Oracle® Database High Availability on VMware vSphere®

May 2013

DEPLOYMENT AND TECHNICAL CONSIDERATIONS GUIDE
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Introduction

Oracle database deployments can generate significant server sprawl due to the need to provision separate systems for development, quality assurance, test, and production environments. As a result, Oracle database implementations can increase exponentially, and even small implementations can have a relatively large IT footprint. In a typical deployment, the database server environment is hosted on dedicated physical systems that are not fully utilized much of the time.

VMware vSphere enables the deployment of multiple virtual machines running different Oracle database solutions consolidated on to the same physical server and storage. This consolidation results in increased CPU utilization, a reduction in overall server requirements, and a lower total cost of ownership (TCO).

This paper describes the validation testing for high availability that was performed using Oracle Database with vSphere 5.1 advanced features including vMotion, Storage vMotion, Distributed Resource Scheduler (DRS), High Availability (HA), and Fault Tolerance (FT). All of the tests were conducted on a testing architecture that employed Hewlett-Packard server and storage hardware.

This paper is written for architects and engineers who are responsible for Oracle Database and the VMware vSphere environment. This paper assumes that the reader has advanced knowledge of Oracle Database products, the VMware vSphere virtualization and cloud computing platform, and related VMware products.
Solution Overview

VMware conducted validation testing with Oracle Database 11g Release 2 running VMware vSphere 5.1 advanced features, including vMotion, Storage vMotion, DRS, HA, and FT, and using a Swingbench workload. The Oracle Database and VMware vSphere products used in this solution are described in the sections below.

Oracle Database

As business operations become more complex, the demand for change in IT increases accordingly, as do the associated risks that must be mitigated. Today’s IT professionals are asked to manage more information and deliver it to their users, with ever-increasing quality of service, in a timely manner. And in today’s economic climate, IT must also reduce budgets and derive greater value out of existing investments.

Oracle Database 11g Release 2 delivers industry leading performance, scalability, security, and reliability on a choice of clustered or single-servers running Windows, Linux, and UNIX. It provides comprehensive features to easily manage the most demanding transaction processing, business intelligence, and content management applications.

Oracle Database 11g Release 2 enables IT professionals to deliver more information with higher quality of service, make more-efficient use of their budgets, and reduce the risk of change in datacenters. By deploying Oracle Database 11g R2 as their data management foundation, organizations can utilize the full power of the world’s leading database to:

- Reduce server costs by a factor of 5
- Reduce storage requirements by a factor of 10
- Improve mission-critical system performance by a factor of 10
- Increase DBA and developer productivity by a factor of 2
- Maximize availability and eliminate idle redundancy
- Maximize security and enable compliance
- Simplify their overall IT software portfolio

For more information, see the “Resources” section at the end of this paper.

VMware vSphere

VMware vSphere is an optimal virtualization platform and enabler for cloud computing architectures. vSphere enables IT to meet service level agreements (SLAs) for the most demanding business-critical applications at the lowest total cost of ownership (TCO). VMware vSphere delivers control over all IT resources with the highest efficiency and choice in the industry, as shown below.

VMware vSphere virtualization solutions provide for:
- **Consolidation.** VMware virtualization allows multiple application servers to be consolidated onto one physical server, with little or no decrease in the overall performance. This helps to minimize or eliminate underutilized server hardware, software, and infrastructure.

- **Manageability.** The live migration of virtual machines from server to server and the associated storage is performed with no downtime using VMware vSphere® vMotion®, which simplifies common operations such as hardware maintenance, and VMware vSphere® Storage vMotion®.

- **Availability.** High availability can be enabled to reduce unplanned downtime and enable higher service levels for applications. VMware vSphere® High Availability (HA) ensures that, in the event of an unplanned hardware failure, the affected virtual machines are automatically restarted on another host in a VMware cluster.

