DR Validation for SAP Solutions with VMware Site Recovery Manager and NetApp Storage and Products

Architecture Jointly Deployed by NetApp, SAP and VMware at SAP Co-Innovation Lab, SAP Labs, Palo Alto
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Version 1.0
Note from the Author

The primary audiences for this document are SAP customers and partners interested in deploying SAP disaster recovery solutions on VMware and NetApp infrastructure.

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1 Introduction

SAP provides a range of enterprise software applications and business solutions to manage and run the complete business of a company. Companies that have deployed such products depend on information and processes managed by SAP solutions, and continuous availability of the SAP system is essential. An integrated architecture of VMware® Site Recovery Manager with NetApp® storage and data management solutions provides an effective disaster recovery (DR) solution to address these business continuity requirements.

This paper documents the configuration and validation of an SAP DR architecture using Site Recovery Manager and NetApp storage and tools. The infrastructure was installed and verified at the SAP Co-Innovation Lab (COIL) in Palo Alto, CA and was jointly deployed by NetApp, SAP and VMware staff.

The scope of the architecture documented here includes:

- Two installations of Virtual Center and Site Recovery Manager to simulate a primary and secondary site
- A freshly installed SAP ECC 6.0 system (MSSQL / Windows Server 2003 64 bit) deployed on: 2 x vCPU, 8 GB virtual machine running on VMware ESX; 4 x NetApp volumes; 1 x VMFS LUN; 3 x RDM LUN.
- A storage array replication of LUNs (via SnapMirror) between two separate NetApp storage systems (in the same lab) simulating a primary and secondary site.
- The execution of a test DR recovery plan using Site Recovery Manager. This test included starting storage array replication while the primary SAP system was subjected to a batch load created by the SAP "SGEN" transaction.
- As of May 2008, the architecture did not include NetApp products for database consistent recovery, and the DR test workflow is based upon the crash recovery of the underlying SAP database (MSSQL).
- A complete solution requires crash consistent recovery of the SAP database (best practice), and this will be incorporated into the COIL setup in the future. The solution will include NetApp products SnapDrive 6.0 and SnapManager for MSSQL. This content will be updated in the next revision of this document.

1.1 VMware Site Recovery Manager

VMware Site Recovery Manager is a DR management and automation solution for VMware® Infrastructure. It integrates with VMware Infrastructure, VMware® VirtualCenter and storage replication software from leading storage vendors. The solution eliminates complex manual recovery steps and enables non-disruptive testing of recovery plans, making failover and recovery rapid, reliable, affordable and manageable.

Figure 1-1 illustrates the technical architecture of Site Recovery Manager with storage array replication across two sites.
Site Recovery Manager is designed as a plug-in to VirtualCenter so that DR tasks can be executed inside the same management tool as other virtual machine administration tasks such as creation, migration and deletion. However, Site Recovery Manager is not “in” VirtualCenter. It is a separate server process with its own separate database. The server processes for Site Recovery Manager and VirtualCenter can be run on the same or different servers and the databases for VirtualCenter and Site Recovery Manager can reside on the same or different database servers.

Site Recovery Manager does not actually do the replication for DR; it only performs the setup, test and recovery workflows. Site Recovery Manager relies on block-based replication (fiber or iSCSI) from VMware storage partners for replication. The storage replication adapters tie together the Site Recovery Manager product and the replication products. These adapters are developed, qualified and supported by the storage vendor. They sit on the Site Recovery Manager server and, once installed, are invisible for the duration of their use.

### 1.2 NetApp Storage and Data Management Solutions

NetApp disaster recovery solutions provide flexibility to address a broad range of recovery point objectives to meet the needs of all customers. These solutions allow customers to replicate data efficiently over long distances, providing protection from both site and regional disasters. The NetApp products and features that are used with VMware Site Recovery Manager to provide a DR solution for SAP include:

- NetApp® Snapshot™ technology

NetApp Snapshot technology is a point-in-time space efficient copy of data. Snapshot technology is a standard feature of the Data ONTAP™ operating system that runs on every NetApp storage system. Snapshot copies can be created while applications are running with
no performance impact and minimal consumption of storage space. Restoring data from a Snapshot copy is nearly instantaneous.

