

Scale Your Middleware to New Heights with Hewlett Packard and Oracle Fusion Middleware 11g

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Abstract

Oracle's Large Scale System Deployment (LSSD) is a suite of Performance, Scalability, Reliability (PSR) tests which simulates real-world, multi-user loads on a customer provided topology. This whitepaper aims to showcase the benchmarking exercise done as part of the LSSD effort targeting High-end Scalability of Oracle Fusion Middleware (OFM) 11gR1 components on HP Hardware (based on Intel Dunnington servers). This is the first ever combined scalability effort on Oracle Fusion Middleware 11gR1, and was done jointly with Hewlett-Packard Development Company, L.P.

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Executive Overview

Oracle Fusion Middleware 11gR1 is the foundation for innovation. It is the first application infrastructure foundation that enables enterprises to create and run agile and intelligent business applications and maximize IT efficiency by exploiting modern hardware and software architectures.

Fusion Middleware 11g is the only Middleware available from any vendor that offers the following unique design principles:

- Complete: Work with a single, strategic partner for all Middleware requirements
- Integrated: Certified integrations with Oracle Fusion Middleware, Oracle Database, and Oracle Applications provide confidence and reduce costs
- Hot-Pluggable: Enhance your existing infrastructure and applications with interoperability that goes beyond industry standards
- Best-of-Breed: Choose from best-of-breed offerings across every product line

This effort was supported by HP, Oracle's hardware partner. It was conducted in the lab fitted with enterprise-grade hardware provided and maintained by HP. Oracle's engineers and HP's engineers jointly estimated the hardware requirements necessary to complete the task, set up the complete farm using Oracle's software out-of-the-box, composed and conducted the tests. HP's engineers provided the necessary hardware, assisted with hardware maintenance and provided valuable guidance on how to best utilize the available hardware resources.

Benchmark Objectives

The objective of this benchmark is to showcase how Oracle Fusion Middleware can support large scale enterprise deployments with 2000 users accessing front-end user interface built using ADF, 400 users collaborating using WebCenter, all of which resulting in a workload of:

SOA Orders	4,600,000 Processed / Day
SOA Integration Objects	86,400,000 Processed / Day
WebCenter Pages	400,000 Rendered / Day
ADF Pages	2,000,000 Rendered / Day

*Day implies 8-hour business period.

Product Components Overview

The Oracle's Fusion Middleware (OFM) 11gR1 components used for this benchmarking effort include the following:

- Oracle Application Development Framework (ADF)
- Oracle Service Oriented Architecture Suite (SOA)
- Oracle WebCenter

Oracle Application Development Framework (ADF)

Oracle ADF framework provides the implementation of extremely rich Java EE applications, adhering to standard patterns and practices with greatly reduced effort and best of breed infrastructure code. ADF makes it easy to develop applications that expose data as services by coupling a service interface to the built-in business services in ADF. This separation of business service implementation details is performed in Oracle ADF via metadata, which enables application developers to focus on the business logic and user experience, rather than the details of how services are accessed.

ADF implements the Model/View/Controller (MVC) design pattern and further separates the model layer from the business services to enable service-oriented development of applications. The Model is the application object, the View is its screen presentation, and the Controller defines the way the user interface react to user input.

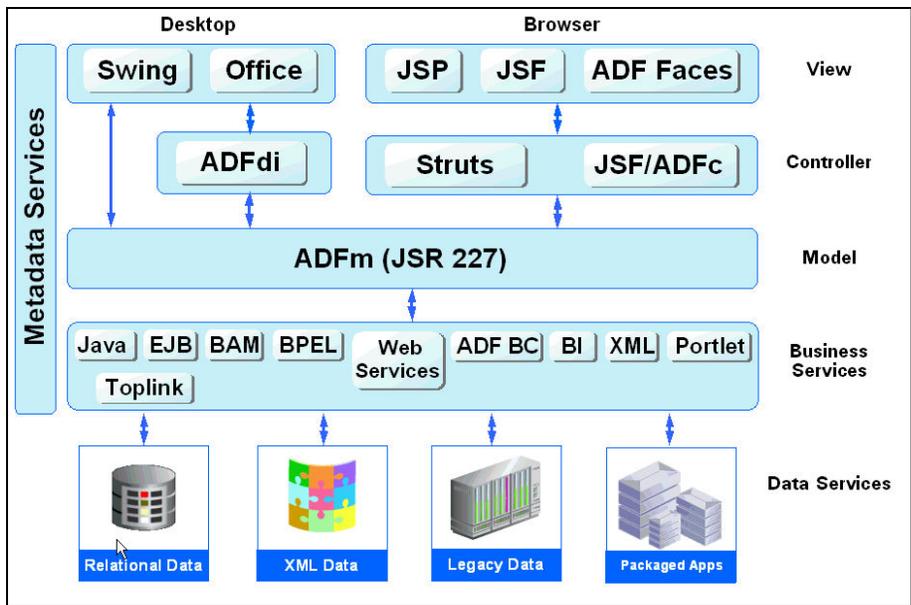


Figure 1: ADF Architecture

Oracle Service Oriented Architecture Suite (SOA)

Oracle SOA Suite 11g, a key member of the Oracle Fusion Middleware family of products, offers a one-stop solution for building, deploying, and managing Service-Oriented Architectures (SOA). SOA can be run in a variety of environments allowing organizations to extend and evolve their existing environments instead of replacing them. SOA Suite provides a simple development experience and delivers a runtime of extreme performance and scalability that manages events and services, along with a unified management and monitoring console.

Businesses can attain improved efficiency and agility through rules-driven, business process automation with Oracle SOA Suite. Oracle SOA Suite provides all the capabilities required to:

- Design SOA composite applications. It is integrated with JDeveloper which enables a developer to connect and work with virtually any data source, messaging service, database, application or trading partner through a unified connectivity framework that provides adapters, an included B2B gateway and pre-integration with Oracle Data Integration Suite.
- Routes, transforms and virtualizes services through the highly scalable Oracle Service Bus.

For more information on Oracle Service Oriented Architecture, see <http://www.oracle.com/technologies/soa/index.html>.

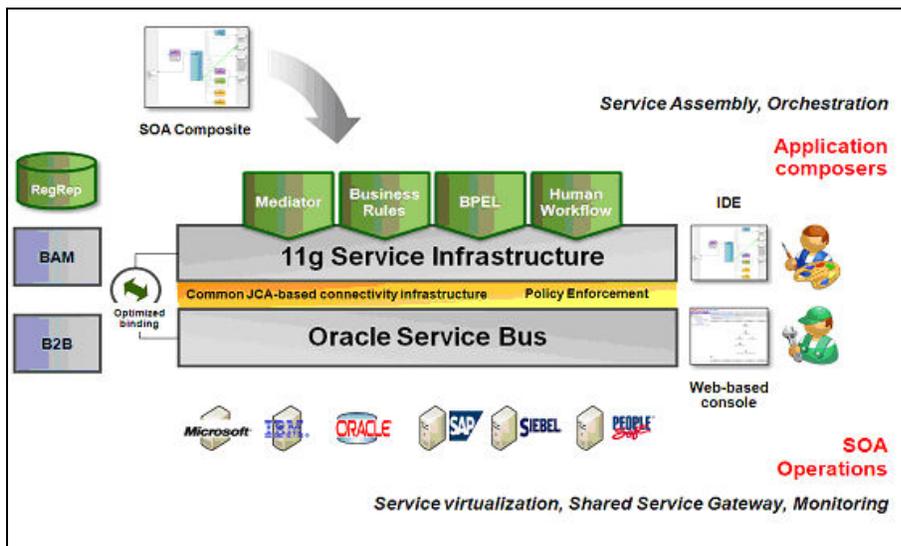


Figure 2: SOA Architecture

WebCenter Personal Spaces provide each user with a private work area for storing personal content, keeping notes and to-do lists, viewing and responding to business process assignments, scheduling personal events, maintaining a list of online buddies, and performing many other tasks relevant to his or her unique working day.

Business Role Pages provide a powerful way to communicate with specific types of users within an organization and across the company. Business Role Pages provide an efficient way to attach a page or set of pages to a specific enterprise role so that all the users are kept up-to-date with information specific to them and their job function.

Group Spaces support discrete communities of any size organized around an area of interest or a common goal, such as solving a business problem. Group Spaces provide a wide range of Web2.0 services and tools and enable social networking capabilities in your enterprise.

The following Webcenter products and services were used:

Oracle Internet Directory (OID)

Oracle Internet Directory is a general purpose directory service that enables fast retrieval and centralized management of information about dispersed users and network resources. It combines Lightweight Directory Access Protocol (LDAP) Version 3 with the high performance, scalability, robustness, and availability of an Oracle Database. Oracle Internet Directory runs as an application on an Oracle Database. It communicates with the database by using Oracle Net Services, Oracle's operating system-independent database connectivity solution.

For more information on OID, see
<http://www.oracle.com/technology/products/oid/index.html>

Oracle Universal Content Management (UCM) Server (Stellent)

Oracle Universal Content Management (UCM) server, formerly Stellent, is an automated system for sharing, managing, and distributing business information using a website as a common access point. Current information can be accessed quickly and securely from any standard web browser. You can manage virtually any type of content—letters, reports, engineering drawings, spreadsheets, manuals, sales literature, and more—in one powerful content management system. It provides capabilities such as Content Repository, Revision Control, Metadata, Security, User Administration, Product Conversion, Indexing, Content Searching, and Workflow invocation.

Oracle Universal Content Management provides industry-leading technology for multi-site Web Content Management, Document Management, Digital Asset Management and Records Management. Built on top of the powerful Oracle Content Server, these solutions allow you to quickly roll out a broad array of content solutions on a single, unified platform.

