White Paper

Oracle 11g Disaster Recovery Solution with VMware Site Recovery Manager and EMC CLARiiON MirrorView/A

Applied Technology

Abstract

This white paper demonstrates how VMware's Site Recovery Manager enables the design of a powerful yet simple disaster recovery solution. Built on the solid foundation of VMware virtualization and leveraging EMC's MirrorView™/Asynchronous storage replication technology, Site Recovery Manager easily resolves typical disaster recovery challenges in an extremely cost-effective manner while providing complete flexibility.

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Table of Contents

Executive summary

Today's data center is a product of change. Technological progress and business growth have added to the complexity of IT infrastructure with new operating system, storage, database, and network technologies. Along with technologies, data center uptime has grown increasingly important for corporations. Even in the event of a site failure or system failure caused by hardware malfunction, corporations must continue to safeguard critical business data such as customer information and rapidly restore system functionality to ensure continuing services. Interruptions or outages affecting important services pose serious threats to the entire business; in certain cases this can result not just in lost income, but in serious damage to the confidence of customers and associated companies. At the same time, data is one of the most critical assets for any company. Corporate data, for example, payroll or employee information, client records, valuable research results, financial records, or history information, can require both significant sums and effort to reconstruct or regenerate once lost, if this is even possible. In some cases such data loss may impair a company's capacity to continue operating.

Smaller businesses, with limited budgets and staff, are typically turned off by the costs and stringent requirements as well as complexities and hence are left with few options for protecting their applications and business. To make matters more complex, more and more mission-critical business applications are now logically combined into distributed, multi-tier (also called n-tier) client/server platforms. Although the use case discussed in this white paper only involves the recovery of an Oracle 11g database leveraging EMC® CLARiiON® MirrorView™/Asynchronous technology, it can easily be adapted to recover multi-tier environments such as Oracle's E-Business Suite. Companies that have deployed Oracle databases depend heavily on the availability of the information even in the case of a disaster. The good news is that VMware's innovative virtualization leveraged with EMC CLARiiON storage technology helps overcome all these challenges related to high availability.

Introduction

This white paper will outline how, using an Oracle 11g environment residing on EMC's CLARiiON storage, VMware Site Recovery Manager can help you:

- Accelerate recovery for the virtual environment through automation
- Ensure reliable recovery by enabling nondisruptive testing
- Simplify recovery by eliminating complex manual recovery steps and centralizing management of recovery plans

This paper will introduce a short, simple approach to disaster recovery that uses Site Recovery Manager and CLARiiON storage and replication software (MirrorView/A) to provide an effective availability solution for the mission-critical Oracle 11g environment. Although only the database tier is discussed, Site Recovery Manager coupled with the CLARiiON MirrorView/A technology also applies to multi-tier deployments as well.

The scope of the architecture documented here includes:

- A freshly installed Oracle 11g R1 database on Oracle Enterprise Linux 5.1 and EMC's CLARiiON CX4 storage
- Storage array replication of LUNs (via MirrorView/A) between two separate CLARiiON storage systems simulating a primary and secondary site using the iSCSI protocol
- Setup of a protection group and recovery plan consisting of an Oracle 11g environment using VMware's Site Recovery Manager
- Performing nondisruptive test execution of a recovery plan
- Execution of a disaster recovery plan using Site Recovery Manager. This test included recovering an Oracle 11g environment at a secondary site while the primary site was subjected to an Online Transaction Processing (OLTP) load created by an Oracle test kit named OAST.

Audience

This white paper is intended for EMC employees, partners, IT managers, storage architects, database administrators, and consultants who are involved in planning for disaster recovery options for their Oracle Database application deployments.

Terminology

CLARiiON consistency support: The logical concept of designating (and enforcing) a group of CLARiiON storage LUNs to be replicated by the replication software as a coherent set. The replication action is performed automatically for all members in the set. Either all members will be replicated, or none will be replicated.

Consistency group: A set of mirrors that are managed as a single entity and whose secondary images always remain in a consistent and restartable state with respect to their primary image and each other.

Fracture: A condition in which I/O is not mirrored to the secondary image; this can happen when you initiate the fracture (Admin Fracture) or when the system determines that the secondary image is not reachable (System Fracture).

Logical unit number (LUN): A unique identifier that is used to distinguish among logical devices that share the same bus.

Primary image: The LUN containing the production data, the contents of which are replicated to the secondary image.

Promote: The operation by which the administrator changes an image's role from secondary to primary. As part of this operation, the previous image becomes a secondary image.

RPO: Recovery point objective is the point in time to which data must be recovered as defined by the organization.

Promote: The operation by which the administrator changes an image's role from secondary to primary. As part of this operation, the previous image becomes a secondary image.

Secondary image: The LUN that contains a mirror of a primary image LUN. This LUN must reside on a different CLARiiON storage system from the primary image.

SRA: Storage replication adapters are created by each storage vendor to carry out specific storage functions required by SRM.

SRM: VMware vCenter Site Recovery Manager is a plug-in for Virtual Center (vCenter Server) that helps to automate the recovery process during a site disaster and eliminates the complexity of managing and testing recovery plans to ensure a seamless recovery when disaster strikes.

VC: VirtualCenter (currently known as vCenter Server) provides a scalable and extensible platform that forms the foundation for virtualization management. It allows IT administrators to centrally manage VMware virtualized environments.

VI: Virtual Infrastructure unifies discrete hardware resources to create a shared dynamic platform while delivering built-in availability, security, and scalability to applications.

Overview

EMC CLARiiON CX4 series storage

The EMC CLARiiON CX4 UltraFlex™ series storage platform, launched in Q3 2008, is EMC's state-of-the-art midrange family of storage systems. The CX4 architecture delivers cutting-edge performance, including the highest levels of resiliency and availability, tiered storage flexibility, and powerful easy-to-use interfaces. The unique combination of flexible, scalable hardware design and advanced software capabilities enables CLARiiON CX4 to achieve up to twice the performance and scale as the previous

CLARiiON generation. With breakthrough architecture and extensive technological innovation, CX4 is the leading midrange storage solution to meet a full range of needs – from departmental applications to data-center-class business-critical systems.

VMware's Virtual Infrastructure featuring CLARiiON CX4 series storage furthers the benefits of VMware by enabling and supporting new functionality such as VMotion, Distributed Resource Scheduler (DRS), High Availability (HA), and Site Recovery Manager (SRM) that makes VMware Infrastructure 3 a powerful solution.

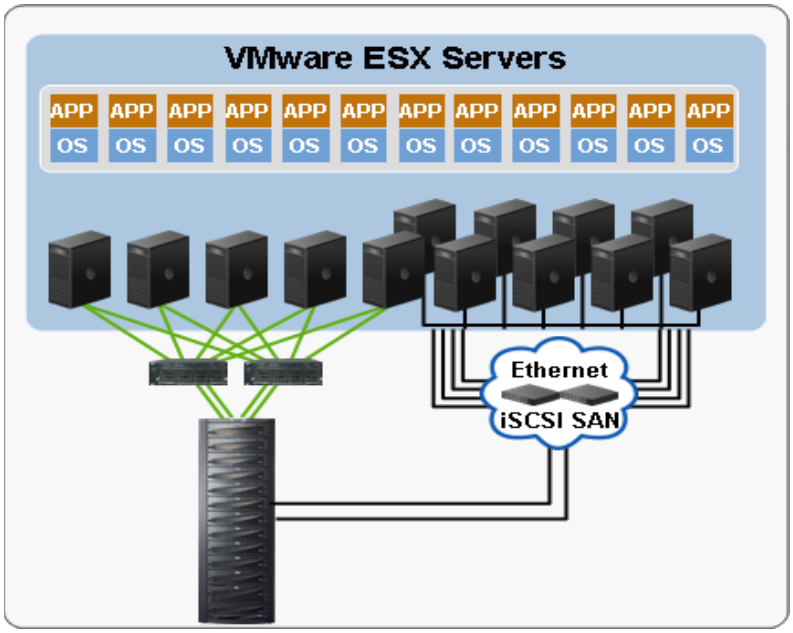

Figure 1. EMC CLARiiON CX4 storage and VMware

For this VMware Site Recovery Manager and Oracle 11g use case, two CX4-480 storage arrays with MirrorView/A are used. The CLARiiON CX4-480 provides high-capacity networked storage that meets the needs of demanding OLTP workloads and large-scale e-mail environments. With the CX4-480 you can scale seamlessly up to 471 TB of storage capacity and consolidate twice the workloads in one array as you can with other storage providers.