- **NetApp® SnapMirror®**

NetApp SnapMirror replicates data to one or more NetApp storage systems at high speeds over a LAN or a WAN. SnapMirror performs intelligent resynchronization, which eliminates the need for full transfers when recovering from a broken mirror or loss of synchronization. Data at the destination can be quickly resynchronized with the source data by copying the new and changed data blocks.

- **NetApp® FlexVol® and NetApp® FlexClones®**

NetApp FlexVol pools storage resources and enables the creation of virtual volumes that can be managed independent of the physical storage. FlexVols can be resized to meet the changing needs of applications without downtime.

FlexVol technology pools storage resources automatically and enables creation of multiple flexible volumes on a large pool of disks.

![Diagram of Storage Virtualization with NetApp FlexVol Technology](image)

**Figure 1-2. Storage Virtualization with NetApp FlexVol Technology**

NetApp FlexClone technology enables true cloning—instant replication of data volumes and data sets without requiring additional storage space at the time of creation. Each cloned volume is a transparent, virtual copy that can be used for essential enterprise operations, such as testing and bug fixing.

- **NetApp® SnapManager® for Microsoft® SQL Server™**

NetApp SnapManager for SQL Server is a data management solution that simplifies and streamlines configuration, backup and restore operations for SQL Server databases.
• NetApp® SnapDrive® for Windows®

NetApp SnapDrive for Windows offers a rich set of capabilities to enhance storage management for SAP environments. It is tightly integrated with the NTFS file system and provides a layer of abstraction between application data and physical storage associated with that data. SnapDrive provides storage virtualization of volumes via the iSCSI or Fibre Channel (FCP) access protocol and includes Windows device drivers and software that is used to manage application Snapshot™ backups.

1.3 SAP Platform Overview

SAP provides a range of enterprise software applications and business solutions to manage and run the complete business of a company. In addition to ERP software, other key SAP products and solutions include business intelligence, customer relationship management, supply chain management, supplier relationship management, human resource management, product life cycle management, enterprise portal software, and knowledge warehouse software.

SAP applications are based on the SAP NetWeaver application and integration platform. SAP enterprise applications can be deployed in a 2- or 3-tiered architecture. The 3-tiered client/server architecture generally consists of a presentation layer, an application layer and a database layer. These three layers can run separately on different computers or together on the same computer, depending on the requirements and size of the SAP solution being deployed. In 3-tiered configurations, the database and application services reside on separate OS images, whereas in 2-tiered configurations, they co-exist on the same OS image. The 3-tiered architecture scales to support large numbers of users. The 2-tiered architecture is usually sufficient for many smaller and midsized companies, as well as for sandbox, development, training and test systems.
# Architecture

## 2.1 Software and Hardware

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

<table>
<thead>
<tr>
<th>VMware</th>
<th>Site Recovery Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMware Infrastructure 3</td>
<td>Site Recovery Manager 1.0 Release Candidate</td>
</tr>
<tr>
<td>• VirtualCenter Server 2.5</td>
<td></td>
</tr>
<tr>
<td>• VMware® ESX 3.5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NetApp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage System</td>
</tr>
<tr>
<td>• FAS 6070C</td>
</tr>
<tr>
<td>• Data ONTAP 7.2.3</td>
</tr>
<tr>
<td>Features and Software</td>
</tr>
<tr>
<td>• FlexClone</td>
</tr>
<tr>
<td>• SnapShot</td>
</tr>
<tr>
<td>• SnapMirror</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP-DEV: SAP ECC 6.0 / MSSQL / Windows Server 2003 64 bit</td>
</tr>
<tr>
<td>• Virtual machine name = &quot;IDES-DEV&quot;</td>
</tr>
<tr>
<td>• 2 x vCPU</td>
</tr>
<tr>
<td>• 8 GB RAM</td>
</tr>
<tr>
<td>• SAP SID = &quot;RDM&quot;</td>
</tr>
<tr>
<td>• SAP install of ECC 6.0</td>
</tr>
<tr>
<td>• Storage - 4 x volumes (4 x LUNs):</td>
</tr>
<tr>
<td>• OS and executables on 1 x VMFS LUN</td>
</tr>
<tr>
<td>• Database data on 1 x RDM LUN</td>
</tr>
<tr>
<td>• Database log files on 1 x RDM LUN</td>
</tr>
<tr>
<td>• TempDB on 1 x RDM LUN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blade Servers running ESX</td>
</tr>
<tr>
<td>• HP ProLiant BL460c G1</td>
</tr>
<tr>
<td>• 4 core (3 GHz)</td>
</tr>
<tr>
<td>• 16 GB RAM</td>
</tr>
<tr>
<td>• 4 Gbit QLogic HBA Card</td>
</tr>
</tbody>
</table>
2.2 Logical Architecture