- **Automation.** VMware automated load balancing takes advantage of vMotion and Storage vMotion to migrate virtual machines among a set of VMware® ESX® hosts. VMware vSphere® Distributed Resource Scheduler™ (DRS) and VMware vSphere® Storage DRS™ enable automatic resource relocation and optimization decisions for virtual machines and storage.

- ** Provisioning.** VMware virtualization encapsulates an application into an image that can be duplicated or moved, greatly reducing the cost of application provisioning and deployment.
vSphere creates a layer of abstraction between the resources required by an application, the operating system, and the underlying hardware that provides those resources. vSphere enables multiple, isolated execution environments to share a single hardware platform. It implements each environment with its own set of hardware resources.

For more information about vSphere, see the Resources section at the end of this paper.

In addition, vSphere advanced features increase availability and automation and improve the operational performance and manageability of Oracle Database solutions. The advanced features described in this paper include VMware vMotion, Storage vMotion, Distributed Resource Scheduler (DRS), High Availability (HA), and Fault Tolerance (FT). Each of these features is described in the sections below.

**vMotion and Storage vMotion**

Together, VMware vMotion and Storage vMotion provide for the complete virtualization of servers, storage, and networking in order to move an entire running virtual machine instantaneously, from one physical server to another. The virtual machine retains its network identity and connections, ensuring a seamless migration process.

In addition, VMware vSphere 5.1 enables a virtual machine to change its host and datastore simultaneously, even when the hosts do not have a shared storage environment. It allows virtual machine migration between clusters in a larger datacenter that might not have a common set of datastores between them. vSphere also allows virtual machine migration in small environments without requiring access to expensive, shared storage equipment, as shown below.

*Figure 2. VMware vMotion and Storage vMotion*
vSphere 5.1 allows vMotion and Storage vMotion to be combined into one process. This combined migration copies both the virtual machine memory and its disk over the network to the destination host. After the memory and disk data are sent over, the destination virtual machine resumes and the source virtual machine is powered off.

vMotion and Storage vMotion are described in more detail in the sections below.

**vMotion**

VMware vMotion enables the live migration of running virtual machines from one physical server to another with zero downtime, continuous service availability, and complete transaction integrity. vMotion is a key enabling technology for creating the dynamic, automated, and self-optimizing datacenter. This capability makes hardware maintenance possible at any time, and vMotion does not require clustering or redundant servers, as shown below.

**Figure 3. VMware vMotion**

- Moves entire running virtual machines instantly. Performs live migrations with zero downtime, undetectable to the user.
- Manages and schedules live migrations with ease at pre-defined times without an administrator’s presence, with the reliability and manageability that is derived from a production-proven product.
- Performs multiple concurrent migrations of a virtual machine running any operating system, across any type of hardware and storage that is supported by vSphere, complete with an audit trail.
- Moves online workloads from one ESXi server host machine to another in order to maintain service levels and performance goals.
- Continuously and automatically optimizes virtual machine placement within resource pools. Proactively moves virtual machines away from failing or underperforming servers.
- Performs hardware maintenance without the need to schedule downtime and disrupt business operations.

VMware vMotion is enabled by these underlying technologies:
• The state of a virtual machine is encapsulated by a set of files stored on shared storage, such as Fibre Channel, iSCSI Storage Area Network (SAN) or Network Attached Storage (NAS). VMware Storage Virtual Machine File System (VMFS) allows multiple installations of VMware ESXi® to access the same virtual machine files concurrently.

• The active memory and precise execution state of the virtual machine is rapidly transferred over a high speed network, allowing the virtual machine to instantaneously switch from running on the source ESXi host to the destination ESXi host.

• vMotion keeps the transfer period imperceptible to users by keeping track of on-going memory transactions in a bitmap. Once the entire memory and system state has been copied over to the target ESXi host, vMotion suspends the source virtual machine, copies the bitmap to the target ESXi host, and resumes the virtual machine on the target ESXi host. This entire process takes less than two seconds on a Gigabit Ethernet network.