For more information on UCM, see
<http://www.oracle.com/technology/products/content-management/ucm/index.html>

Jive

Jive Forums is a powerful, open architecture, customizable community product that supports dynamic, threaded discussions on websites. Companies use Jive Forums for a variety of purposes, such as support communities, e-learning environments and internal collaboration environments. Jive discussion forum, which promote a sense of community and allow members to share and discuss information and opinions. Discussion forums are ideal for broadcasting thoughts to a wide audience or in situations where not all participants are logged on simultaneously.

For more information on Jive Forums, see <http://www.jivesoftware.com/beyond/forums>

Oracle Weblogic Communication Server (OWLCS)

Real Time collaboration (RTC) enables users to publish their availability and presence to the RTC community of their site. Send and receive messages between users and participate in chat or web conference. We have used OWLCS (formerly known as OCMS) to support user presence. Oracle Weblogic Communication Server (OWLCS) is a fully featured, Carrier-Grade, converged J2EE and SIP Application Server based on the JSR-116 (SIP Servlets) standard. It provides services such as Voice over IP, Presence, Instant Messaging, and an ability to create a multitude of other voice and multimedia services leveraging the SIP, Diameter, and other protocols. Deployment-wise, OWLCS can serve as the 'SIP AS' in IMS(Instant Messaging Server) networks or as a core SIP Server in telecom and enterprise networks.

For more information on Oracle WebCenter, see <http://www.oracle.com/technology/products/webcenter/index.html>.

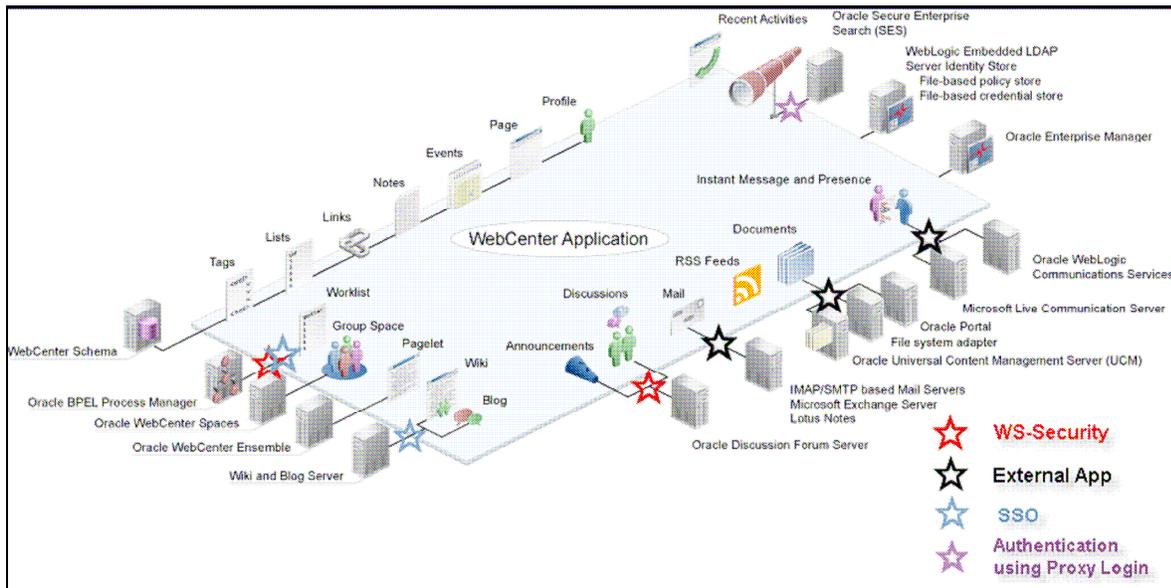


Figure 4: Identity Propagation Mechanisms leveraged by WebCenter Services

Benchmark Setup

The following sections describe the hardware/software specifications, the equipment layout, topology and the data set usage details for the benchmarking.

Hardware and Software Specifications

Installation	Computer	# CPU	# Cores/ CPU	CPU Speed	Memory	OS	# M/C
HP's Mercury LoadRunner Agent/Generator 8.1.4	HP Proliant DL380 G4 AMD Opteron 8356	2	2	3.4 GHz	2 GB	Win 2003 SP2	3
Oracle OFM 11g: Weblogic Server, EM, SOA, ADF, WebCenter, Jive, ECM, OID	HP Proliant BL680c G5 Intel(R) Xeon(R) E7450	4	6	2.4 GHz	32 GB	Oracle Enterprise Linux v2.6.18-128.el5	6
Database: Oracle 11g RAC ADF, SOA, WebCenter	HP Proliant BL680c G5 Intel(R) Xeon(R) E7450	4	6	2.4 GHz	64 GB	Oracle Enterprise Linux v2.6.18-128.el5	2
Database: Oracle 11g Jive, ECM, OID	HP Proliant BL680c G5 Intel(R) Xeon(R) E7450	4	6	2.4 GHz	32 GB	Oracle Enterprise Linux v2.6.18-128.el5	1
EVA8100 Disk Array	8GB Cache, 112 x 146 GB 15K RPM Fibre Channel Disks, 4/16 Full SAN Switch						

Equipment Layout and Interconnections

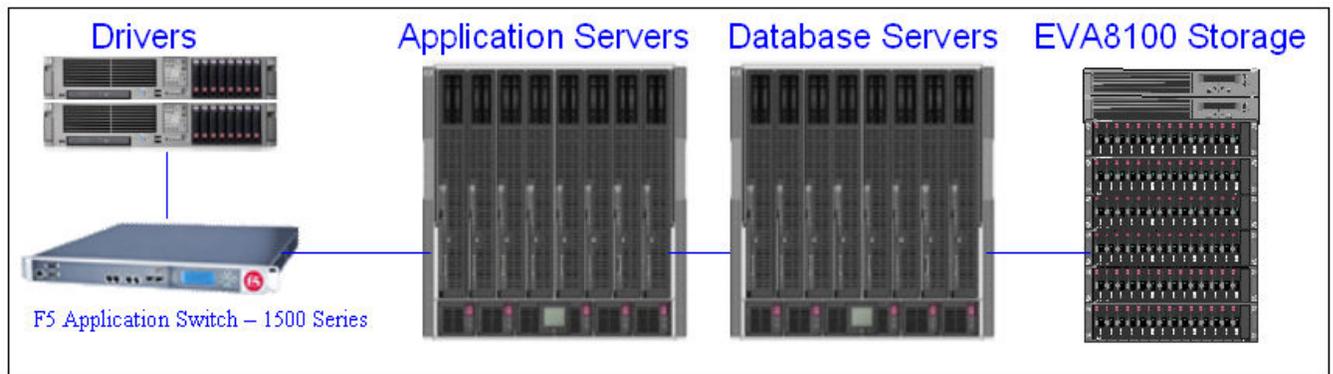


Figure 5: Equipment Layout and Interconnections

HP BladeSystem

A blade is literally a self-contained server, which collectively fits into an enclosure with other blades. Sometimes known as a chassis, this enclosure provides the power, cooling, connectivity, and management to each blade. The blade servers themselves contain only the core processing elements, making them hot-swappable. HP refers to the entire package as a BladeSystem.

A single blade contains hot-plug hard-drives, multiple I/O cards, memory, multi-function network interconnects, and Integrated Lights Out remote management. Blades normally connect to network attached storage, like the HP StorageWorks EVA, to provide high performance, high capacity and high availability "virtual" storage.

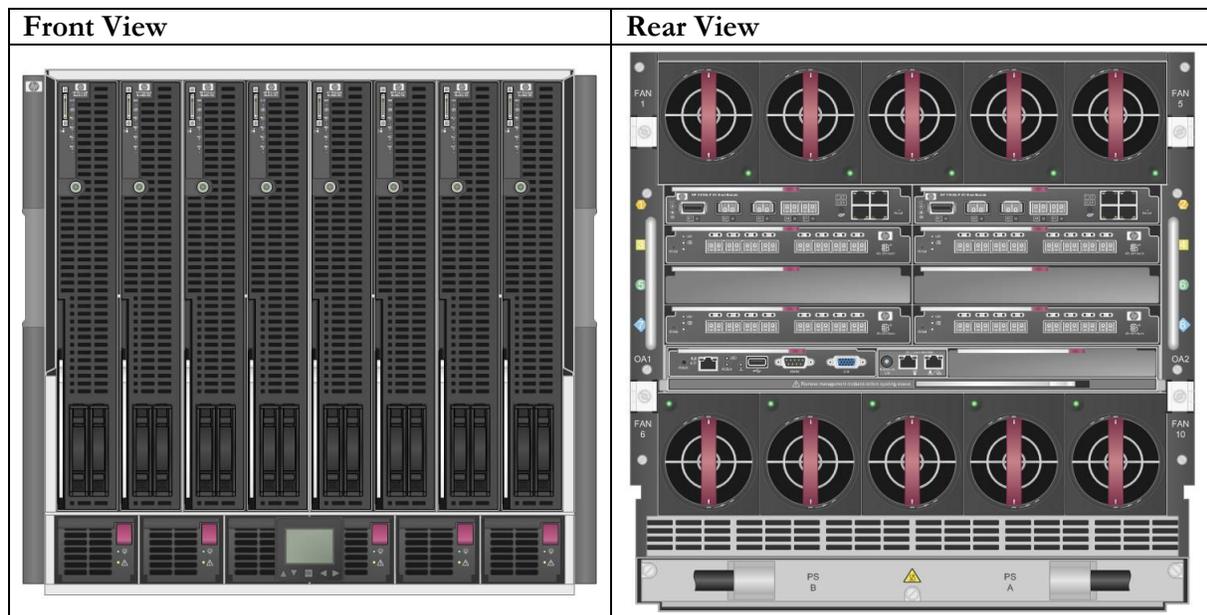


Figure 6: HP BladeSystem

In above figure the HP BladeSystem is shown with eight BL680c blades, and the rear shows the virtual connect modules, the SAN interconnects, and the on-board administrator module. When compared to other traditional rack-mount servers, a blade server can be dedicated to a single task, such as:

- Database and application hosts
- Virtual server host platforms
- Remote desktop or workstations
- File sharing
- Web page serving and caching
- SSL encrypting of Web communication
- Transcoding of Web page content for smaller displays
- Streaming audio and video content

Or, the HP BladeSystem can be combined into a Large Scale System as demonstrated in this paper. In other words, blades can be whatever you need them to be.