Overview

- The SAP system was assigned to one Site Recovery Manager protection group called "SAP-dev," which was created on the primary VirtualCenter server.
- NetApp SnapMirror replicated the volumes from the primary to secondary site.
- A Site Recovery Manager recovery plan called "SAP-dev" was created on the secondary VirtualCenter server based on the protection group of the same name.
- The Site Recovery Manager NetApp adapter:
  o Automatically discovers the replicated volumes on the primary site.
  o Facilitates a Site Recovery Manager test recovery workflow on the secondary site: The replicated volumes are copied via NetApp FlexClone (based on Snapshots) and the virtual machine in the clone is registered into the secondary site VirtualCenter server and booted.
2.3 Physical Architecture

An FC-based NetApp Cluster Storage Array with two nodes was used to simulate a primary and secondary site.

Two separate VLANs served as the networks at the primary and secondary sites. Routing was configured to allow connectivity between those networks - required by Site Recovery Manager.

The primary and secondary site VirtualCenter servers were installed in virtual machines hosted on a single VMware ESX instance with connectivity to the primary and secondary VLANs.

Network connectivity was set up between the VirtualCenter servers and the NetApp storage to allow Site Recovery Manager to communicate with the storage array.

SAP Virtual Machine Configuration

The following VMware Infrastructure client screenshots show the SAP virtual machine ("IDES-dev") setup on the primary VirtualCenter server.
VM "C:" drive on VMFS
MSSQL DB on 3 x RDMs

VM created with name "prd10202" & renamed to "IDES-dev"
2.4 SAP Storage Layout

Figure 2-3 shows the volume layout of the SAP system at the NetApp storage level. The configuration can be viewed from the output of NetApp commands, shown in Appendix 2.

Figure 2-3. SAP NetApp Volume layout

The following best practice guidelines were followed (some of which are also documented in the NetApp paper “TR-3585 SAP on Windows and MSSQL Server with NetApp Storage,” available at http://www.netapp.com/us/library/technical-reports/tr-3585.html):

- One volume for the database data files.
- One volume for the database log files.
- One volume for the OS and executables.
- One volume for SQL Server TempDB (temporary workspace for MSSQL Server).
- The LUN for the OS and executables was configured as VMFS.
- The LUNs for the remaining volumes were configured as RDM.
3 Installation Overview

The complete DR architecture in the COIL facility was installed in the following order. Steps are described at a high level (note that the NetApp storage system was already operational):

- Configure primary and secondary networks and routing between the two.
- Install VMware ESX on primary and secondary networks.
- Install VirtualCenter Server 2.5 and the VMware® Infrastructure Client (VI Client) in virtual machines on primary and secondary networks, and verify network connectivity between the two via a guest OS “ping.”
  - Note that direct IP addresses were entered for the Site Recovery Manager servers during Site Recovery Manager installation and configuration here (see Section 8.1, Appendix 1). Use of DNS names is a best practice; hence, it is necessary to validate that DNS is working as expected by performing the DNS lookups for the VirtualCenter, Site Recovery Manager and ESX host servers.
- Configure storage volumes for an SAP system on primary site.
- Create virtual machine on primary site and install SAP ECC 6.0 in virtual machine.
- Manually execute a DR test (see following chapter for details): A manual verification of a DR test scenario is beneficial to validate the infrastructure prior to testing with Site Recovery Manager.
- Install Site Recovery Manager on the same guest OS of the primary and secondary VirtualCenter servers.
- Configure Site Recovery Manager (instructions in chapter 5):
  - Configure primary/secondary connectivity, array managers and inventory preferences.
  - Create protection group on primary Site Recovery Manager instance.
  - Create recovery plan on secondary Site Recovery Manager instance.
- Execute Site Recovery Manager DR test workflow.
4 Manually Execute DR Test

Prior to installing Site Recovery Manager, manual execution of a DR test was conducted. The manual test was required because Site Recovery Manager DR testing automates most of this process so any infrastructure issues discovered here can be resolved prior to Site Recovery Manager testing. Otherwise, they would have also occurred with Site Recovery Manager. Note that Site Recovery Manager does not perform the storage array replication - this is managed by the NetApp SnapMirror utility.