Note that the methodologies discussed in this paper for use with Oracle extend to all models in the CLARiiON family that support MirrorView/A, including the CX[1], CX3, and the latest CLARiiON CX4 series storage.

EMC MirrorView

EMC MirrorView is storage system-based disaster recovery software that provides end-to-end data protection by replicating the contents of a primary volume to a secondary volume that resides on a different CLARiiON storage system. It provides end-to-end protection because in addition to performing replication, it protects the secondary volume from tampering or corruption by making the mirrored volume only available for server access when it is promoted through Navisphere®. The flexibility of the CLARiiON storage system does allow for the creation of both SnapView snapshots and clones of the mirrored volumes if access to contents of the volume is desired at the secondary site without the disruptive promotion step.

MirrorView offers consistency groups, which is a unique consistency technology for the midrange market that replicates write-order dependent volumes. Using this technology, MirrorView maintains write ordering across the secondary volumes in the event of an interruption to one, some, or all of the write dependent secondary volumes.

[1] SRM is supported on the original CX series through the RPQ process.

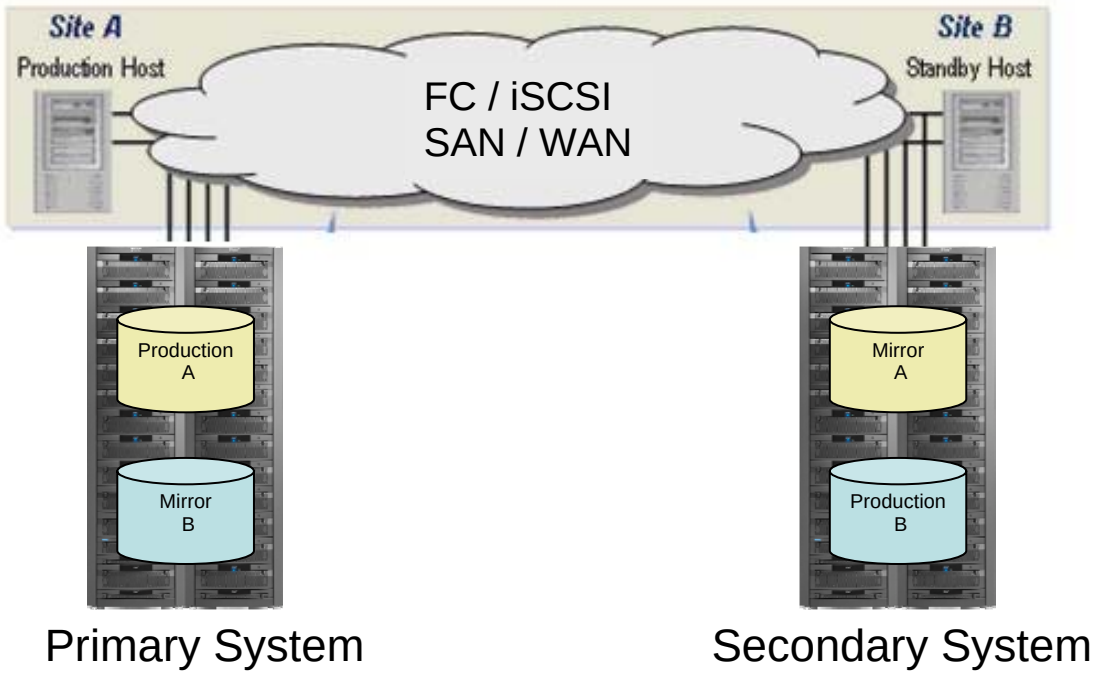

Figure 2. EMC MirrorView configuration possibilities

Figure 2 shows the various MirrorView configuration possibilities with different protocols. It is important to understand that there are two modes of MirrorView operation, Synchronous and Asynchronous.

Synchronous mirroring mode ensures that the data on the secondary CLARiiON is bitwise tracking all the production data. When changing data has to be kept in synchronization over significant distances, application performance will be compromised.

For the solution discussed in the paper, we used MirrorView/Asynchronous mode. Because of its asynchronous nature, MirrorView/A allows greater flexibility in terms of how far the replicated site can be from the primary site. Depending on how much data change takes place and the quality of the replication link, MirrorView/A makes replication between regional sites possible.

MirrorView/A is an ideal solution for customers with flexible RPO requirements where some data loss is acceptable. For those with more demanding RPOs, the MirrorView/S option can provide a zero-data loss solution for disaster recovery of database systems. In addition, since it is storage-based disaster recovery software, applications and server resources can be dedicated to service users rather than being tied up to perform backups.

For replication over longer distances, it may be more feasible and cost-effective to use a robust WAN link rather than fiber. For CLARiiON models that offer both FC and iSCSI options, the replication can be configured to use the iSCSI ports to natively send data over the IP network without the need for specialized hardware that converts between FC and IP. The CX4 series storage systems come equipped with both options standard.

VMware Site Recovery Manager

VMware Site Recovery Manager is a pioneering disaster recovery management and automation solution for VMware Infrastructure. Site Recovery Manager accelerates recovery by automating the recovery process and simplifying the management of disaster recovery plans by making disaster recovery an integrated

element of managing your VMware virtual infrastructure. The solution ensures reliable recovery by eliminating complex manual recovery steps and enabling nondisruptive testing of recovery plans. Site Recovery Manager enables organizations to take the risk and worry out of disaster recovery, as well as expand protection to all important systems and applications. It integrates tightly with VMware Infrastructure, VMware VirtualCenter, and EMC's MirrorView software to make failover and recovery rapid, reliable, affordable, and manageable. Figure 3 shows a configuration involving Site Recovery Manager and MirrorView.