HP BladeSystem servers have the following advantages:

- Modular – The blade fits into a slot in an intelligent enclosure; physically swapping a blade takes seconds.
- Integrated – Wired-once slots mean that cabling can be reduced by up to 87% and the number of provisioning tasks minimized. After being inserted into a slot, the blade automatically connects to power, IP and fibre networks, and the advanced management features of HP BladeSystem. The management software is aware of the blade's physical slot location and the other resources to which the blade is connected.
- Automated – Blades, even if un-provisioned, are automatically discovered by HP management software; they are automatically managed and become candidates for provisioning and, subsequently, for automated monitoring.

HP Integrity and ProLiant Blade servers in particular will deliver all of the performance and reliability of rack-mounted servers in a compact, power-efficient form-factor. This means that services oriented application landscapes can easily be supported using HP Blades and HP BladeSystem enclosures. Blade enclosures support Integrity, ProLiant, and StorageWorks blades, and a complete compliment of networking capability, allowing for a flexible application environment with simple, consolidated management.

The scalability of HP BladeSystem makes it an ideal choice for a provisioning model; once the HP BladeSystem infrastructure has been set up, adding new servers becomes a trivial process. This infrastructure includes the HP server blades, an enclosure, networking (switches, Virtual Connect Ethernet modules), Fiber Channel (FC) network (switches, Virtual Connect FC modules), power supplies and fan options.

The provisioning model decreases the time taken to deploy Oracle nodes from hours or days to minutes. Repeatable, reliable, predictable, uniform results are achieved by using automated processes instead of manual procedures, eliminating the possibility of operator errors and helping to lower operations costs in the data center.

The HP BladeSystem Matrix provides the benefits of shared services today with the industry's first integrated infrastructure platform, that doubles admin productivity with payback of less than a year, built on HP BladeSystem the industry's leading blade architecture. Matrix instantly adjusts to dynamic business demands – provisioning and modifying complex infrastructure in minutes not months. Matrix combines disaster recovery, capacity planning, and automated provisioning with a self-service portal into one command center to unite your physical and virtual worlds. With Matrix, you get a wire-once infrastructure that converges network, storage and compute to help you accelerate complex IT projects, simplify daily tasks and continuously lower costs across your data center.

HP BL 680c G5

For this effort, the HP BL680c Generation 5 (G5) blade is used to host the middleware and database. The BL680c has a maximum of four Intel Xeon processors that may contain up to six cores each, as used in this project. Some maximum specifications follow.

- Four Intel Xeon processors with up to six cores each
- 128 GB of PC2-5300 DDR2 FB memory
- 1.0 TB of internal storage
- Three I/O expansion mezzanine slots
- Four embedded Gigabit Ethernet adapter ports

To review the latest Generation 6 configurations and for more information:

<http://www.hp.com/go/bladesystem>

HP BladeSystem InterConnects

To connect the BladeSystem to outside networks and storage, HP offers a variety of options to support familiar standards such as Ethernet, Fibre Channel and Infiniband. The built-in Virtual Connect architecture includes a 5 Terabit backplane, supports 4 redundant fabrics at once and includes 8, high-performance interconnect bays. All interconnect options are hot-pluggable and can be installed in pairs for full redundancy. To enhance the administration and manageability of the system interconnects, HP has developed the Virtual Connect modules.

Virtual Connect

Virtual Connect (VC) is an industry standards-based implementation of server-edge input-output virtualization. It puts an abstraction layer between servers and the external networks so that the Local Area Network (LAN) and Storage Area Network (SAN) see a fixed pool of servers rather than individual servers.

Oracle Applications and Database landscapes commonly need dense stacks of servers with hundreds of Ethernet and Fibre Channel (FC) connections to make the infrastructure work. HP Virtual Connect eliminates point to point connections and configuration complexity. The Virtual Connect Manager allows you to create I/O profiles, defining unique Media Access Control (MAC) addresses and World Wide Names (WWN). A VC profile is assigned to a specific bay in the blade enclosure, thus the addresses assigned to the bay override the factory defaults of the LAN and FC hardware on the blade server installed in the bay. The bay assigned MAC addresses and WWNs are the only addresses seen by the upper level operating system and other external references. This approach allows you to upgrade or replace a blade server without the need to change any of the external resources used by that server.

The ability to support Virtual Connect is built in to each HP BladeSystem c-Class component, including the Onboard Administrator (OA), FC Host Bus Adapters (HBA), Network Interface Controllers (NIC), and the HP Integrated Lights-Out (iLO) communication channels. Virtual Connect modules works with the standard Ethernet NICs and FC HBAs available for HP BladeSystem c-Class server blades; no other specialized mezzanine cards are required.

VC modules are required to activate server-edge I/O virtualization. VC Ethernet and FC modules simplify the connection of server NICs and HBAs to the data center environment and extend the capabilities of these standard server devices by supporting the secure administration of their Ethernet MAC addresses and FC WWNs. The effect of the VC modules make it appear that there are no virtual devices but that all the bay assigned addresses are the real and only identifiers seen by the system, the OS, and the network. Let's clarify this point, Virtual Connect has the unique ability to manage the MAC addresses and WWNs presented by the hardware without re-cabling and without requiring the assistance of multiple administrators. Although the hardware ships with default MAC addresses and WWNs, Virtual Connect resets these identifiers prior to boot so that Preboot eXecution Environment (PXE)/SAN boot and the OSs only see the identifiers managed by Virtual Connect.

Secure management is achieved by accessing the physical NICs and HBAs via the enclosure's OA and the iLO interfaces on the individual server blades.

See also: <http://www.hp.com/go/virtualconnect>

Virtual Connect Enterprise Manager

Virtual Connect Enterprise Manager (VCEM) enables centralized management of multiple Virtual Connect enabled c-Class enclosures. In addition, VCEM resolves some of the following Virtual Connect management challenges with the use of the embedded Virtual Connect Manager. These challenges include:

- All Virtual Connect Domains require a separate instance of the embedded Virtual Connect Manager to maintain, configure, and control its domain. No single management tool to control Virtual Connect across domains.
- Virtual Connect allows for up to 64 ranges of VC-Managed MAC addresses and WWNs. After 64 Virtual Connect Domains are created, duplicate MAC addresses and WWNs will be used.
- Virtual Connect (current generation) profiles cannot be copied or moved between BladeSystem Enclosures.

Virtual Connect Enterprise Manager solves each of these challenges by becoming the focal-point tool for managing and monitoring Virtual Connect Domains at an Enterprise wide level. HP Virtual Connect Enterprise Manager simplifies the management of multiple HP BladeSystem enclosures that use Virtual Connect to control LAN and SAN connectivity. VCEM adds the capability to configure spare bays and when used in conjunction with HP System Insight Manager (SIM) Automatic Event Handling, allows for automation of VC profile migration. Virtual Connect profile failover can be manually triggered by an administrator or automatically triggered by an event.

For more information: <http://www.hp.com/go/virtualconnect> or <http://www.hp.com/go/bladesystem>

HP StorageWorks EVA8100 Disk Array

The HP StorageWorks 8100 Enterprise Virtual Array offers customers in the mid-range to enterprise market place; high performance, high capacity and high availability "virtual" array storage solutions. The HP StorageWorks Enterprise Virtual Array family is the next generation of storage array products. Designed specifically for customers in the business critical, enterprise marketplace offering a high performance, high availability "virtual" array storage solution. Not only does this solution save time, space and costs compared to traditionally architected storage, it is supported by a powerfully simple suite of management software making it easy for users to achieve highest level of productivity.

The HP StorageWorks Enterprise Virtual Arrays are designed for the data center where there is a critical need for improved storage utilization and scalability. They meet application specific demands for transaction I/O performance for mid-range and enterprise customers and provide easy capacity expansion, instantaneous replication, and simplified storage administration. The Enterprise Virtual Arrays combined with HP StorageWorks Command View EVA software provides a comprehensive solution designed to simplify management and maximize performance. The EVA8100 has a maximum capacity of 240 drives representing 240 TB of virtual storage with 8GB of cache.

For more information:

<http://www.hp.com/go/storageworks/eva>

HP LoadRunner Software

HP LoadRunner, using minimal hardware resources, emulates hundreds or thousands of concurrent users to apply production workloads to almost any application platform or environment. HP LoadRunner stresses an application from end-to-end—applying consistent, measurable, and repeatable loads. This capability assists in applying a transaction load on the system under test to measure its load capacity.