• The networks being used by the virtual machine are also virtualized by the underlying ESXi host, ensuring that even after the migration, the virtual machine network identity and network connections are preserved. vMotion manages the virtual MAC address as part of the process. Once the destination machine is activated, vMotion pings the network router to ensure that it is aware of the new physical location of the virtual MAC address. Since the migration of a virtual machine with vMotion preserves the precise execution state, the network identity, and the active network connections, the result is zero downtime and no disruption to users.

Storage vMotion

Storage vMotion enables organizations to perform proactive storage migrations, simplify array migrations, improve virtual machine storage performance and free up valuable storage capacity. It enables the live migration of virtual machine disk files within and across storage arrays, without a service disruption, and it provides for automated storage management. Storage vMotion relocates virtual machine disk files and it provides for continuous service availability and complete transaction integrity, as shown below.
vSphere Storage vMotion:

- Enables the live, automated migration of virtual machine disk files from an existing shared storage location to different classes of tiered storage with zero downtime.
- Migrates virtual machines running any supported operating system on any supported server hardware based on usage and priority policies for tiered storage.
- Perform live migration of virtual machine disk files across any Fibre Channel, Internet Small Computer System Interface (iSCSI), Fibre Channel over Ethernet (FCoE), and Network File System (NFS) storage system supported by vSphere.
- Dynamically optimizes storage I/O performance by moving virtual machine disk files to alternative LUNs that deliver the required performance without scheduled downtime.
- Eliminates over-allocation of storage resources in order to proactively deal with I/O bottlenecks.
- Efficiently manages storage capacity and utilization by reclaiming unused or “stranded” storage capacity and allocating it to other virtual machines.
- Moves virtual machines with higher performance needs or critical workloads to larger capacity storage LUNs as virtual machine disk files approach their total available LUN size limits.
- Storage vMotion is fully integrated with VMware vCenter Server to provide easy migration and monitoring.
Distributed Resource Scheduler

VMware Distributed Resource Scheduler (DRS) is an automated load balancing technology that aligns resource usage with business priority by enabling automated load balancing across hosts, balances computing capacity, and it optimizes power consumption in the datacenter by turning off hosts during lower load periods. DRS continuously monitors utilization across vSphere servers and intelligently allocates available resources among virtual machines according to business needs. DRS takes advantage of vMotion to migrate virtual machines among a set of ESXi hosts.

DRS enables automatic initial virtual machine placement on any of the hosts in the cluster. It also makes automatic resource relocation and optimization decisions as hosts and virtual machines are added or removed from the cluster, or the load on individual virtual machines goes up or down. VMware DRS makes cluster wide resource pools possible. When DRS is configured for manual control, it makes recommendations for review and later implementation only; there is no automated activity.

Figure 5. VMware Distributed Resource Scheduler

DRS also provides the capability to control the placement of virtual machines based on different affinity rules. This enables virtual machines to be placed based on high availability or other business criticality requirement.
High Availability

VMware HA delivers the high availability many applications running in virtual machines require, independent of the operating system or underlying hardware configuration. HA provides failover protection from hardware and operating system failures in the virtualized IT environment by:

- Monitoring virtual machines to detect operating system and hardware failures.
- Restarting virtual machines on other physical servers in the resource pool, without manual intervention when a server failure is detected.
- Protecting applications from operating system failures by automatically restarting virtual machines when an operating system failure is detected.
The VMware cluster provides the power of multiple hosts with the simplicity of managing a single entity. It enables the aggregation of the hardware resources of individual ESXi server hosts, and manages the resources as if they are residing on a single host. VMware HA allows virtual machines running on a specific ESXi hosts to be restarted automatically using other host resources in the cluster, in the case of host machine failures.

VMware HA continuously monitors all ESXi server hosts in a cluster and detects failures. The VMware HA agent placed on each host maintains a heartbeat with the other hosts in the cluster using the service console network. Each server sends heartbeats to the others servers in the cluster at five-second intervals. If any servers lose heartbeat over three consecutive heartbeat intervals, VMware HA initiates the failover action of restarting all affected virtual machines on other hosts.

