	78.120	79.060
User & UBE-One Node	59.390	69.440	60.210	78.990
User & UBE-Two Nodes	55.970	64.600	78.530	79.240

Figure 14 - Average Memory Consumption on Web Server

Observations and findings

Oracle JD Edwards EnterpriseOne application configuration and performance was smooth during testing of the DIL kit workload. Oracle Database Appliance proved to be an effective environment from a performance and availability point of view. The following major observations and findings were made during this project.

1. The interactive user response time exhibited consistency and constancy in both a single instance (non-clustered database) and 2 node (clustered database) configurations.
2. The interactive user response time exhibited consistency and constancy with both the VERY SMALL as well as the MEDIUM Oracle Database Appliance database configuration templates.
3. The overall response time and resource consumption increased in expected and acceptable proportions as interactive workload increased.

4. All of the testing was performed using a single Java Virtual Machine (JVM).
5. All tests were performed using dedicated connections to the Oracle database.
6. As workload increased, the PROCESSES parameter in the database configuration was a limiting factor in both the VERY SMALL and MEDIUM configurations, and was increased from the default value to a value to 3000. The maximum number of processes invoked during testing was 1256 and thus a lower value of the PROCESSES parameter may have been adequate.
7. The OPEN_CURSORS parameter was increased from the default value to a new value of 5000. The maximum number of open cursors observed was less than 2500. A value of 2500 would have been adequate.
8. Certain minor anomalies were observed during testing. These were a result of resource limitations on the EnterpriseOne server.

Conclusion

Oracle Database Appliance proved to be a powerful, highly available, ready to deploy database solution for running Oracle JD Edwards EnterpriseOne applications. The pre-built, pre-tuned nature of Oracle Database Appliance made the process of deployment rapid and flawless. The default configurations as enabled by the pre-built database configuration templates were adequate except for two minor changes. These changes allowed for generating significantly more horse power out of the default configurations. Unleashing additional workload caused the middle tier to become a bottleneck, although Oracle Database Appliance appeared willing to take additional workload. The response time and throughput of the test workloads was adequate and well within acceptable limits. A couple of minor anomalies observed during the testing can be attributed to the insufficient resource availability of the EnterpriseOne server. Users should perform a complete end to end exercise in order to remove any such bottlenecks proactively.

ORACLE®

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