For more information:

<http://www.hp.com/go/loadrunner>



Figure 7: HP StorageWorks EVA8100 Disk Array

Topology

The overall topology was constructed using out-of-the-box configuration wizards with 3 horizontal Weblogic clusters spanning across 4 hardware nodes. The Fusion Order Processing application (FOP)-ADF and SOA clusters were comprised of 8 Weblogic Server managed servers each. The WebCenter cluster had 4 Managed servers. Each ADF managed server was loaded with 250 concurrent users and each WebCenter managed server was servicing 100 concurrent users. All WebCenter servers shared common services on a separate node for external collaboration request processing like Documents, Presence, Worklist Items, Topics and Announcement Forums. The Oracle Internet Directory (OID) provided enterprise level authentication and authorization.

The Oracle Enterprise Manager (EM) console was running on a separate node (Node 6), which monitored the health and performance of OFM components.

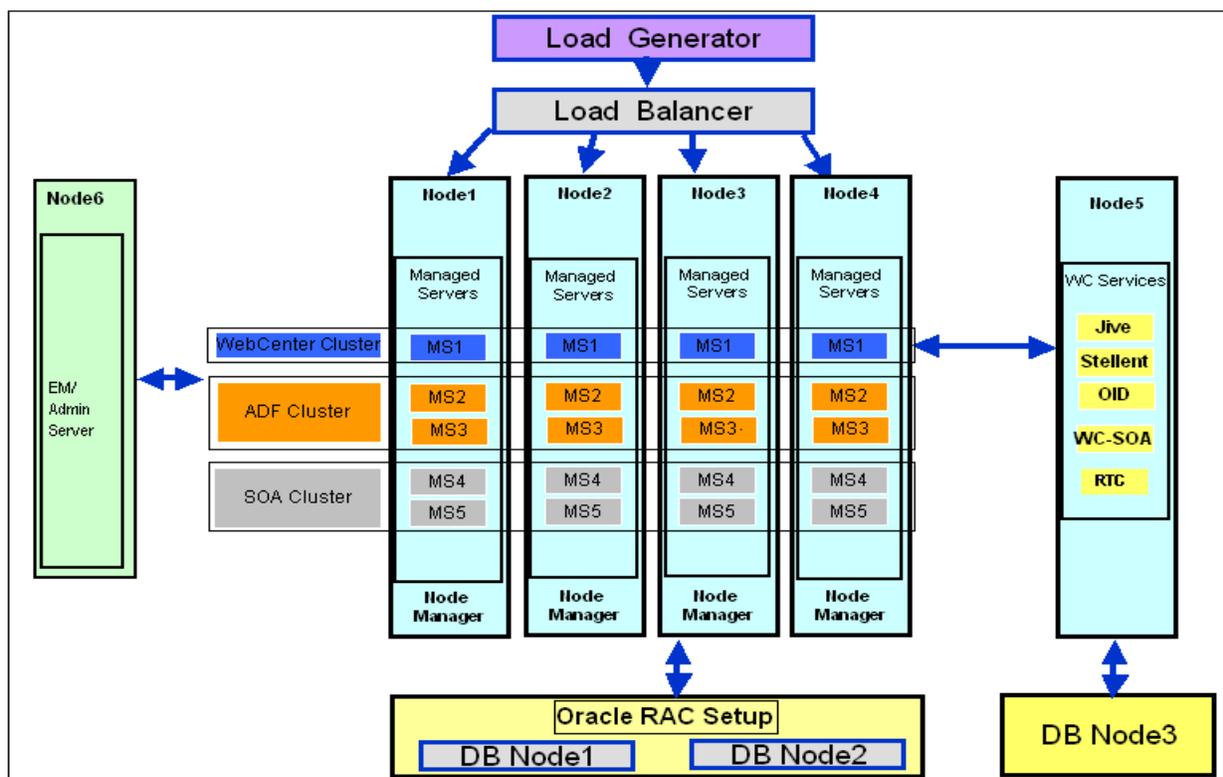


Figure 8: Large Scale System Deployment Topology

Benchmark Scenario

The Fusion Order Processing application represents a typical order-processing scenario with users accessing several pages and performing searches before placing the order. At the back end, the orders would be processed from booking to shipment.

The following scenarios were built using an application called Fusion Order Processing (FOP). This application comprises a storefront module built using ADF, Order Booking composite built using SOA suite and the Webcenter spaces application. Further details can be found at: <http://www.oracle.com/technology/obe/obe11jdev/bulldog/deploysoapp/deployment.htm>.

All tests were based on an 8-hour steady-state period. A steady-state period is when all three Fusion Middleware components used in the benchmark have reached their projected performance metrics, which remained stable for 8 hours.

ADF StoreFront Module

The **ADF StoreFront module** of the Fusion Order Processing application illustrates the use of the Fusion web application technology stack to create transaction-based web applications as required for a web shopping storefront. In this application, electronic devices are sold through a storefront web application. Customers can visit the web site, register, and place orders for the products.

ADF-StoreFrontModule Scenario
Navigate to homepage
Click start shopping
Select a random Item
Add to shopping cart
Go to search for deals
Search a product deal
Select an item
See full Item details
Close full details
Add to shopping cart
Click on checkout
Login
Click on submit order
Logout application

The workload for ADF StoreFront module included:

- 200,000 orders spanning 10,000 products
- 2000 concurrent end users selecting products for purchase
- 30 seconds were added between each request to simulate a user's decision making process

The SOA - Fusion Order Booking Composite

This is where the Business Processing Rules gets evaluated to ship the orders placed by the users at the front end. For example, orders below \$1000 dollars in total would not require human approval. Orders above that limit would need an approval by a human operator that has been assigned a corresponding role.

The workload for SOA included:

- Processing 175 BPEL instances per second and 3075 Integration objects per second.

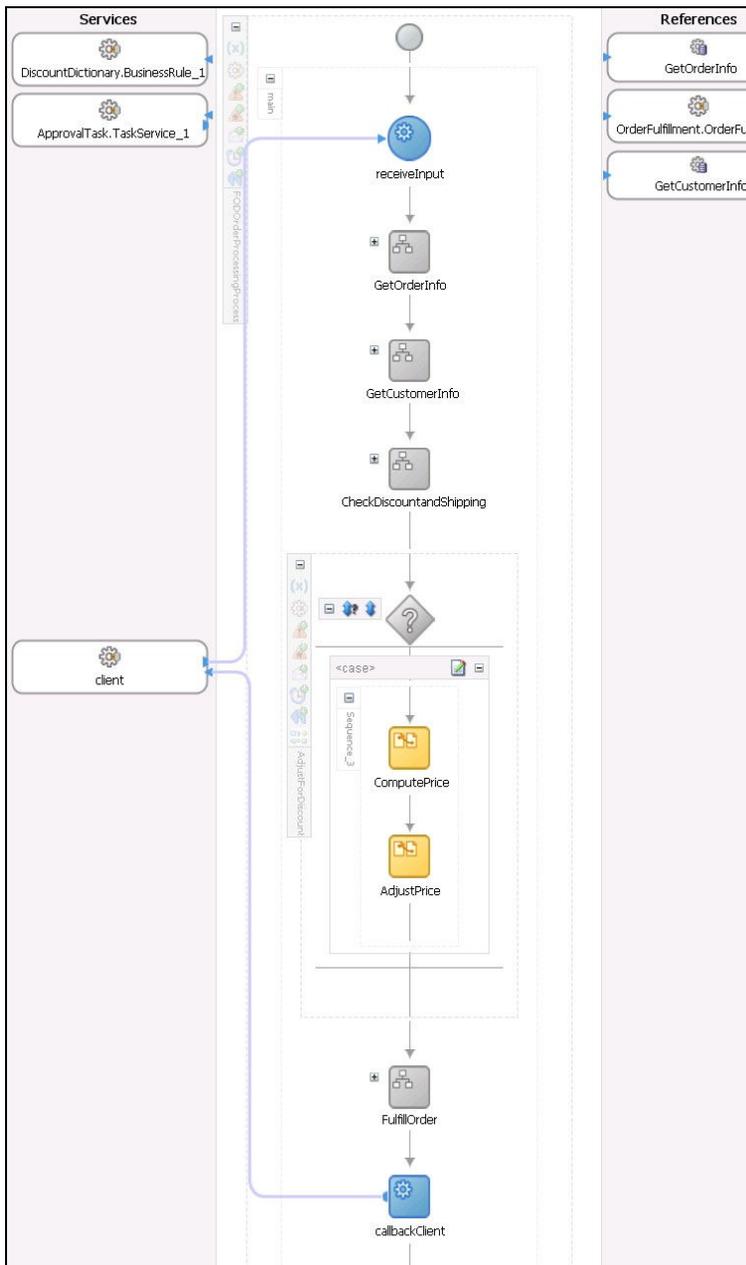


Figure 9: Fusion Order Booking Composite

The WebCenter Spaces Application

The WebCenter spaces application scenario has 400 concurrent users with 90% of them executing the read only navigation scenario and 10% of them executing the write navigation scenario.

The Read scenario involves sidebar and switch tab transactions. After each user logs in they will exercise the same click streams twice: once cold and once warm. The Write scenarios involve uploading documents and creating issues, forums, and pages in a group space.

The workload for WebCenter included:

- 5000 group spaces with 50,000 topics, 100,000 announcements, 100,000 documents, and 75,000 work list items
- 400 concurrent users split into 90% read and 10% write operations
 - 360 concurrent users recycling through a 1080 users list with unique group spaces for read transactions
 - 40 users using 20 group spaces doing write transactions
- 30 second random think time was included between requests
- Each JVM touched 275 unique Group spaces (Read scenario: 90 concurrent users recycling through 270 users list with 270 unique GS + Write scenario: 10 users with 5 GS shared)
- User/Group spaces recycled approximately every 13 minutes

Read Only Navigation Scenario

Read scenario involves some sidebar and switch tab transactions. After each user logs in they will exercise the same click streams twice: once cold and once warm.