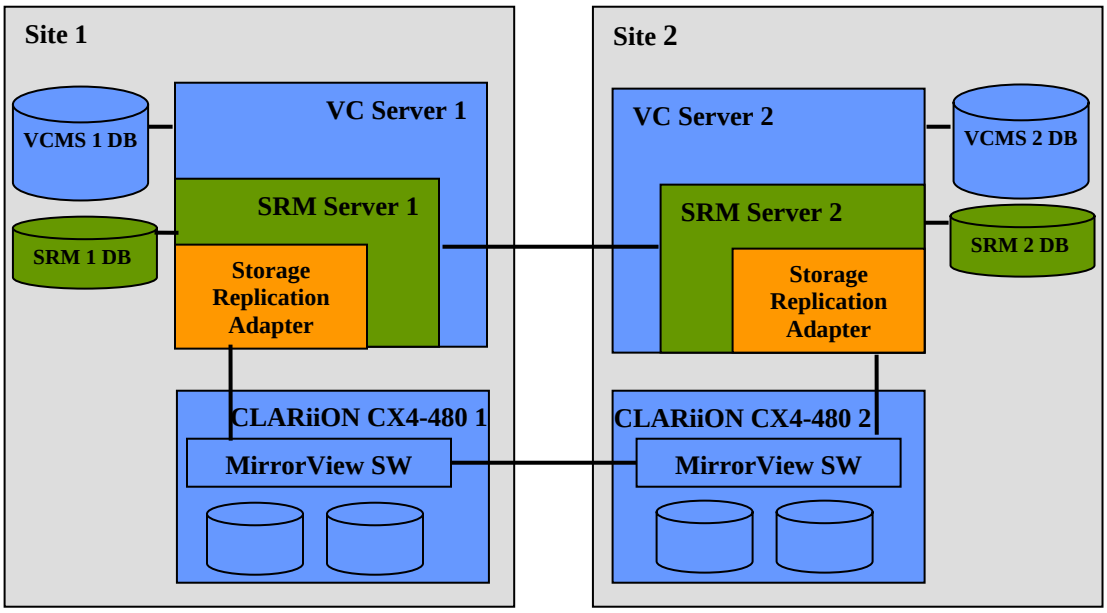

Figure 3. Site Recovery Manager with MirrorView/A

Site Recovery Manager does not actually perform the replication for disaster recovery but facilitates the setup, test, and recovery workflows. Site Recovery Manager relies on array-based replication using MirrorView for the transport of data. The communication between Site Recovery Manager and MirrorView is managed by a storage replication adapter (SRA) provided by EMC. A single SRA is available for EMC CLARiiON MirrorView and allows for both MirrorView/S and MirrorView/A functionality. Storage replication adapters exist on the Site Recovery Manager server and, once installed, are invisible for the duration of their use. Additional details about Site Recovery Manager setup and configuration are covered in the VMware white paper *Planning for the Unplanned*.

Oracle Database 11g

Oracle Database 11*g* 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. It can serve as the database tier for a multi-tier client/server platform such as Oracle E-Business Suite.

As previously discussed in the *Oracle E-Business Suite Disaster Recovery Solution with VMware SRM and EMC CLARiiON* white paper, SRM integrates seamlessly with MirrorView/S to replicate multi-tier deployments. With MirrorView/A, the primary goal is to ensure the database is restarted to a state that falls within the specified RPO, so this paper focuses on the database tier only. Since the application tier is solely dependent on the state of the database tier, SRM with MirrorView/A would be able to handle the recovery of environments that include other tiers such as an application.

Solution design and setup

Architecture

Figure 4 highlights the infrastructure setup for this solution. The asynchronous mode of replication was configured to use the iSCSI ports of the CX4 storage system. Although not depicted, a Linux host was placed between the iSCSI connection of the storage system that allowed for variations in delays of the data sent across the link. This allowed for the simulation of a real world replication over the IP network of geographically disparate locations, which is the typical deployment scenario for MirrorView/A. Of course the simulated distance (and corresponding latency over the link) should be compliant with EMC Pre-Sales Qualification requirements for MirrorView using iSCSI or undesired and inconsistent behavior might be observed during the mirror update process. If the MirrorView implementation used Fibre Channel rather than iSCSI, the Pre-Sales Qualification is not needed for replication over longer distances.

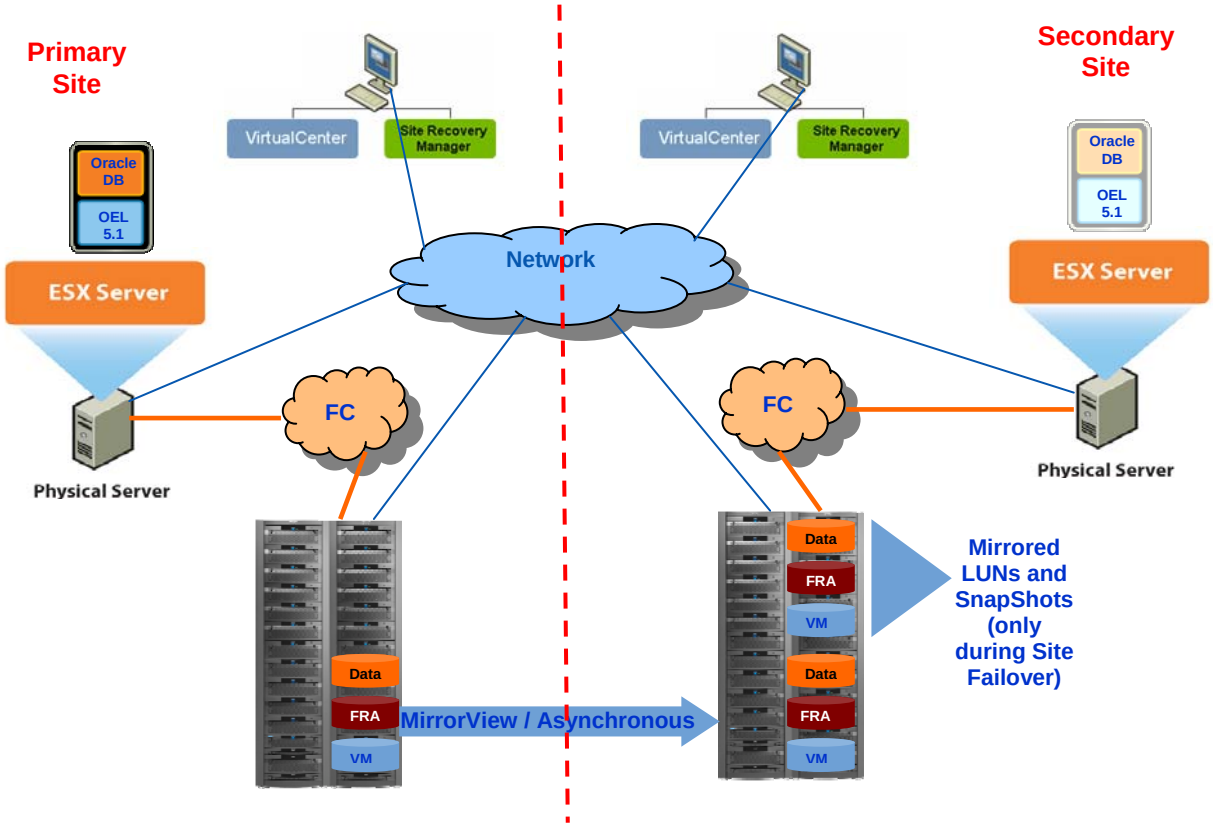

Figure 4. Site Recovery Manager configuration with CLARiiON CX4-480 storage

Hardware and software

The following table lists the software and hardware used in the architecture.

Table 1. Solution hardware and software requirements for primary and secondary sites

VMware	
Virtual Infrastructure 3	VirtualCenter Server 2.5 ESX 3.5
Site Recovery Manager	Site Recovery Manager 1.0
EMC	
Storage system	CLARiiON CX4-480
Features and software	MirrorView/Asynchronous
Storage configuration	13 LUNs: LUN 1: 50 GB, OS LUN for 1 VM LUN 2-7: 10 GB each, Data LUNs LUN 8-9: 10 GB each, Online Redo Logs LUN 10-13: 20 GB each, Flashback Recovery Area
Oracle 11g R1	
Oracle 11g R1	Virtual Machine 1 Database virtual machine (VM) name = "OEL5U1-Ora11g" 2 x vCPU 4 GB RAM Oracle Database 11g R1 Database SID = "oastoltp" Storage is 13 x volume (13 x LUNs): OS on 1 x VMFS LUN Data on 6 x VMFS LUNs Logs on 2 x VMFS LUNs FRA on 4 x VMFS LUNs
Dell	
Servers running ESX	Dell PowerEdge 2950 4 core (2.8 GHz) 16 Gb RAM 4 Gb QLogic HBA card

Here are the key points regarding the setup.