Figure 8. Host failover using VMware HA
VMware HA also monitors whether sufficient resources are available in the cluster at all times, in order to be able to restart virtual machines on different physical host machines, in the event of host failure. Safe restart of virtual machines is made possible by the locking technology in the ESXi server storage stack, which allows multiple ESXi server hosts to have simultaneous access to the same virtual machine files.

VMware HA can be turned on by simply checking Data Center settings in vSphere client as shown below.

Figure 9. VMware HA feature settings

Fault Tolerance

VMware Fault Tolerance (FT) allows virtual machines to operate continuously, even when server failures occur. When Fault Tolerance is enabled on a virtual machine called the Primary VM, a copy of the Primary VM, called the Secondary VM, is automatically created on another host that is selected by DRS. If DRS is not enabled, the target host is chosen from the list of available hosts. Fault Tolerance then runs the Primary and Secondary VMs in lockstep with each other – essentially mirroring the execution state of the Primary VM to the Secondary VM.

During a hardware failure that causes the Primary VM to fail, the Secondary VM immediately picks up where the Primary VM ended. It continues to run without any loss of network connections, transactions, or data.
It provides operational continuity and high levels of uptime in VMware vSphere environments, with simplicity and at a lower cost.

When enabled for a virtual machine, VMware Fault Tolerance:

- Creates a live shadow instance of the Primary VM, running on another physical server.
- Keeps the two instances in virtual lockstep with each other using VMware vLockstep technology, which logs non-deterministic event execution by the Primary VM, and transmits them over a Gigabit Ethernet network to be replayed by the Secondary VM.
- The two virtual machines play the exact same set of events, because they receive exactly the same set of inputs at any given time.
- The two virtual machines access a common disk and appear as a single entity, with a single IP address and a single MAC address to other applications. Only the Primary VM is allowed to perform writes.
- The two virtual machines constantly check heartbeats and if either virtual machine instance loses the heartbeat, the other takes over immediately. The heartbeats are very frequent, with millisecond intervals, making the failover instantaneous with no loss of data or state.
• VMware Fault Tolerance requires a dedicated network connection between the two physical servers, separate from the VMware vMotion™ network.

Testing Architecture
The architecture used in this testing, as well as how one typically deploys the architecture, includes:
• VMware vSphere infrastructure was built at the VMware Lab in Palo Alto, California.
• Hewlett-Packard servers included two HP Proliant DL 380p Gen8 servers, with one ESXi host on each physical server (Host 1 and Host 2).
• Network switch configuration for both hosts is described in “Appendix A: Testing Configuration”. No external connection was required.
• Hewlett-Packard storage include HP Proliant P4500 G2 iSCSI storage. The storage was connected using iSCSI hardware.
• One virtual machine was configured on each host. This included one virtual machine for the Oracle Database 11g, R2 server, and one for the Swingbench load generator and the vCenter appliance.

For more details on the testing configuration, see “Appendix A: Testing Configuration” below.

Testing
The primary objective of the validation testing was to determine the high availability use cases for Oracle Database 11g, R2 running on VMware vSphere 5.1 for a given workload using Swingbench. The testing used VMware advanced features for high availability and business continuity, including vMotion, Storage vMotion, DRS, HA, and FT with Oracle Database deployments in a virtual environment. Note that VMware also provides separate solution for disaster recovery (DR), but this was not part of this testing.

The testing methodology, workload used, test cases, results observed, and recommendations are described in the sections below.

Testing Methodology
VMware conducted testing to validate that Oracle Database 11g, Release 2 can successfully sustain the planned downtime, and recover from unplanned downtime, when VMware 5.1 high availability features including vMotion, Storage vMotion, DRS, HA, and FT. This testing also outlines the best practices for deploying this solution in the datacenter.

Note that the testing conducted in the VMware Lab was for validation only. No scalability tests were conducted.