Read Navigation Scenario
Invoke the URL
Login
Expand the Application
Collapse the Application
Expand the Worklist
Review items in Worklist
Collapse the Worklist
Expand Search
Collapse Search
Go to Group Spaces
Go to Documents
Go to Discussions
Go to Group Space 2 (GS2)
Go to Personal Space (PS)

Read Navigation Scenario
Expand the Application
Collapse the Application
Expand the Worklist
Review items in Worklist
Collapse the Worklist
Expand Search
Collapse Search
Go to Group Spaces
Go to Documents
Go to Discussions
Go to Group Space 2 (GS2)
Go to Personal Space (PS)
Logout

Write Navigation Scenario

Write scenarios involve uploading documents, creating issues, creating forum, and creating pages in a group space.

Write Navigation Scenario
Invoke the URL
Login
Go to Project Home
Create an Issue
Save the issue
Delete the issue
Confirm issue deletion
Go to announcement Viewer
Create an announcement
Confirm the announcement creation
Delete the announcement
Confirm the announcement deletion
Go to Documents
Upload a Document
Confirm that document upload
Delete the document
Confirm the document deletion
Go to discussion
Create a topic
Confirm the topic was created
Delete a topic
Confirm the topic was deleted
Go to settings
Go to Pages
Create a page
Confirm page creation
Add content to the page

Write Navigation Scenario
Go to Resource Catalog Personal
Add worklist
Close the Resource Catalog
Save the page
Close the page
Go to settings Warm1
Refresh settings pages
Go to PSRTestPage manager
Delete PSRTestPage
Confirm page deletion
Go to settings warm2
Go to projectHome warm1
Go to pwcwelcome warm1
Logout

NOTE: The database schemas used for ADF and WebCenter (MDS, SOA-Infra, WC Spaces) were executed exactly as created by the repository creation utility shipped with the product. Performance enhancing changes were applied to the out-of-the-box SOA schemas. The changes involved partitioning some tables and modifying the indices to reduce contention incurred by RAC instances. The data available in the database tables was generated by continuous execution of real business logic over prolonged periods of time.

Benchmark Results

Results Summary

2000 concurrent users running StoreFront module were able to process 134,000 orders in 8 hrs with an average response time of 0.7 seconds. All tests were based on an 8-hour steady-state period.

11gR1 Goals and Actuals		
WebCenter	Requirement	Actual
Concurrent Users	400	400
Application Data		
Number of Users in the system	3,000	3,000
Number of Group Spaces	5,000	5,000
Pages Rendered /Day	400,000	400,000
ADF FOP	Requirement	Actual
Concurrent Users	2,000	2,000
Pages Rendered /Day	2,000,000	2,000,000
Application Data		
Number of Products	10,000	10,000
Orders in System	200,000	200,000
SOA	Requirement	Actual
Orders Processed / Day	4,600,000	Over 5,000,000
Integration Objects Processed / Day	86,400,000	Over 88,000,000
Application Data		
Orders in System	5,760,000	Over 6,000,000
Customers in System	1,000,000	Over 1,000,000

Table 1: 11gR1 Goals (Requirement) and Obtained Results (Actual)

Results – CPU and Memory Usage

The following table shows the individual CPU and memory usage for all nodes during the 8 hour steady state period.

Application Servers	CPU usage %
App1 (SOA/ADF/WC)	73
App2 (SOA/ADF/WC)	72
App3 (SOA/ADF/WC)	73
App4 (SOA/ADF/WC)	73
App5 (WC external svcs)	5
App6 (Admin console/EM)	1
Database Servers	CPU usage %
DB1 CPU usage%	21.2
DB2 CPU usage%	21.6

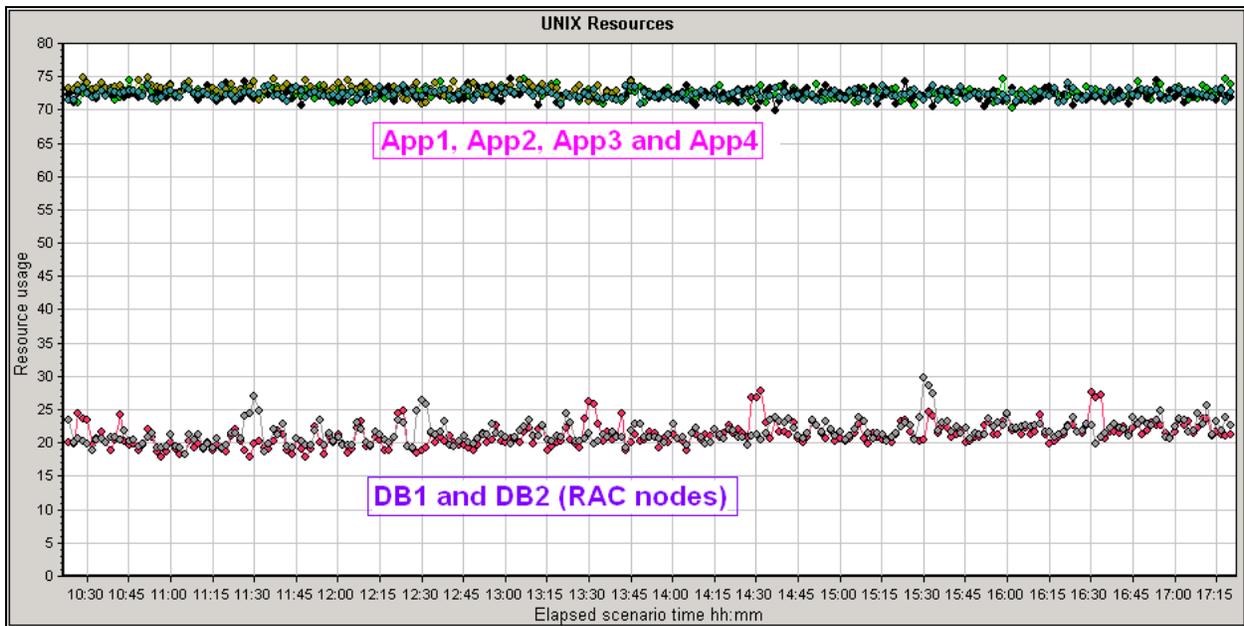


Figure 10: APP & RAC DB CPU Usage Graph

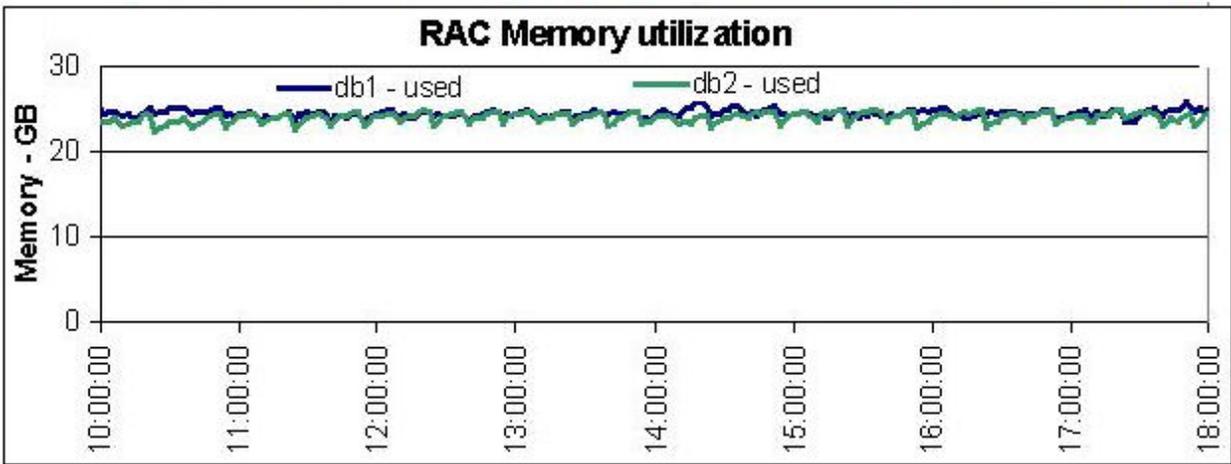


Figure 11: RAC DB Memory Usage Graph

Results – ADF StoreFront Module

Number of users	2000
Steady state period	8 hours
Total Orders submitted	134,006
Transaction	Avg RT(Secs)
Navigate to homepage	0.7
Click start shopping	0.69
Select a random Item	0.34
Add to shopping cart	0.37
Go to search for deals	0.92
Search a product deal	1.24
Select an item	0.59
See full Item details	0.6
Close full details	0.59
Add to shopping cart	0.63
Click on checkout	0.67
Login	1.04
Click on submit order	0.7
Logout application	0.54