- The ESX server at the primary site has a single database virtual machine that hosts the transactional database that is accessed during the failover processes.
- The Site Recovery Manager requires two VirtualCenter servers. One resides at the primary site and the second manages the standby site. For this solution, we used one ESX server that hosts the primary and secondary site VirtualCenter servers configured in virtual machines. However, it is a best practice to separate primary and secondary site VirtualCenter servers for disaster recovery practices.
- EMC CLARiiON CX4 Fibre Channel storage arrays are used for primary and secondary site storage. For data replication, MirrorView/A is configured to replicate all 13 LUNs from primary to secondary storage.
- The EMC Storage Replication Adapter (SRA) is installed on the primary and secondary VirtualCenter servers. The EMC SRA:
  - Automatically discovers the replicated LUNs on the primary side.

- Facilitates a Site Recovery Manager test recovery workflow on the secondary site during failover - the clone of replicated LUNs (based on snapshots) including the VM clone is registered into the secondary site VirtualCenter server and is started.

- The primary site containing the OEL 5.1 virtual machines is added to the Site Recovery Manager protection group called "Primary_Oracle11g Protection Group." Obviously, this protection group is created on the primary VirtualCenter server.
- At the recovery site VirtualCenter, a recovery plan called "Oracle11g_MVA Recovery Plan" is created. This recovery plan protects the “Primary_Oracle11g Protection Group” that is created at the primary site.

Hardware configuration

Let us look at the hardware configuration used in this paper. Configuration of the hardware is carried out in the following order:

- Configure EMC storage arrays at the primary and secondary sites (each array per each site).
- Create 13 LUNs on the primary site storage and expose to the primary site ESX server. Create VMFS datastores on those LUNs as follows:
  - LUN1: “VM_OS” datastore OS virtual disks
  - LUN2-7: “data1-6” datastore for the ASM data disk group
  - LUN8-9: “log1-2” datastore for the ASM redo log disk group
  - LUN10-13: “FRA1-4” datastore for the ASM flash recovery area disk group
- Once the virtual machines are created and configured with operating systems and patches, install Oracle 11g.
- Install a VirtualCenter 2.5 server on two Windows virtual machines on the appropriate ESX server. These will serve as primary and secondary site VirtualCenter servers.

Note: We used static IP addresses for this exercise. Use of DNS names is the best practice and highly recommended.

- Configure storage replication between primary and secondary site storage arrays by:
  - Configuring MirrorView/A to replicate three LUNs (Data, FRA, Logs, OS).
    - With MirrorView/A, various update intervals can be configured to meet just about any RPO.
      - Manual Update – Each update interval is initiated by the end user through Navisphere Manager or through Naviseccli.
      - Start of Last Update – After the specified time has been reached since the start of the last update, a new update session is started. If the update period itself takes longer than the specified value, a new update interval will be started right after the previous session has completed. This option can be used to maintain a specified time lag between primary and secondary sites as long as the link bandwidth is able to push data across fast enough. This option was used for the configuration of the mirrors used in this test case.
      - End of Last Update – This option starts a new update session after the specified time has elapsed since the previous update completed. This option is ideal for environments with a lower rate of data change on the primary image and the RPO is more relaxed.
  - Creating a consistency group containing all 13 LUNs. This unique feature ensures appropriate I/O ordering at the remote site in case of failover.
  - Creating SnapView snapshots of replicated LUNs. These snapshots are used during the failover test operation of Site Recovery Manager.
- Install Site Recovery Manager on the primary and secondary VirtualCenter servers.
- Configure Site Recovery Manager (covered in subsequent sections).
  - Configure primary/secondary connectivity, array managers, and inventory preferences.

- Create a protection group on the primary Site Recovery Manager.
- Create a recovery plan on the secondary Site Recovery Manager.
- Edit the recovery plan and update virtual machine start order.

Site Recovery Manager installation

The Site Recovery Manager installation and configuration are fairly straightforward. At the primary site and secondary site:

- Install a Site Recovery Manager server into a separate database instance on the same guest OS running the VirtualCenter server.
- Install the Site Recovery Manager Plug-in into VirtualCenter.
- Install EMC Storage Replication Adapter (SRA).

For more information about Site Recovery Manager installation, please refer to Site Recovery Manager product manuals.

Site Recovery Manager configuration

After installation, a Site Recovery Manager icon is visible on VirtualCenter and is accessed via a VI client. Figure 5 shows the primary VirtualCenter and defines the configuration steps required after the initial installation.

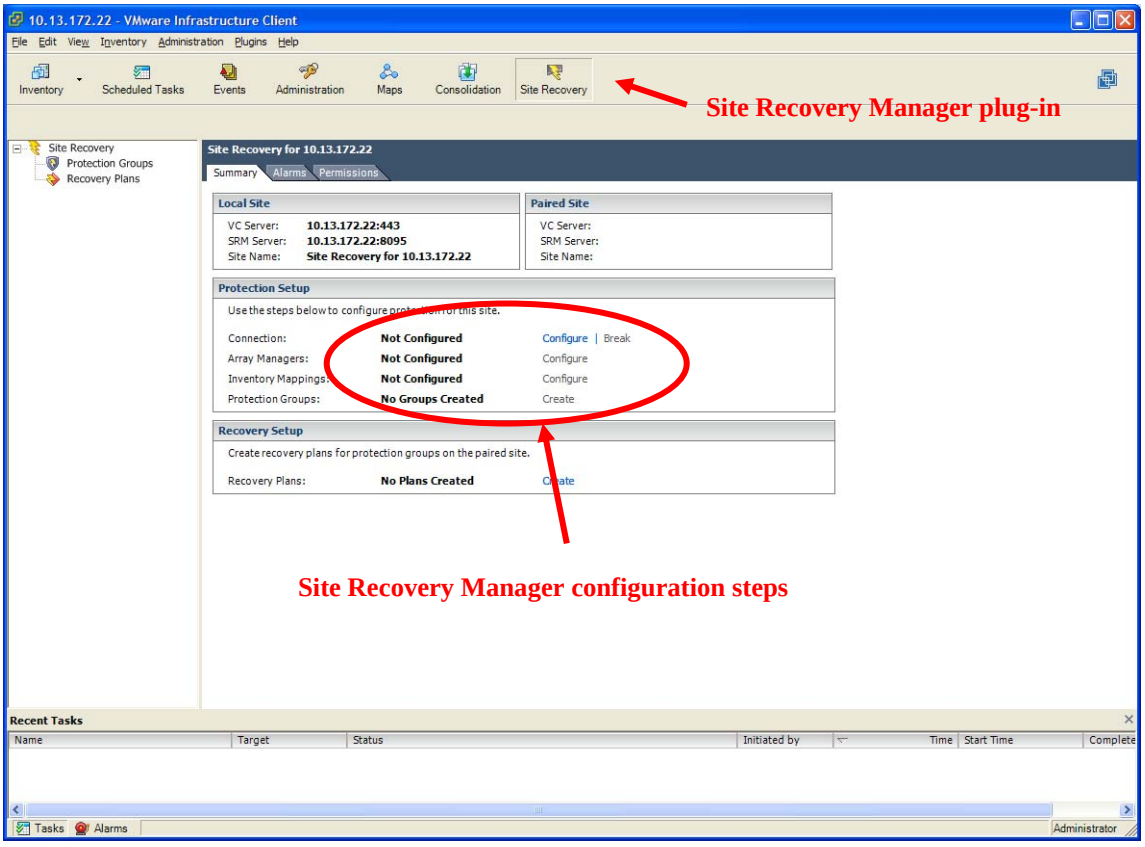

Figure 5. Primary Site Recovery Manager server screenshot immediately after installation

As shown in the figure, execute the configuration steps to establish connectivity between the primary and secondary site. At the primary Site Recovery Manager server:

- Configure a connection between the primary and secondary Site Recovery Manager servers.
- Configure the array manager.
- Configure inventory preferences.

- Create a protection group "Primary_Oracle11g Protection Group" for the virtual machines at the primary site. Only one protection group was created in this case because all LUNs for the virtual machine were put into a single consistency group on the storage system.

