EMC MIGRATION OF AN ORACLE DATA WAREHOUSE

EMC Symmetrix VMAX, Virtual Provisioning, and SRDF

- Improve storage space utilization
- Simplify storage management with Virtual Provisioning
- Designed for enterprise customers

EMC Solutions Group

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Executive summary

Solution overview  At its headquarters in Hopkinton, Massachusetts, EMC IT maintains a 12 TB Oracle data warehouse, deployed on an Oracle Real Application Cluster (RAC) 11g environment. This production database was cloned, backed up, and then shipped by air from the primary data center in Hopkinton, Massachusetts to the EMC Solutions Center in Cork, Ireland. The Oracle 11g database was then restored as single instance, recovered, and upgraded to Oracle 11g R2 for test and development with storage residing on traditional thick provisioned devices. This is described in the white paper Remote Site Recovery of Oracle Enterprise Data warehouse using EMC Data Domain – a Detailed Review.

Following on from this solution, the EMC Solutions Group had a requirement to migrate the Oracle 11g R2 database to a new Symmetrix VMAX array with thin provisioned devices and convert the database from single instance to Oracle RAC. This use case technical notes document outlines the steps undertaken.

There are many factors that influence the selection of a data migration solution. Environments are diverse and migration projects are rarely identical. The process to migrate data can be complex. It requires detailed planning, co-ordination between stakeholders, and multiple steps and resources. This topic is explored in detail in the EMC TechBook: Choosing a Data Migration Solution for EMC Symmetrix Arrays.

Symmetrix Remote Data Facility (SRDF) was used to copy the data between arrays as SRDF met all the requirements for successfully migrating this environment.
Introduction

Purpose
This document provides a “how-to” which describes migrating a real-world 12 TB database from a traditional thick provisioned VMAX array, to another VMAX array utilizing thin provisioned devices. It also demonstrates the effect of zero space reclaim during the migration (previously unused storage space is reclaimed).

Scope
The technical note includes the following:

- An overview of the technologies in the solution
- Storage design
- Migration process
- Conversion of an Oracle 11g R2 database from single instance to Oracle RAC
- Validation of the migrated database

Audience
This document is intended for Oracle, storage, and server administrators who want to understand how to use SRDF as a solution for migrating an Oracle database to a different Symmetrix array using thin provisioned storage. It is assumed that the reader is familiar with the following EMC and Oracle products:

- EMC Symmetrix VMAX
- EMC Virtual Provisioning
- Oracle Database 11g R2 Enterprise Edition with Grid infrastructure
### Key technology components

<table>
<thead>
<tr>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>The solution used the following hardware and software components:</td>
</tr>
<tr>
<td>• EMC Symmetrix VMAX</td>
</tr>
<tr>
<td>• Symmetrix Management Console</td>
</tr>
<tr>
<td>• EMC PowerPath®</td>
</tr>
<tr>
<td>• Oracle Database 11g R2 Enterprise Edition</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EMC Symmetrix VMAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC Symmetrix VMAX storage is a high-end, scalable storage array comprising a system bay and separate storage bays. The system scales from a single high-availability (HA) node configuration to eight-node configurations with up to 10 storage bays.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Virtual Provisioning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overview</strong></td>
</tr>
<tr>
<td>EMC Virtual Provisioning is EMC’s implementation of thin provisioning and is designed to simplify storage management, improve capacity utilization, and enhances performance by enabling the creation of thin devices that present applications with more capacity than is physically allocated in the storage array.</td>
</tr>
<tr>
<td>Virtual Provisioning provides for the separation of physical storage devices from the storage devices as perceived by host systems. This enables nondisruptive provisioning and more efficient storage utilization.</td>
</tr>
<tr>
<td>The following concepts and components are introduced by Virtual Provisioning:</td>
</tr>
<tr>
<td>• <strong>Thin devices (TDevs)</strong> are devices that do not have storage allocated to them when they are created. Thin devices can be created with an inflated capacity, because the actual storage space for data written to them is provided by data devices (see below). To a host operating system, thin devices look like regular devices with their configured capacity, and the host interacts with them in the same way as with regular devices.</td>
</tr>
<tr>
<td>• <strong>Data devices</strong> are special devices (not mapped to the host) that provide physical storage for thin devices. Data devices must be contained in a virtual pool before they can be used.</td>
</tr>
<tr>
<td>• <strong>A virtual pool</strong> is a collection of data devices that provides storage capacity for the thin devices that are bound to the pool. All data devices in a given virtual pool share the same RAID protection level and are of the same drive technology.</td>
</tr>
<tr>
<td>Virtual Provisioning automatically stripes data across all data devices in a virtual pool, balancing the workload across physical storage devices. To ensure even striping of data, it is recommended that all data devices in a virtual pool are the same size.</td>
</tr>
<tr>
<td><strong>Note</strong> Virtual pools provide the storage tiers used by FAST VP.</td>
</tr>
<tr>
<td>Virtual Provisioning is described in detail in the <em>EMC Solutions Enabler Symmetrix Array Controls CLI Version 7.3 Product Guide</em>.</td>
</tr>
</tbody>
</table>
Considerations