The workload for this testing was generated using the Swingbench load generator as described below.
Workload Used

The Swingbench load generator was used to enable the workload for this testing. Swingbench is an open source tool that is comprised of scripts and load drivers. Swingbench generates business transactions that simulate large scale order entry OLTP loads that are I/O-intensive. It is a TPC-C (database throughput) workload generator that includes a data generator tool that was used to create larger schemas that generate much higher levels of I/O (larger index lookups).

The Swingbench Order Entry workload for Oracle Database was enabled on one virtual machine. The workload was used to generate a reasonable load in the system. Data was loaded to grow the database size to 400 GB. This workload had a read/write ratio of 80/20.

For more information, see the “Resources” section at the end of this paper.

Test Cases

The test set used for this testing was selected to verify that Oracle Database behavior and functionality is not affected when VMware vSphere high availability operations are performed. The test set was defined to validate the operation of each of the vSphere advanced features used in this testing for a given workload, including vMotion, Storage vMotion, DRS, HA, and FT.

The results for each of these tests are described in the section below.

Results Observed

This testing was performed using the test set and workload described above. The results observed for each test case are described in the sections below. Overall, the testing results demonstrate that the behavior and functionality of Oracle Database 11g, R2 running on VMware vSphere 5.1 was not affected when vSphere high availability operations were performed. VMware functioned well with the workload and all of the tests passed successfully.

The average transactions per second (TPS) was well within an acceptable range for all tests. The TPS indicates the number of transaction per second that occur for a given workload.

The test results observed and their impact during the testing of high availability operations are summarized in the table below. For detailed information, review each specified test area.

<table>
<thead>
<tr>
<th>VMware vSphere advanced feature</th>
<th>Test duration*</th>
</tr>
</thead>
<tbody>
<tr>
<td>vMotion</td>
<td>20 seconds</td>
</tr>
<tr>
<td>Storage vMotion</td>
<td>8 minutes</td>
</tr>
<tr>
<td>Distributed Resource Scheduler (DRS)</td>
<td>20 seconds</td>
</tr>
<tr>
<td>High Availability (HA)</td>
<td>3 minutes</td>
</tr>
<tr>
<td>Fault Tolerance (FT)</td>
<td>4 seconds</td>
</tr>
</tbody>
</table>

* The transactions per second (TPS) results are described in the sections below.
vMotion Testing Results

vMotion testing was successful and all tests passed. The average TPS was well within an acceptable range for all tests.

For vMotion testing, two tests were performed. One test included 200 users and the other test included 400 users. The purpose for varying the number of users was to demonstrate that, even when the number of users is increased, the minimal TPS decrease during the vMotion transition remains the same, regardless of the number of users, as described in the table below.

Table 2. vMotion testing results summary

<table>
<thead>
<tr>
<th>vMotion testing</th>
<th>Results</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vMotion initiation</td>
<td>1 second</td>
<td>The workload starts at a steady state. When vMotion starts in the source host, the TPS value decreases, and then returns to its nominal value.</td>
</tr>
<tr>
<td>vMotion host switch - (host 1 to host 2)</td>
<td>3 seconds</td>
<td>When the virtual machine switches hosts (Host 1 to Host 2), the TPS value decreases, and then returns to its steady state.</td>
</tr>
<tr>
<td>Test duration</td>
<td>20 seconds</td>
<td>The TPS value remains steady during the vMotion operation, with the exception of vMotion start, and the host migration.</td>
</tr>
</tbody>
</table>

* The transactions per second (TPS) averages for vMotion testing are described in the tables below.

The TPS variation and CPU utilization in the virtual machine during the vMotion operation is shown in the figures below.

Figure 12. VMware vMotion testing results

![VMware vMotion testing results](image)

The Swingbench results for 200 users provides the TPS before and after a vMotion migration from Host 1 to Host 2, as shown in the figure below.