At the secondary Site Recovery Manager server:

- Create a recovery plan "Oracle11g_MVA Recovery Plan" consisting of “Primary_Oracle11g Protection Group.”
- Because there is only one virtual machine in this protection group, no other configuration steps are necessary. If there were application servers dependent on the database tier, prioritize the virtual machine start order to start a database virtual machine ahead of the middle tier virtual machines.

Planning and testing

Disaster recovery testing is an interdisciplinary concept used to create and validate a practiced logistical plan for how an organization will recover and restore partially or completely interrupted critical function(s) within a predetermined time after a disaster or extended disruption. This logistical plan is commonly referred to as the Business Continuity plan. An effective Business Continuity plan provides a smart balance of business needs versus cost considering all the risk factors. It is beyond the scope of this paper to detail all the aspects of building a master Business Continuity plan. However, it is nevertheless important to discuss the importance of frequent testing of the disaster recovery plan. The old saying goes that any disaster recovery plan is only as good as your last (successful) test. Indeed, most disaster recovery efforts have one or both of the following shortcomings: the team either spends an inordinate amount of effort doing continual testing (not good), or — worse — neglects to test often, the result being an insurance policy that doesn't pay off when you really need it.

So, what makes disaster recovery testing so hard? The simple reason is it's usually very disruptive, expensive in terms of resources, and extremely complex. Site Recovery Manager has the ability to create a “virtual remote recovery image” — storage, virtual machines, even network connections — and test this as a walled-off virtual entity, perhaps even co-resident with production apps that might be running at the remote site. This ability to logically encapsulate and test a complete recovery scenario in a set of virtual machines is simply huge and saves significant time and resources. Site Recovery Manager also eliminates the human error element, thus eventually making disaster recovery testing easier, better, and far more frequently possible compared to the physical environment. Along with a user-friendly user interface to manage disaster recovery tasks such as creating protection groups and recovery plans, Site Recovery Manager also accommodates frequent testing of the recovery plans in a nondisruptive manner.

The recovery plan test for our solution is highlighted next. As part of the solution, EMC’s MirrorView software provided the means to maintain asynchronous remote copies of production data with MirrorView/A. Customers can ensure rapid, reliable disaster recovery by leveraging VMware SRM using MirrorView/A software to simplify and automate disaster recovery setup, failover, failback and testing, and to ensure the proper execution and management of recovery plans.

Recovery plan test using Site Recovery Manager

The following sequence is executed to validate the recovery plan test:

- On the primary site, ensure the database virtual machine is running. Start a transactional workload generated by OAST using the command line.
- Start a Site Recovery Manager disaster recovery test on the secondary site for recovery plan "Oracle11g_MVA Recovery Plan". The recovery steps that follow show that the Oracle 11g recovery plan used in this test executes successfully in just a few minutes using SnapView snapshot techonology.
- Once the recovery plan test completes, click **Continue** to ensure proper cleanup.

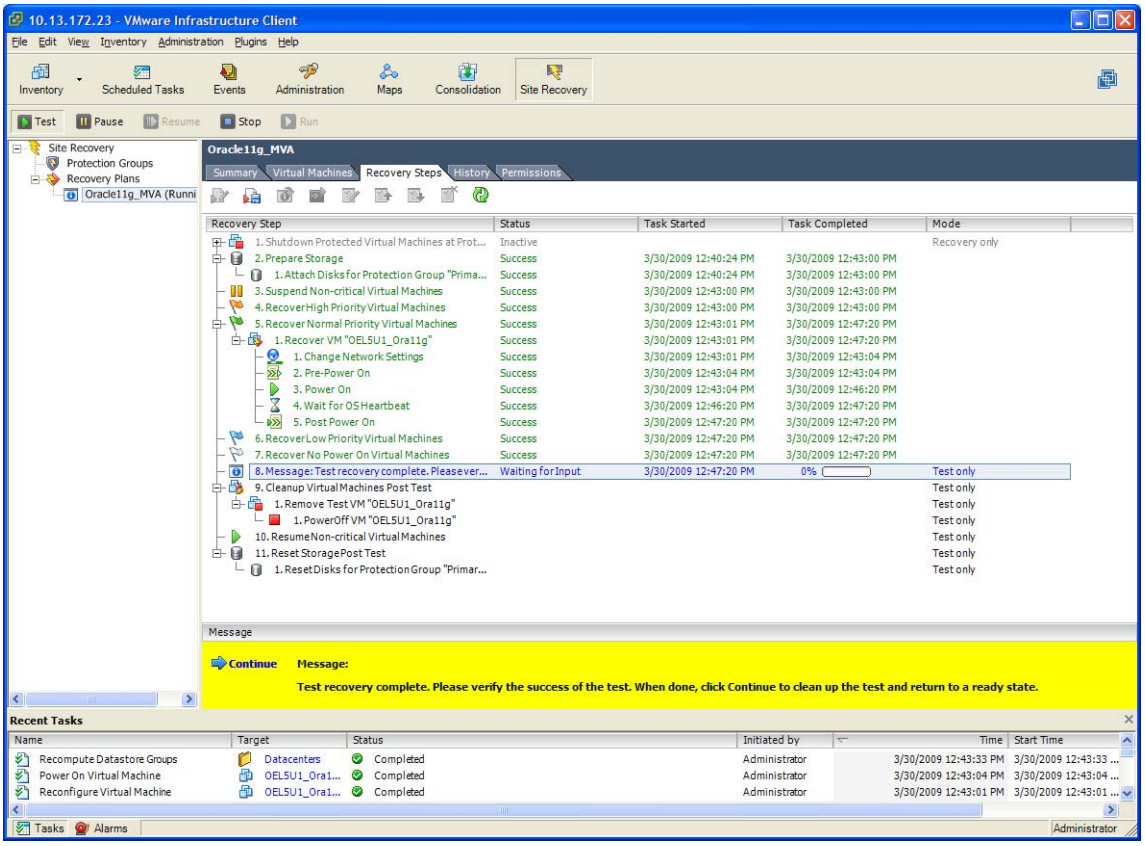

Figure 6. Recovery Plan test execution

As highlighted, Site Recovery Manager facilitates virtually nondisruptive testing of recovery plans. Next, we will discuss the setup and flow for an actual site failover.

Site failover (disaster recovery) test

During a disaster, even a small corner case may cause significant issues in bringing up the remote site. Therefore, it is extremely important to test the failover while the database is under load conditions. In order to represent a realistic scenario, we used an OLTP workload on the primary site. Once the workload is started we allow any MirrorView/A update operation to complete, making the secondary MirrorView/A mirrors come to a consistent state. We then initiate site failover from Site Recovery Manager on the remote site. We use the following sequence to validate the site failover test:

- On the primary site, we start up the OAST workload. This generates the necessary resource consumption for the VM while incurring database I/O.