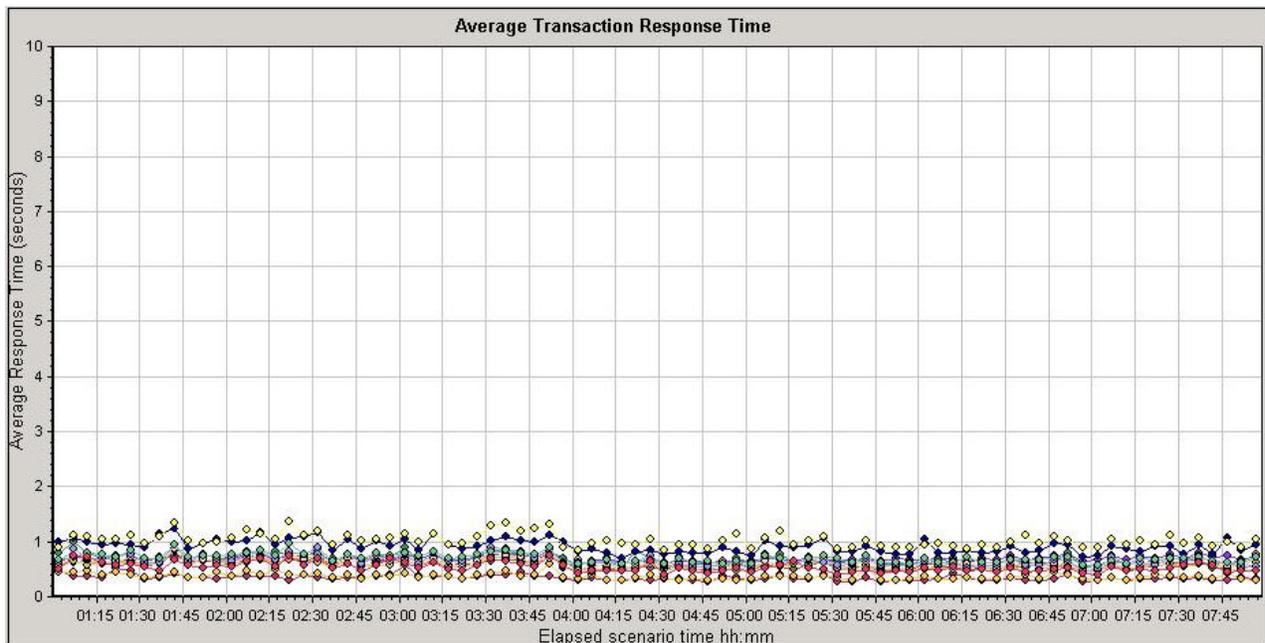


Figure 12: Average Transaction Response time for ADF Storefront module

Results – SOA

	Fusion Order Booking	Integration Objects
Instances/Integration Objects per second	175	3075
Instances/Integration Objects per day	5,040,000	88,560,000

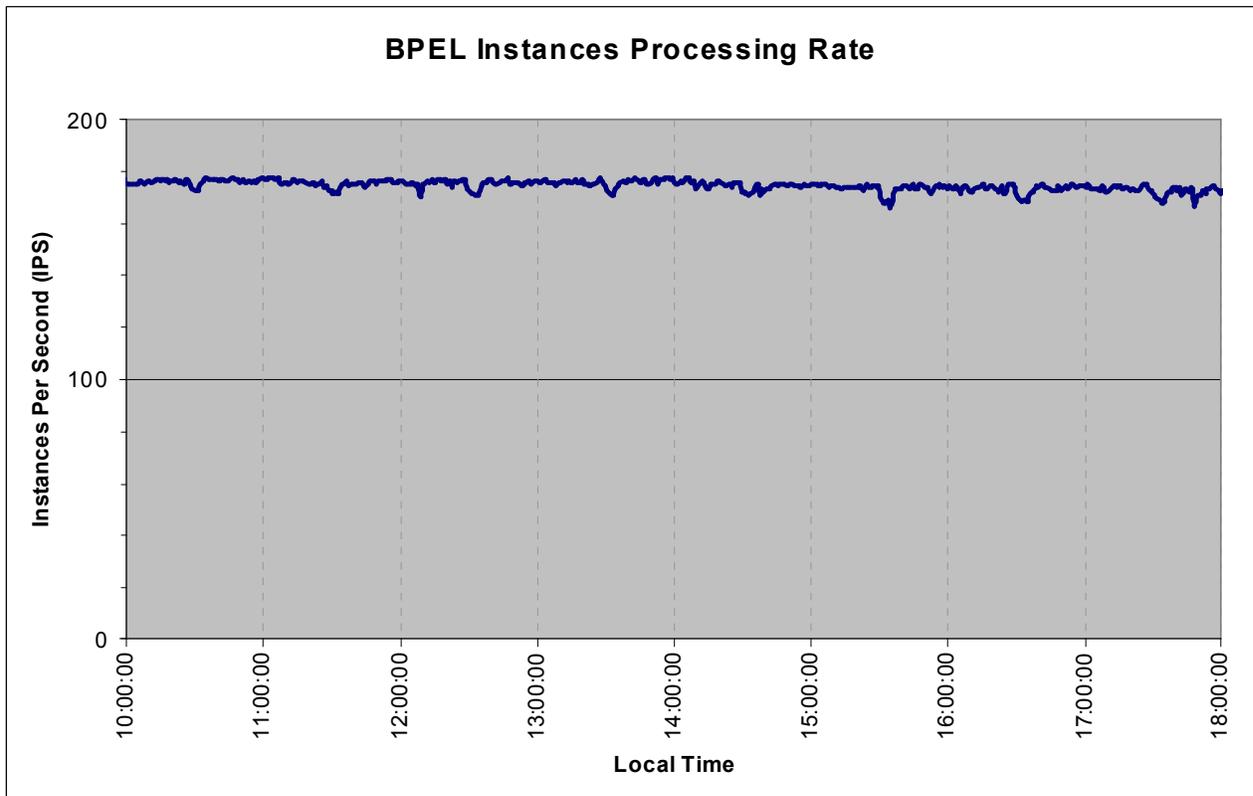


Figure 13: This graph shows the rate of processing BPEL Instances in the database every second. One BPEL Instance corresponds to one order placed.

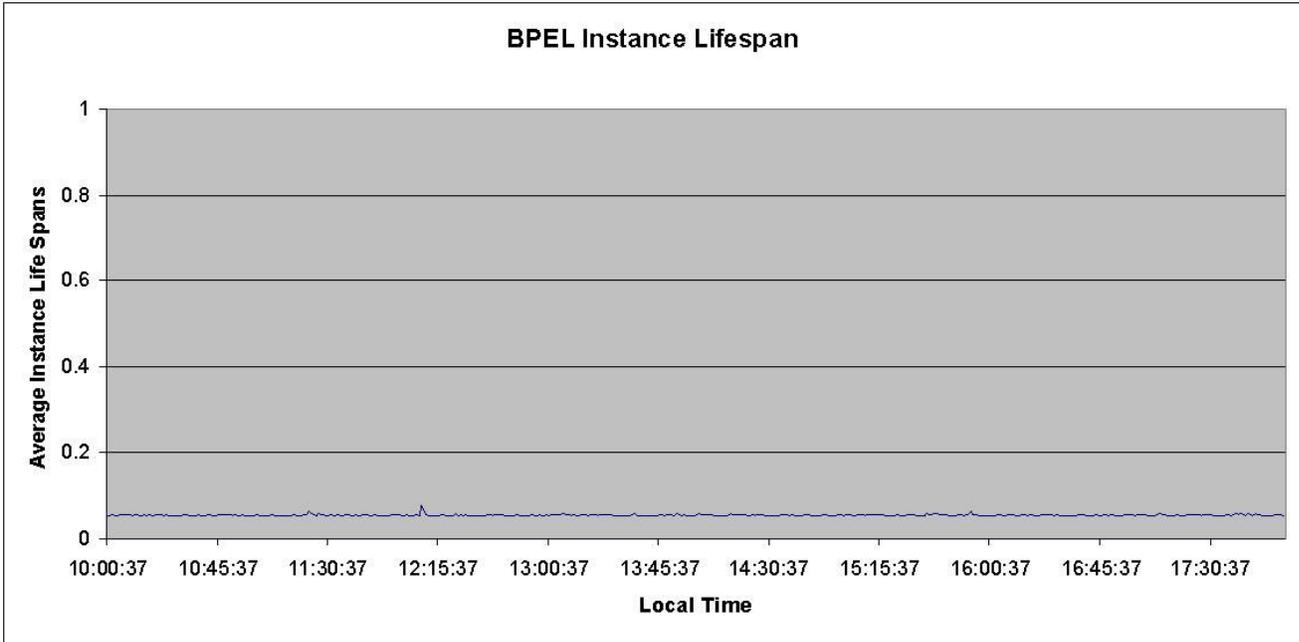


Figure 14: This graph demonstrates the BPEL Instance lifespan, which is the time taken to process an order, without human workflow. Both graphs in Figure.13 and Figure.14 demonstrate constant and sustainable processing rate.