Figure 13. Swingbench vMotion test results for 200 users

![Swingbench vMotion test results for 200 users](image)
The results for vMotion test of 200 users shows:

1. At vMotion start, there is a minor decrease in TPS (1 second).
2. When vMotion switches hosts, the TPS value decreases (3 seconds).
3. Duration of the vMotion test (20 seconds)

The results for the vMotion test of 200 users are described in the table below.

**Table 3. vMotion test results for 200 users***

<table>
<thead>
<tr>
<th>Users</th>
<th>Test duration (seconds)</th>
<th>VM CPU % utilization</th>
<th>Average TPS</th>
<th>Average TPS - vMotion kick off (drop)</th>
<th>Duration - vMotion kick off (seconds)</th>
<th>Average TPS - vMotion completion (drop)</th>
<th>Duration - vMotion completion (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>20</td>
<td>50</td>
<td>850</td>
<td>750</td>
<td>1</td>
<td>30</td>
<td>3</td>
</tr>
</tbody>
</table>

* All values in the table above are approximate.

Similar results were observed during the first vMotion migration for 400 users, as shown below.

**Figure 14. Swingbench vMotion test results for 400 users**

The results of the vMotion test for 400 users shows:

1. When vMotion starts, there is a minor decrease in TPS (1 second), and then a return to the steady state.
2. When vMotion switches hosts, the TPS value decreases (3 seconds), and then returns to a steady state once vMotion is completed.
3. Duration of the vMotion test (20 seconds)

The test results for vMotion with 400 users are described in the table below.

**Table 4. vMotion test results for 400 users***

<table>
<thead>
<tr>
<th>Users</th>
<th>Test duration (seconds)</th>
<th>VM CPU % utilization</th>
<th>Average TPS</th>
<th>Average TPS - vMotion kick off (drop)</th>
<th>Duration - vMotion kick off (seconds)</th>
<th>Average TPS - vMotion completion (drop)</th>
<th>Duration - vMotion completion (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>20</td>
<td>70</td>
<td>1050</td>
<td>650</td>
<td>1</td>
<td>50</td>
<td>3</td>
</tr>
</tbody>
</table>

* All values in the table above are approximate.
Storage vMotion Testing Results

Storage vMotion testing was successful and all tests passed. The average TPS was well within an acceptable range for all tests.

The Swingbench test results for Storage vMotion show the workload starts at a steady state. When the Storage vMotion operation starts, the TPS value can fluctuate for approximately 60 seconds to 10 percent of its initial value. Then the workload returns to a steady state for the remainder of the operation. When Storage vMotion is about to complete, the value drops incidentally for approximately 1 second. The TPS value returns to its nominal value once the Storage vMotion operation is completed.

Figure 15. VMware Storage vMotion testing results

Figure 16. Swingbench Storage vMotion test results

1. The initial spike in TPS when Storage vMotion started (approximately 60 seconds).
2. When the storage vMotion about to complete, the value drops (1 second) and then returns to a steady state.
3. Duration of the Storage vMotion operation (8 minutes)

The test results for Storage vMotion are described in the table below.

Table 5. Storage vMotion test results*

<table>
<thead>
<tr>
<th>Users</th>
<th>Test duration (minutes)</th>
<th>Average TPS</th>
<th>Average TPS (with drop)</th>
<th>Average TPS - kick off (drop)</th>
<th>Duration - Kick off (seconds)</th>
<th>Average TPS - completion (drop)</th>
<th>Duration - completion (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>8</td>
<td>850</td>
<td>750</td>
<td>400</td>
<td>60</td>
<td>30</td>
<td>3</td>
</tr>
</tbody>
</table>

* All values in the table above are approximate.

DRS Testing Results

For DRS testing, similar results obtained as vMotion. For more information, see “vMotion Testing Results” above.
HA Testing Results

HA test was successful and all tests passed. The average TPS was well within an acceptable range for all tests. The results demonstrate that there was minimal downtime for both planned and unplanned HA activities.