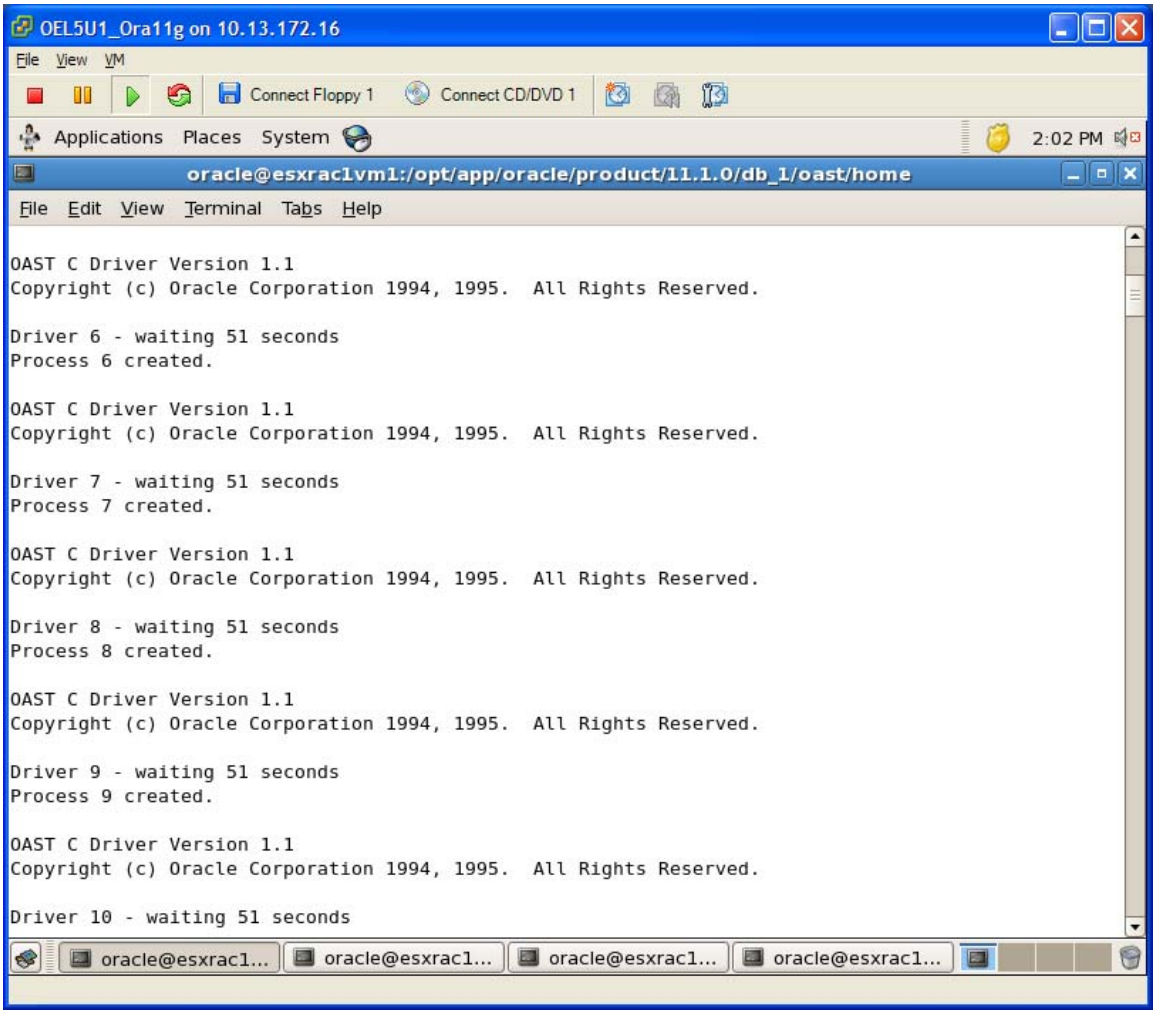

Figure 7. OLTP workload submission

- Verify there is I/O activity going to the different LUNs using a tool such as iostat.

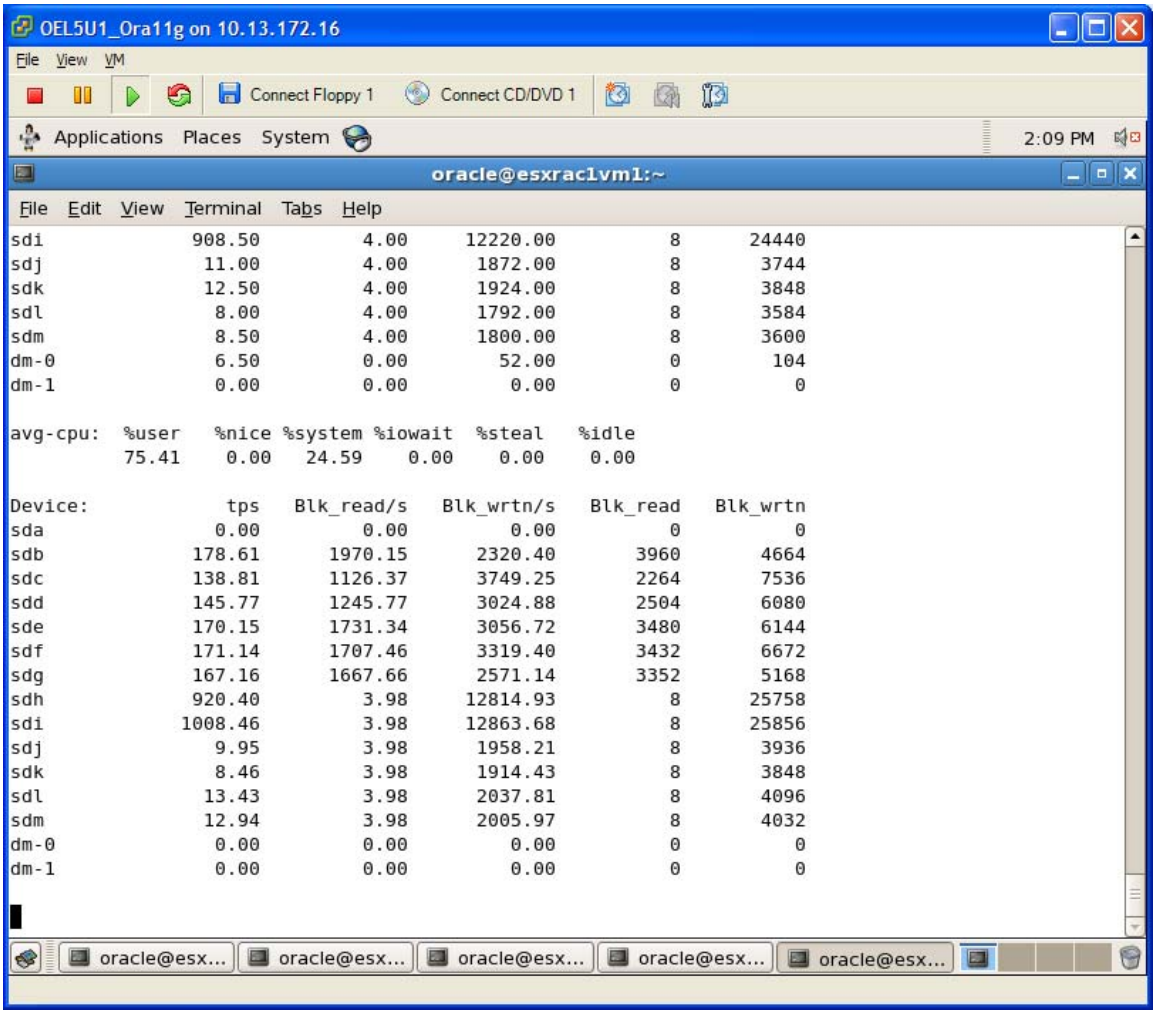

Figure 8. Verification of I/O activity to LUNs using iostat

- Check to make sure the remote mirror status is consistent for all LUNs that are a part of the VM.