The manual DR test execution consisted of the following steps, with NetApp commands and VMware steps identified at a high level:

- At the primary site: start SAP.

The remaining steps were executed at the secondary site:

- Run the following NetApp commands for each of the four volumes of the SAP system:
  - "snapmirror" command: replicates volume from primary to secondary.
  - "vol clone create" command: creates a volume (FlexClone) from the snapshot.
  - "lun map" command: maps LUN to initiator group (SAN fabric, which includes the WWN of the VMware ESX HBA card).
  - "lun online" command: brings the LUN online.

- Register virtual machine onto secondary VirtualCenter server using the VI Client:
  - Rescan all storage adaptors.
  - Under configuration, advanced settings, select "LVM" and set "LVM.EnableResignature" to 1. This enables ESX to recognize an existing VMFS datastore, even if it is presented on a different LUN ID than the LUN ID it had when it was created.
  - Refresh storage.
  - Create a new virtual machine and point it to the existing disks.

- Start virtual machine on secondary site; select "Yes" when prompted to create a new UID.

- Start SAP on secondary site and log into the application.

- Remove virtual machine from VirtualCenter server inventory.

- Delete FlexClone via NetApp commands.
  - "vol destroy" command: deletes the volume and snapshot.
5 Site Recovery Manager Installation and Configuration

5.1 Site Recovery Manager Installation

The installation of Site Recovery Manager was executed in the following order:

- At the primary site:
  - Install Site Recovery Manager server into a separate database instance on the same guest OS that runs the VirtualCenter Server.
  - Install Site Recovery Manager plug-in into the VI Client.
  - Install NetApp Adapter.
- At the secondary site:
  - Install Site Recovery Manager server into a separate database instance on the same guest OS that runs the VirtualCenter Server.
  - Install the Site Recovery Manager plug-in into the VI Client.
  - Install NetApp Adapter.

The installation steps for the tasks outlined above are detailed in the Site Recovery Manager product manuals.

5.2 Site Recovery Manager Configuration

Site Recovery Manager access was achieved using the VI Client and Site Recovery Manager plug-in to the Site Recovery Manager server. Figure 5-1, a screenshot from the primary Site Recovery Manager server, shows the configuration steps required after initial installation.

![Figure 5-1. Primary Site Recovery Manager Server Screenshot Immediately After Installation](image-url)
The following configuration steps were executed:

- On the primary Site Recovery Manager server:
  - Configure the connection between primary and secondary Site Recovery Manager servers.
  - Configure the array manager.
  - Configure inventory preferences.
  - Create a protection group "sap-dev" for the SAP virtual machine.

- On the secondary Site Recovery Manager server:
  - Create recovery plan "sap-dev" for the SAP virtual machine.

Appendix 1 contains the screenshots associated with the steps outlined above.
6 Execute DR Test Using Site Recovery Manager

The following sequence was executed to validate a DR simulation test using Site Recovery Manager:

- On the primary site, run SAP transaction "SGEN" to generate a batch load and database I/O.
- While SGEN is running, execute replication of the SAP volumes via NetApp SnapMirror.
- Let SGEN complete on the primary site.
- On the secondary site, execute a Site Recovery Manager test of the recovery plan for the SAP system.
- On the secondary site, log into the recovered SAP system:
  - Verify the status of SGEN batch job.
  - Verify the time/date stamp of generated ABAP reports in table "REPOLOAD." SGEN compiles ABAP programs and updates the date and time of the generation in table REPOLOAD, providing a quick and simple way to determine how many objects SGEN has processed.

The test was started by running SGEN on the SAP system on the primary site at time 18:56:28.

- SGEN was executed for software component "ERECRUIT" and the batch job monitored via transaction SM37 (see following).
• Executed replication just after 18:58:42 using NetApp commands executed with "rsh" from the command line of the Windows guest OS of the secondary VirtualCenter/ Site Recovery Manager server.

• Replication was completed within few minutes - See the output of NetApp command "SnapMirror status" below.
- Started Site Recovery Manager DR test on the secondary for recovery plan "SAP-dev." The recovery steps below show that the SAP virtual machine was up and available for testing in less than five minutes.

- Opened the console to the SAP system on the secondary site and logged into the guest OS.
Note that Windows started up as if it had crashed (see above).
• Started SAP, logged in and verified the status of the batch job transaction SM37. (See following screenshot.)