For this test, the Oracle Database was running the workload in a steady state on the ESXi host (Host 1). Then the host was shutdown, the virtual machine running Oracle Database was failed over to the next available host (Host 2), and the virtual machine was rebooted on the host. Then Oracle Database was manually restarted, the workload was reconnected, and it was able to generated load on the database. After failover, it returned to its steady state prior to the HA operation.

During HA failover, the TPS dropped to zero and returned to a steady state over a period of 3 minutes. Failover included rebooting the operating system in the second host, manually logging into the virtual machine, restarting Oracle Database, and reconnecting the workload.

Note that, when there is no manual intervention, the database can be restarted on its own, once the virtual machine is rebooted on the second host. For an automated process, the time required to connect back to the workload is lower.

Figure 17. VMware High Availability testing results

Fault Tolerance Test Results

FT testing was successful and all test passed. The average TPS was well within an acceptable range for all tests.

For the Fault Tolerance testing, the Oracle Database virtual machine configuration was changed to support 1 vCPU. Note that FT supports one CPU only at present. The RDM-P disks were converted to VMDK as part of the FT requirement. The FT logging network was configured with a 1 Gb NIC. For more information about the FT configuration, see “Appendix A: Testing Configuration” below.
When FT was started and the load was transferred from the Primary VM to the Secondary VM, there was an incidental TPS decrease of approximately 4 seconds, as shown below. After that, the Secondary VM was enabled and FT assumed connectivity.

There was no load driver disconnect or load decrease when the Secondary VM started, and it drove the same amount of load as Primary VM.

Figure 18. VMware Fault Tolerance testing results

![Figure 18. VMware Fault Tolerance testing results](image1)

1 FT transferred the load from the Primary VM to the Secondary VM (4 seconds).

Deployment Best Practices

The best practices for deploying the Oracle Database solution for high availability include:

- Follow VMware vSphere performance best practices guide to configure the virtual machine and database, and to configure vMotion, Storage vMotion, DRS, HA, and FT:
- vSphere High Availability Deployment Best Practices:
- Best Practices for iSCSI Storage:
- Note that the Oracle Database server was built using minimal specifications as it was intended for a Lab environment.

Conclusion

VMware vSphere enables the deployment of multiple virtual machines running different Oracle database solutions consolidated on to the same physical server and storage. This consolidation results in increased CPU utilization, a reduction in overall server requirements, and a lower total cost of ownership (TCO).

This paper describes the validation testing for high availability that was performed using Oracle Database with vSphere 5.1 advanced features including vMotion, Storage vMotion, Distributed Resource Scheduler (DRS), High Availability (HA), and Fault Tolerance (FT). All of the tests were conducted on a testing architecture that employed Hewlett-Packard server and storage hardware. The paper also outlines best practices for deploying the solution in the datacenter.

Overall, testing results show that how high availability can be achieved (planned and unplanned downtime) for Oracle database running on VMware vSphere. Furthermore, it shows the impact of transaction per second (TPS) in the database while high availability operations are initiated in VMware vSphere infrastructure.
Appendix A: Testing Configuration

The configuration of the VMware ESX host servers and storage, iSCSI configuration, network configuration, installed software, and virtual machine configuration used in this testing is described in the sections below.

Hardware and Storage Configuration

Tables A-1 and A-2 describe the configuration of VMware ESXi host servers and the storage server used in this testing.

Table A-1. ESXi host hardware configuration

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>Two HP Proliant DL 380p Gen8 servers. Each server is equipped with:</td>
</tr>
<tr>
<td></td>
<td>• 16 CPUs (2 x 8) x 2.693 GHz (cores)</td>
</tr>
<tr>
<td></td>
<td>• Intel Zeon CPU E5-26800, 2.7 GHz (processor)</td>
</tr>
<tr>
<td></td>
<td>• 8 NICs</td>
</tr>
<tr>
<td></td>
<td>• Hyperthreading enabled</td>
</tr>
</tbody>
</table>