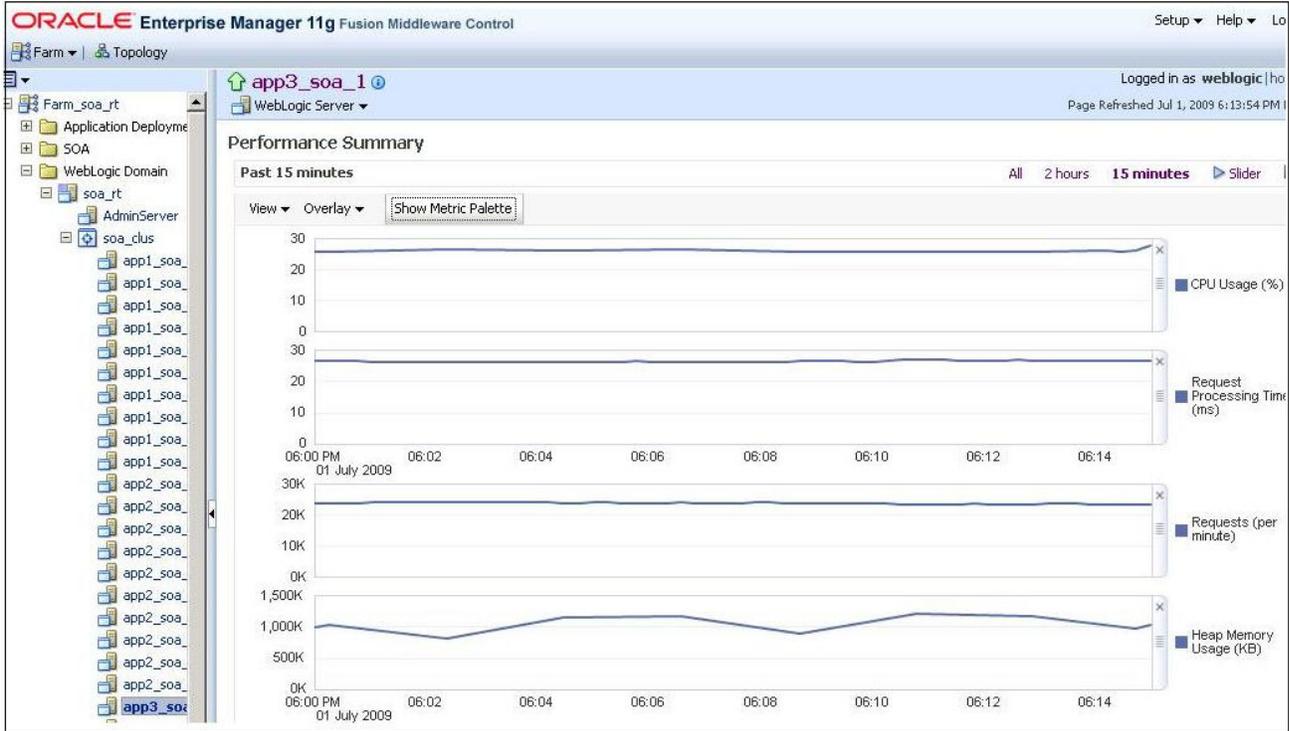


Figure 15: EM-SOA Performance Summary Page

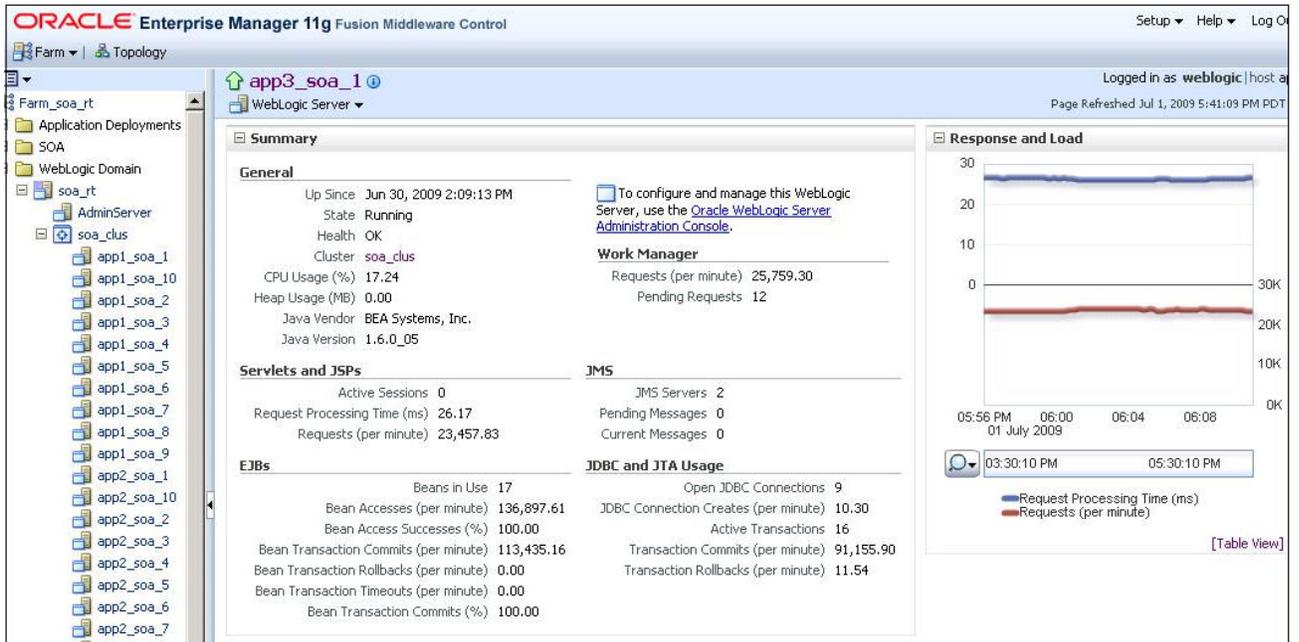


Figure 16: EM-SOA Dashboard Page

Results – WebCenter

WebCenter (5000 GS and 3000 users)	
No Of Concurrent Users	400
No Of Concurrent Group Spaces	380
Think time	30s
Users/GroupSpace traversal for Read scenario	1080
Avg Hits/sec	21.06
Avg RT	2.97 secs