![Screenshot of SAP system status](image)

**RECOVERED SAP SYSTEM ON SECONDARY**

**Job Overview**

<table>
<thead>
<tr>
<th>Job</th>
<th>Job Create on</th>
<th>Status</th>
<th>Start Date</th>
<th>Start Time</th>
<th>Duration (sec)</th>
<th>Delay (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPSRANGEN</td>
<td>NETAPP</td>
<td>Terminated</td>
<td>14.05.2008</td>
<td>18.55.28</td>
<td>912</td>
<td>1</td>
</tr>
</tbody>
</table>

**GEN batch job cancelled on recovered SAP system as storage replication occurred before task completed on primary**

• The status showed terminated as expected; storage replication occurred in the middle of the batch task.

• Verified the time/date stamp of generated programs in table REPOLOAD (via transaction SE17) and entered query parameters to display programs generated on the same day.
Executed the query selection above, which returned a list of ABAP programs that were generated on the specified input date.

For the first and last entries, see the screen shots below. (Note the earliest time of 18:56:39 corresponded to the approximate time the batch job was started on the primary site.)
### Recovered SAP System on Secondary

#### Time when SGEN Batch Job was Started on Primary Site

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14.05.2008</td>
<td>10:56:39</td>
</tr>
</tbody>
</table>

#### Approx. Time when Storage Array Replication/Sync was Started. Corresponds approx. to the recovery point in time.

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14.05.2008</td>
<td>10:57:00</td>
</tr>
</tbody>
</table>

---

**Note:**
- The table above shows the time when the SGEN batch job was started on the primary site.
- The marked time on the secondary site indicates the approximate time when the storage array replication/sync was started, corresponding to the recovery point in time.
• Note the latest time of the generated programs was at 18:58:59, approximately when storage replication began.

• The total number of entries, 495, corresponded to 495 reports that were generated until storage array replication was started by the NetApp SnapMirror utility.

• This test example demonstrates that the SAP system was able to recover to a point in time corresponding to the last storage array sync. This recovery capability is a function of the storage array replication technology, which is configured outside of Site Recovery Manager with a method similar to native environments.
7 Conclusion

The architecture and tests described in this paper show that a DR test of an SAP system can be successfully and quickly carried out within minutes using VMware Site Recovery Manager and NetApp storage and data management solutions, with no impact to the main production system on the primary site. This combined infrastructure from VMware and NetApp addresses the following SAP DR challenges:

- Recovery Time Objective (RTO): The time it takes to recover an SAP production system. RTO is closely associated with recovery workflow, which is fully automated by Site Recovery Manager and facilitated by the flexibility of virtual machines.
- Recovery Point Objective (RPO): How current the protected data needs to be, which is dependent on the frequency of storage array replication. The test described here shows a simple example of an SAP batch job, whose recovery point objective is based on the time of the last storage sync between the primary and secondary sites.

Note the following differences between the architecture described here and a real-world scenario that may produce different recovery times, workflows and characteristics:

- Production workloads were not tested during storage array replication.
- The primary and secondary sites were simulated on a NetApp clustered storage system in the same lab. A real-world situation would have the primary and secondary sites separated by large distances and connected via a WAN.
- Only one virtual machine was tested. Customer scenarios would normally involve the recovery of multiple production SAP systems on virtual machines, with dependencies and priorities - a situation for which Site Recovery Manager is well suited.
- The SAP database was in an open state during storage array replication, and database changes cached in memory may not have been committed to disk on the primary site. Hence, system recovery during the DR tests forced the underlying Microsoft SQL Server (MSSQL) database to perform a crash recovery. While MSSQL can manage crash recovery, this is not best practice. Best practice requires database-consistent recovery, which is covered in the next section.

7.1 Database Consistent Disaster Recovery of SAP MSSQL Database

Database-consistent DR means that the SAP database does not execute a database crash recovery at the secondary site. This practice requires the database to be backed up in a consistent state on the primary site.

The following NetApp products are required to design a database-consistent DR scenario of an SAP on MSSQL system running in a virtual machine:

- SnapDrive for Windows: Installed in the guest OS of the SAP virtual machine.
- SnapManager for MSSQL: A data management product that manages backup, restore and cloning operations for SQL Server databases.
The following logical architecture illustrates the complete database crash consistent DR solution using NetApp storage and tools and VMware Site Recovery Manager.