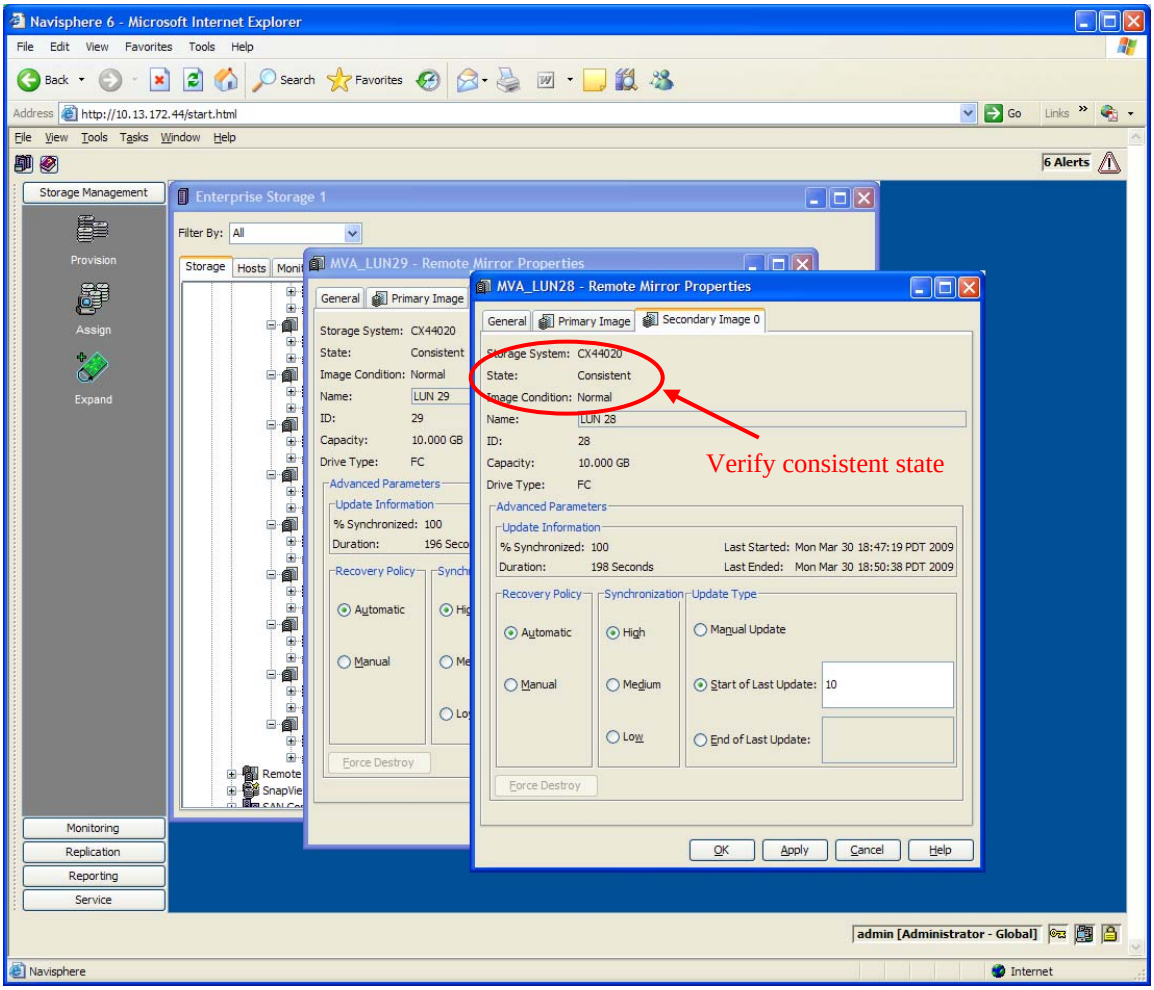

Figure 9. Verification of consistent secondary mirrors using Navisphere Manager

- Check the current SCN and date recorded in a table created in the database for tacking purposes.

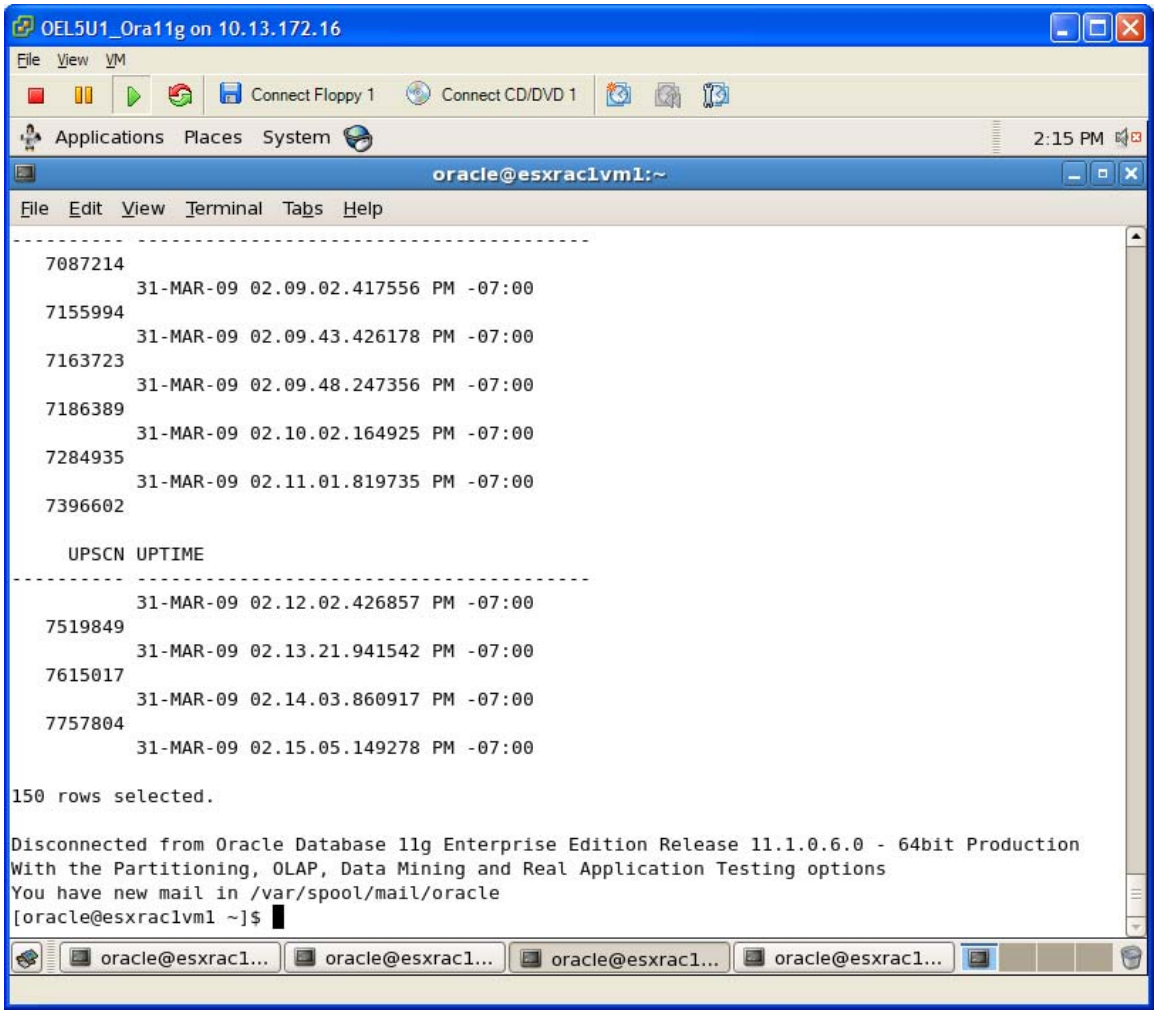

Figure 10. Check current SCN and timestamp of the database on the primary site

- Once everything is verified, initiate a site failover test using the recovery plan on the secondary site.