Table A-2. Storage server configuration

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>HP Proliant P4500 G2 iSCSI storage equipped with:</td>
</tr>
<tr>
<td></td>
<td>• Aggregate of 36 disks</td>
</tr>
<tr>
<td></td>
<td>• RAID 1 + 0</td>
</tr>
<tr>
<td></td>
<td>• SAS 3.0 GBPS connectivity</td>
</tr>
<tr>
<td></td>
<td>• Hardware iSCSI Protocol (10 Gb NIC)</td>
</tr>
<tr>
<td></td>
<td>• Software version 9.5.00.1215.0</td>
</tr>
</tbody>
</table>
iSCSI Configuration

Figure A-1 describes the iSCSI configuration used in this testing.

Figure A-1. iSCSI configuration

Network Configuration

Figure A-2 describes the network switch configuration used in this testing.

Figure A-2. Network switch configuration for both hosts
Installed Software

Table A-3 lists the installed software used in this testing.

Table A-3. Software installation

<table>
<thead>
<tr>
<th>Software Type</th>
<th>Software configuration</th>
</tr>
</thead>
</table>
| VMware        | • VMware vSphere 5.1, with vMotion, Storage vMotion, DRS, HA, and FT enabled  
|               | • VMware vCenter Server 5.1 |
| Oracle        | • Oracle Database 11g Release 2 |
| Swingbench    | • Swingbench 2.4 |

Virtual Machine Configuration

Table A-4 describes the configuration of virtual machines running on ESXi host servers in this testing.

Table A-4. Virtual machine configuration

<table>
<thead>
<tr>
<th>Virtual machine</th>
<th>Hardware configuration</th>
</tr>
</thead>
</table>
| Oracle Database (RHEL 6 – 64 bit) | • 4 vCPUs  
|                           | • 16 GB memory  
|                           | • 1 Ethernet card (vmxnet 3)  
|                           | • 100 GB OS Disk (VMDK)  
|                           | • 400 GB Data Disk (RDM-Physical)  
|                           | • 50 GB Temp File Disk (VMDK) |
| Swingbench (RHEL 6 – 64 bit) | • 4 vCPU  
|                           | • 8 GB memory  
|                           | • 1 Ethernet card  
|                           | • 300 GB storage (VMDK) |
Resources

Customers can find more information about the VMware and Oracle Database products described in this paper using the links listed below.

**VMware**

**Deployment References**

- VMware vSphere:
- VMware Support and Downloads web site:
- Performance Best Practices for VMware vSphere 5.1:
- vSphere High Availability Deployment Best Practices:
- Best Practices for iSCSI Storage:
- Compatibility Guides (VMware Certified Compatibility Guides):
- VMware Compatibility Guide (compatible storage and networking devices):
  http://www.vmware.com/resources/compatibility/search.php

**General Information**

- VMware web site:
  http://www.vmware.com/
- Featured VMware Documentation Sets:
  http://www.vmware.com/support/pubs/
- VMware Licensing Help Center:
  http://www.vmware.com/support/licensing/
- VMware Product Podcasts:
  http://www.vmware.com/technical-resources/podcasts/
- VMware Technology Network (Community) web site:
  http://communities.vmware.com/community/vmtn
- Community, VMware Knowledge Base:
  http://communities.vmware.com/community/vmtn/resources/knowledgebase
• VMware Support Insider:
  http://blogs.vmware.com/kbtv/
• VMware TV:
  http://www.youtube.com/user/vmwaretv
• VMworld TV:
  http://www.youtube.com/user/VMworldTV
• VMware KB TV (external):
  http://www.youtube.com/user/VMwareKB

Hewlett-Packard (HP)
• HP ProLiant DL380p Gen8 Server - Overview:
• HP Proliant P4500 G2

Oracle Database
• Oracle web site:
  http://www.oracle.com
• Oracle Database web site:

Swingbench
• Swingbench web site:
  http://www.dominicgiles.com/index.html