**Site Recovery Manager and NetApp Storage and Tools**

In **Figure 7-1** note the additional volume called "SnapInfo" that contains the log files for SnapManager and the log backups of the SQL Server database.

The concepts for the solution described in Figure 7-1 are as follows:

- SnapManager for MSSQL and SnapDrive for Windows are installed in the guest OS of the SAP virtual machine.
- SnapManager for MSSQL manages database backup and restore operations and communicates with the NetApp storage controller via SnapDrive for Windows.
- SnapDrive for Windows issues NetApp storage commands and requires network connectivity to the storage controller. This version of SnapDrive is designed to work with a virtual machine running a Windows guest OS.
• SnapManager puts the SAP database into online backup mode and creates a Snapshot copy of the volumes containing the database files while the database is in a consistent state.
• The database volumes, which contain the Snapshot copies, are replicated via SnapMirror to the secondary site. This for example can be scheduled every four hours.
• After the database volumes are replicated, the database log files are automatically replicated to the secondary site. This can be done more frequently e.g. scheduled every 10 minutes, preventing data loss. SnapManager can be configured to manage this replication schedule.
• The recovery process on the secondary site involves starting up the database whose state is based on the last replicated Snapshot copy. MSSQL will start normally as the backup is consistent. Files in the log backups can then be applied to roll the database forward to the desired recovery point.


### 7.2 Best Practice Recommendations

• RDM LUNs are required for the MSSQL database data files and log files so that they can be managed by NetApp tools for backup and recovery and for database consistent DR. The LUN for the guest OS and executables ("C:\") can be configured as VMFS.

• The SAP system should be spread across multiple NetApp volumes:
  o The database data files, log files, and backup of the logs (SnapInfo dir) must be stored on separate NetApp volumes. If they are not, a forward recovery of the database will not be possible.

• Use NetApp products for database-consistent MSSQL database recovery: SnapDrive for Windows and SnapManager for MSSQL.

• Site Recovery Manager protection group creates a shadow virtual machine, which should be located on shared storage on secondary site.

• Storage array replication (SnapMirror) and volume cloning must be working correctly for Site Recovery Manager to operate; hence, we recommend performing a clean manual DR test first before trying recovery with Site Recovery Manager.

• As of June 2008 use of RDM by Site Recovery Manager 1.0 is experimental. Official VMware support for RDM use in production with Site Recovery Manager is currently being worked on.
8 Appendix 1 - Site Recovery Manager Configuration Screenshots

The screenshots in this appendix document the following configuration steps:

- On the primary Site Recovery Manager server:
  - Configure connection between primary and secondary Site Recovery Manager servers.
  - Configure the array manager.
  - Configure inventory preferences.
  - Create protection group "sap-dev" for the SAP virtual machine.

- On the secondary Site Recovery Manager server:
  - Create recovery plan "sap-dev" for the SAP virtual machine.

NOTE: The following shots may not capture every screen. For a more comprehensive guide to the configuration steps, consult Site Recovery Manager product documentation.

8.1 On Primary - Configure Connection between Primary and Secondary Site Recovery Manager Servers

- Click Connection...........Configure.
• Click OK.
Connect to Remote Site

Complete Connections
Establish reciprocity with the remote VirtualCenter Server.

Remote Site Information
Authentication
Complete Connections

Final Results:
- Connected to remote VirtualCenter Server: 10.1.3.50.
- Certificate validation.
- Connected to remote Site Recovery Manager.
- Certificate validation.
- Reciprocity is established.

Click Finish to exit setup.
8.2 On Primary - Configure Array Managers

- Click Add.
• Enter details of array on primary site, click –Connect. When the array appears below, click OK.
• Click Next.
• Enter details of array on secondary site, then click Connect. When the array appears below, click OK.
• Click Next.
- Site Recovery Manager via the NetApp Adapter discovers the replicated datastores (see below). Note the SAP system is on datastore `dr_rdm_ds` (other datastores existed but were not related to the SAP system being tested).
8.4 On Primary - Create Protection Group

- Click Create Protection Group.
• Click Next.
Select "dr_rdm_ds" datastore, then select virtual machine "IDES-dev" and click Next.
• Select the datastore on the secondary site on which you want to place the Site Recovery Manager shadow virtual machine ("virtual machine configuration files" as documented above). Best practice is to select a datastore on shared storage. In this case, a local datastore on the ESX host machine on the secondary site was chosen. Click Finish.
8.5 On Secondary - Create Recovery Plan

Creating the protection group in the previous section creates a shadow virtual machine on the secondary VirtualCenter server (see screenshot below).
• Click Site Recovery.