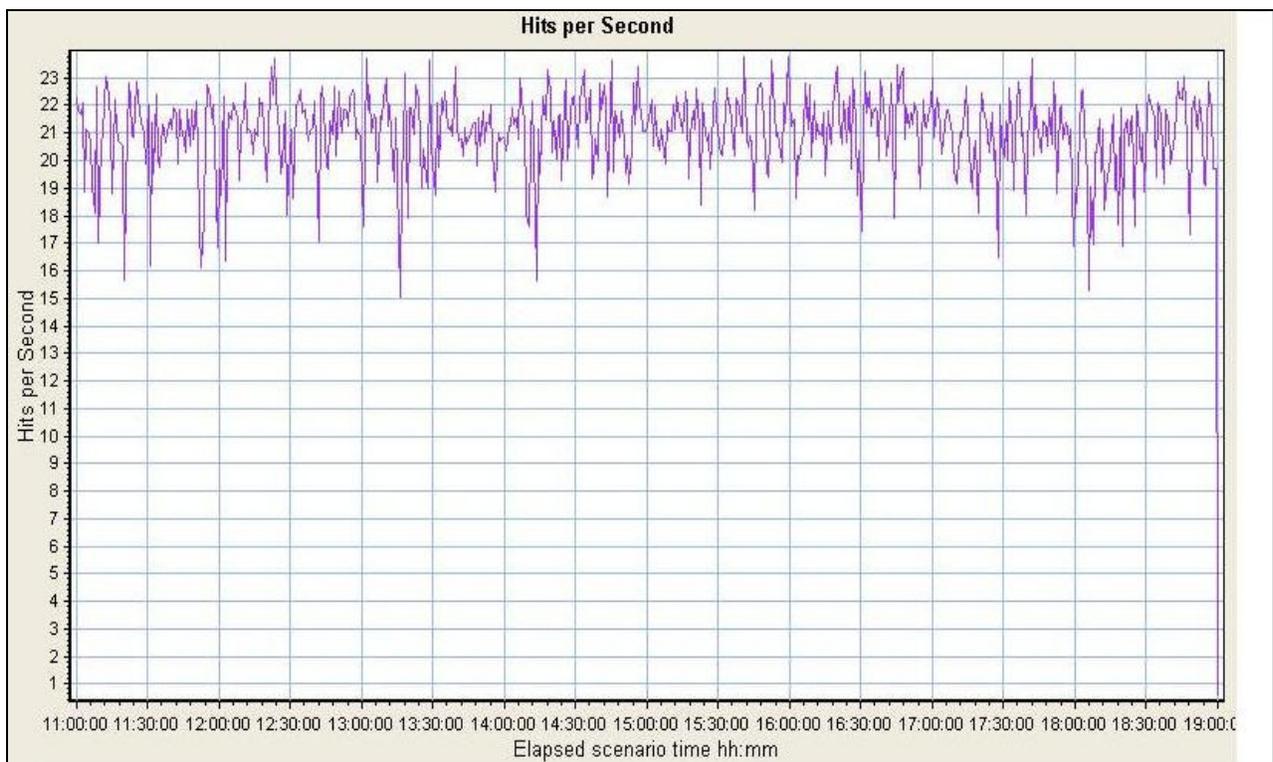


Figure 17: WebCenter hits/sec Graph

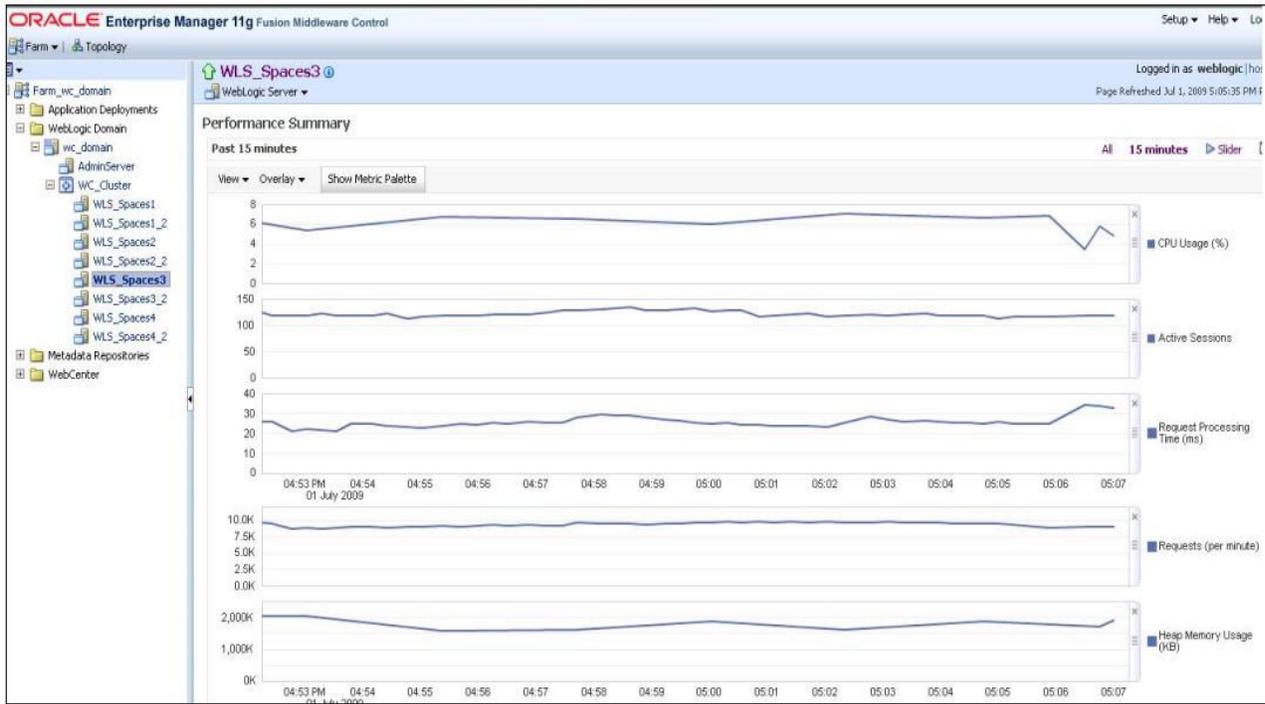


Figure 18: EM-WebCenter Performance Summary Page

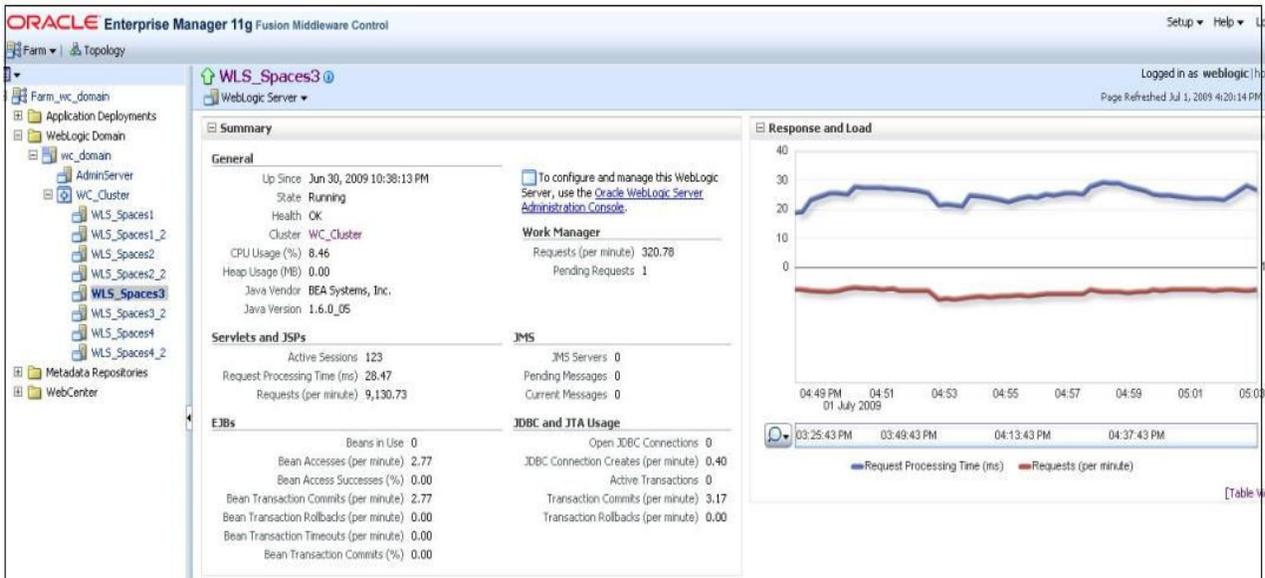


Figure 19: EM-WebCenter Dashboard Page

Recommendations

We have found that management of the CPU affinity for JVM processes and hardware interrupt handlers is a very important factor in multi-processor systems. In scenarios with intensive IO, sharing the core between a JVM and IO interrupt processing can adversely impact Garbage Collection times and hence the overall throughput of the JVM. It is a good practice to adjust the number of Garbage Collection threads to the number of cores assigned to the JVM, which can be done using command-line options. We allocated a small in-memory partition for temporary files created by the SOA composites used in this test, which allowed to further reduce impact of IO operations. Using RAC DB increases reliability of the setup, and pools in more computing power and memory to guarantee throughput. Some additional table partitioning is needed to make efficient use of all RAC nodes.

Conclusions

This paper demonstrates the scale that Oracle's Fusion Middleware 11gR1 supports on enterprise-grade hardware. The focus has been on tying together 3 pieces: ADF, SOA and WebCenter, and achieving maximal hardware utilization using out-of-the-box settings for the Middleware components with recommended high-availability configuration and tuning. The tests exceeded our expectations both in terms of throughput and the efficiency of the use of the hardware resources available on the application servers and the DB. We anticipate that case-specific tuning can help achieve significantly higher goals in the same environment.

Appendix A : Configurations

WebCenter

1) JVM Options :

```
« -server -Xms2048M -Xmx2048M -Xns512M -Xgc:genpar -noverify -Djrockit.codegen.newlockmatching=true  
-Djps.auth.debug=false «
```

2) Server logging set to error

3) Session timeout 3 minutes and Think Time = 30 seconds

4) JDBC pool set to max 200, with trust connection set to 60 seconds

5) jps-config.xml settings for the jps caches

```
<property value="true" name="oracle.security.jps.policystore.rolemember.cache.warmup.enable"/>
```

```
<property value="STATIC" name="oracle.security.jps.policystore.rolemember.cache.type"/>
```

```
<property value="FIFO" name="oracle.security.jps.policystore.rolemember.cache.strategy"/>
```

```
<property value="1000" name="oracle.security.jps.policystore.rolemember.cache.size"/>
```

```
<property value="true" name="oracle.security.jps.policystore.policy.lazy.load.enable"/>
```

```
<property value="PERMISSION_FIFO" name="oracle.security.jps.policystore.policy.cache.strategy"/>
```

```
<property value="1000" name="oracle.security.jps.policystore.policy.cache.size"/>
```

ADF

1) AM Pooling paramters (250 users load per JVM):

```
jbo.ampool.doampooling=true jbo.dofailover=true jbo.ampool.initpoolsize=300  
jbo.ampool.maxpoolsize=300
```

```
jbo.ampool.maxavailablesize=300 jbo.recyclethreshold=300 jbo.ampool.timetolive=14400000
```

2) JVM Options :

```
USER_MEM_ARGS="-Xrs -server -Xms2048m -Xmx2048m -Xgc:genpar -  
Djrockit.codegen.newlockmatching=true -DHTTPClient.config.configContextProvider= -  
Djps.auth.debug=false"
```

3) JDBC pool set to max 150 per RAC node

4) Session timeout 5mins and Think Time = 30s

'jbo.doconnectionpooling' AM configuration parameter usage:

This parameter defines and controls, the interaction of ADF AM pools with the database connection pools. The default value of 'false' turns off JDBC connection pooling and results in the AM module instance not disconnecting from its database connection on each check in to the application module pool. This results the highest performance through the cost savings of resources like DB CPU, DB sessions and Application Server heap memory usage.

Turning on JDBC connection pooling is advisable only when database resources are limited when serving several thousands of concurrent users. For 2000 user ADF StoreFrontModule scenario with this parameter turned 'ON', we noticed 50% improvement in the Application Server heap memory usage. The total DB sessions across both RAC nodes reduced from 2000 to 400. However this setting impacted the response time of "Search transaction" (SQLs) . The DB CPU usage also registered a 50% increase; the AWR reports attribute this to the presence of direct physical reads on LOB segments. No direct physical reads were observed when this connecting pooling is turned off.

SOA

1) JVM Options :

-DHTTPClient.config.configContextProvider= -Xms1484m -Xmx1484m -XgcPrio:throughput

2) Logging

logger-severity = Warning

OFM logging.xml - level for all loggers set to ERROR

3) JDBC

Statement Cache = 100

Test Connection on Reserve = disabled

DB connection Max = 500

Shrink Frequency = 0

4) soa-infra-config.xml

audit level = Off

5) bpel-config.xml

audit level = Off

statsLastN = 0

6) FOD composite

JCA file adapter = eis/HAFFileAdapter

UseStaging = false

serializeTranslation = true

inMemoryTranslation = true

Appendix B : Abbreviations

The following abbreviations may be referred to throughout this document:

Abbreviation	Meaning
ADF	Application Development Framework
AM	Application Module
Avg	Average
B2B	Business-to-Business
BPEL	Business Process Execution Language
DB	Database
ECM	Enterprise Content Management
EM	Enterprise Manager
OFM	Oracle Fusion Middleware
FOP	Fusion Order Processing Application
GS	Group Space
HP	Hewlett-Packard Development Company, L.P.
IPS	Instances per Second
JVM	Java Virtual Machine
LSSD	Large Scale System Deployment
MDS	MetaData Repository
MEM	Memory
MS	Managed Server
OID	Oracle Identity Management
OS	Operating System
RAC	Real-Application Cluster
RT	Response Times
Secs	Seconds
SOA	Service-Oriented Architecture
WC	WebCenter
WLS	Weblogic Server



Oracle Fusion Middleware componets -LSSD White paper

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