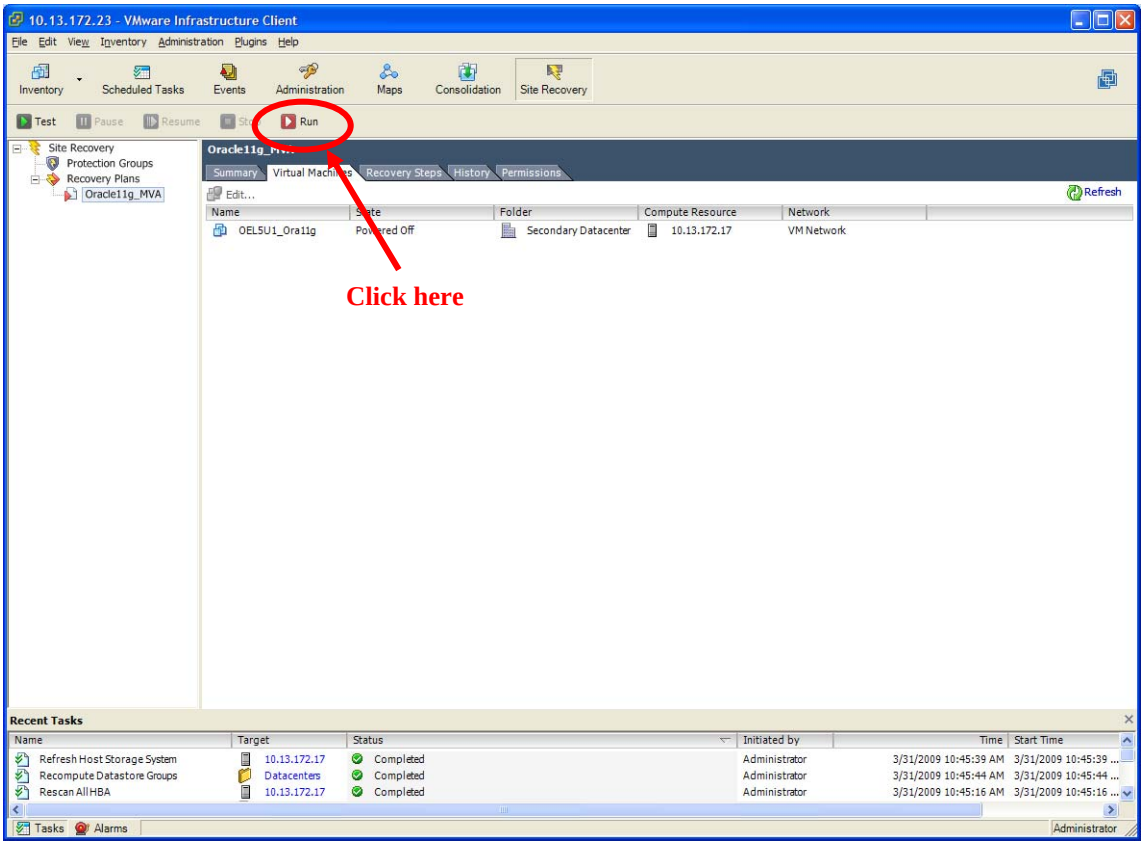

Figure 11. Site Recovery failover initiation

- Once site recovery is complete, log in to the Oracle instance at the recovery site and the check the table for SCN and timestamp vales to ensure it falls within the RPO specified. Also check the ASM and database instance logs to make sure that the recovery process completed properly.

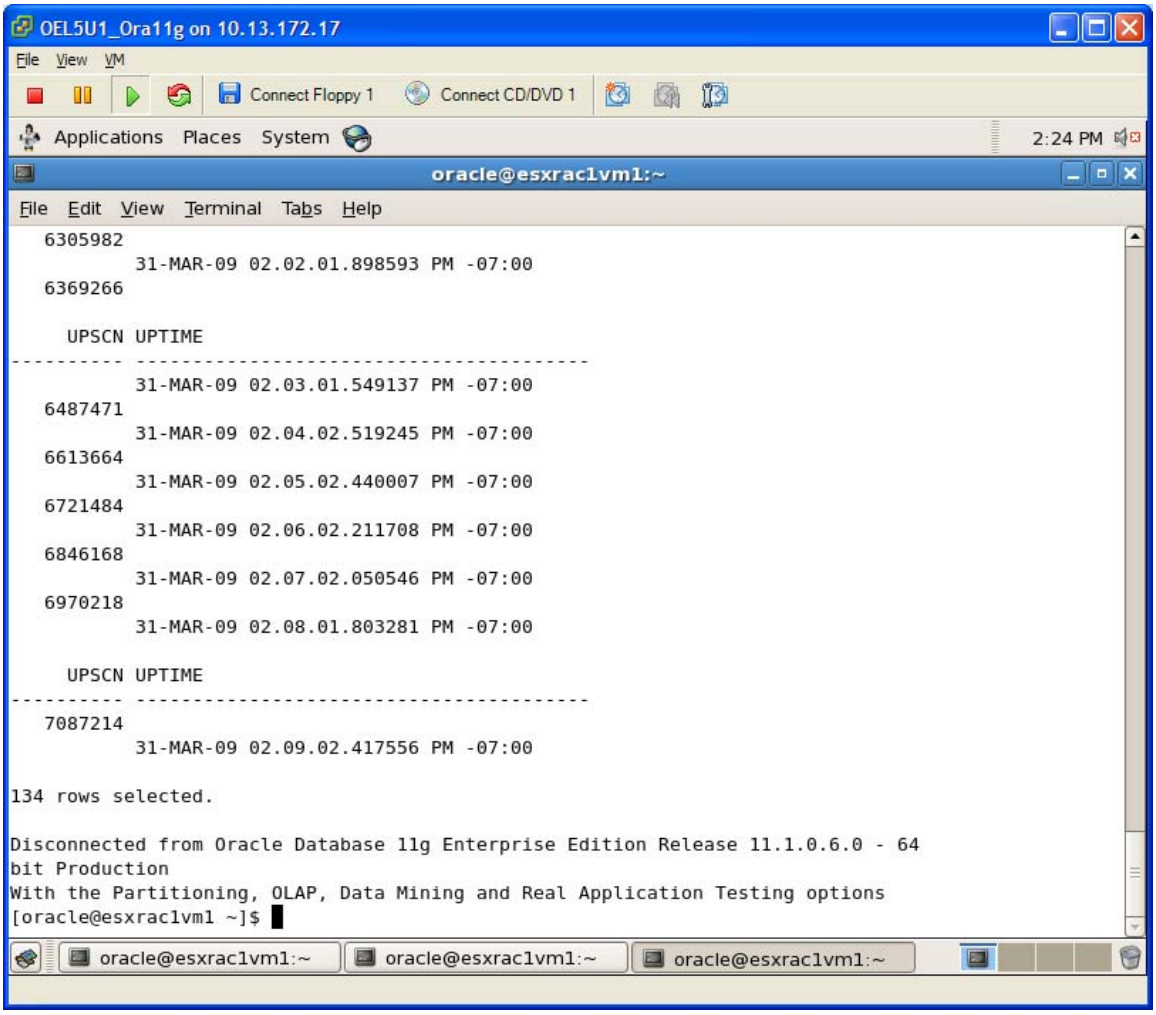

Figure 12. Check the recorded SCN and timestamp on the secondary site

- To ensure everything is functional and there are not any errors, check the alert logs for the database instance and ASM instance (if present) for recovery messages. Additionally, query several tables to ensure there is no data corruption. In this test case, a new workload is started against the database.

Conclusion

In this paper, we demonstrated how VMware's Site Recovery Manager along with EMC's MirrorView/A enable the design of a powerful yet simple disaster recovery solution. Built on the solid foundation of VMware virtualization and CLARiiON CX4's revolutionary technologies, this solution easily resolves typical disaster recovery challenges in an extremely cost-effective manner while providing complete flexibility. Using an Oracle 11g database environment residing on EMC CLARiiON storage, we highlighted how Site Recovery Manager lets you:

- Accelerate recovery for the virtual environment through automation.
- Ensure reliable recovery by enabling nondisruptive testing.
- Simplify recovery by eliminating complex manual recovery steps and centralizing management of recovery plans.

In conclusion, traditional disaster recovery solutions are slow and prone to failures because they involve many manual and complex steps that are difficult to test, and require expensive duplication of the production data center infrastructure to ensure reliable recovery. Working with CLARiiON storage replication technology, Site Recovery Manager can help eliminate complexity and automate the disaster recovery process so that customers can reliably recover from data center outages in hours rather than days.

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