• Click Create Recovery Plan.
Enter the name and description, then click Next.
• Select the protection group created previously, "SAP-dev," and click Next.
- Select defaults, then click Next.
• Select defaults, then click Next.
No virtual machines are selected for suspension in this case. Click Finish.
## 9 Appendix 2 - NetApp Storage Layout

The following table shows the status of the storage configuration of the SAP system on the NetApp Controller (based on the output of standard NetApp commands - note not all of the command output is shown).

<table>
<thead>
<tr>
<th>NetApp Cmd</th>
<th>Command Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary - volume status</td>
<td><strong>Volume State</strong></td>
</tr>
<tr>
<td>Netapp1 &gt; vol status</td>
<td><code>dr_rdm_data</code> online</td>
</tr>
<tr>
<td></td>
<td><code>dr_rdm_exe</code> online</td>
</tr>
<tr>
<td></td>
<td><code>dr_rdm_log</code> online</td>
</tr>
<tr>
<td></td>
<td><code>dr_rdm_exe</code> online</td>
</tr>
<tr>
<td><strong>These four volumes make up the single SAP system.</strong></td>
<td></td>
</tr>
<tr>
<td>Primary - LUN status</td>
<td><strong>LUN path</strong></td>
</tr>
<tr>
<td>Netapp1 &gt; lun show - m</td>
<td><code>/vol/dr_rdm/dr_rdm_ds</code></td>
</tr>
<tr>
<td></td>
<td><code>/vol/dr_rdm_data/data</code></td>
</tr>
<tr>
<td></td>
<td><code>/vol/dr_rdm_exe/exe</code></td>
</tr>
<tr>
<td></td>
<td><code>/vol/dr_rdm_log/log</code></td>
</tr>
<tr>
<td>Secondary - volume status</td>
<td><strong>Volume State</strong></td>
</tr>
<tr>
<td>Netapp2 &gt; vol status</td>
<td><code>dr_rdm_exe_2</code> online</td>
</tr>
<tr>
<td></td>
<td><code>dr_rdm_log_2</code> online</td>
</tr>
<tr>
<td></td>
<td><code>dr_rdm_2</code> online</td>
</tr>
<tr>
<td></td>
<td><code>dr_rdm_data_2</code> online</td>
</tr>
<tr>
<td><strong>These four volumes correspond to the volumes replicated from the primary side.</strong></td>
<td></td>
</tr>
<tr>
<td>Secondary - volume status, while Site Recovery Manager test running</td>
<td><strong>Volume State</strong></td>
</tr>
<tr>
<td>Netapp2 &gt; vol status</td>
<td><code>testfailoverClone_nss_v10745371_dr_rdm_log_2</code> online</td>
</tr>
<tr>
<td></td>
<td><code>testfailoverClone_nss_v10745371_dr_rdm_exe_2</code> online</td>
</tr>
<tr>
<td></td>
<td><code>testfailoverClone_nss_v10745371_dr_rdm_2</code> online</td>
</tr>
<tr>
<td></td>
<td><code>testfailoverClone_nss_v10745371_dr_rdm_data_2</code> online</td>
</tr>
<tr>
<td>The output above shows the cloned volumes created by NetApp FlexClone technology and was initiated by the Site Recovery Manager test workflow.</td>
<td></td>
</tr>
<tr>
<td>Secondary - LUN status, while Site Recovery Manager test running</td>
<td><strong>LUN path</strong></td>
</tr>
<tr>
<td>Netapp2 &gt; lun show - m</td>
<td><code>/vol/testfailoverClone_nss_v10745371_dr_rdm_2/dr_rdm_ds</code></td>
</tr>
<tr>
<td></td>
<td><code>/vol/testfailoverClone_nss_v10745371_dr_rdm_2/dr_rdm_data_2/data</code></td>
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<td></td>
<td><code>/vol/testfailoverClone_nss_v10745371_dr_rdm_2/exe</code></td>
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<td><code>/vol/testfailoverClone_nss_v10745371_dr_rdm_log_2/log</code></td>
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