Virtual Provisioning makes it possible to provision storage for applications without providing the physical storage upfront. This means that administrators can assign enough storage to last the lifetime of the application without needing to purchase all the physical storage in advance. This approach is called over-provisioning or oversubscription.

A second approach is to under-subscribe storage pools. With this methodology the total capacity of the thin devices bound to the pools is less than that of the pool while still providing the benefits of wide striping, pool sharing and faster storage provisioning.

The alternative is to pre-allocate storage to thin devices. This approach provides all the provisioned storage upfront, thin devices reserve all the provisioned space that they have been allocated upon binding to pools guaranteeing their capacity whether or not a pool is over subscribed. With Enginuity release 5875 Q2SR devices can be persistently pre-allocated meaning that even in the event of zero space reclaim on the pool that they are bound to these devices will not relinquish any storage that they have reserved even if it is unused.

Zero space reclaim and Oracle ASM

A key feature of virtual provisioning is the ability to reclaim allocated but unused space from thin pools. A reclamation activity initiates a scan of the thin pool for allocated tracks that contain all zero and returns these to the unallocated space for the thin pool marking tracks never written by host. Reclaim is effective only if unused space contains zeros, however most file systems, including Oracle ASM, do not zero out the space when allocated storage is no longer needed, for example, deleting files.

Oracle provide a utility called ASM Storage Reclamation Utility (ASRU), which is a Perl script that uses ASM commands to zero out unused space within ASM disk groups. This enables effective recovery of unused space by Virtual Provisioning zero space reclaim to thin pools. ASRU is discussed in greater detail in the white paper Implementing Virtual Provisioning on EMC Symmetrix VMAX with Oracle Database 10g and 11g—Applied Technology.

Symmetrix Remote Data Facility (SRDF)

The Symmetrix Remote Data Facility (SRDF) family of products offers a range of Symmetrix-based disaster recovery, parallel processing, and data migration solutions based on active remote mirroring.

SRDF configurations require at least two Symmetrix systems. These systems are known as the primary (R1) and the secondary (R2) system. Both sites can be located in the same room, in different buildings within the same campus, or hundreds to thousands of kilometers apart.

EMC Solutions Enabler or Symmetrix Management Console can be used to control SRDF operations.

Additional information and example commands are available in the EMC Solutions Enabler Symmetrix SRDF Family CLI Product Guide.
All SRDF migration solutions that use Enginuity versions 5773, or higher, support zero data detection. This mechanism detects whether or not a track contains all zeros prior to transmitting it to the target array. This means that thin SRDF devices at Enginuity version 5875, or higher, provide users with storage capacity savings even if the SRDF partner of the thin device is a thick SRDF device.

Figure 1 shows zero block detection employed by SRDF.

The track to be transmitted is read from the source device. Tracks that contain all zeros are not transmitted to the target site.

On the target array, the track pointer table for the R2 TDEV is marked never written by host, and no space is taken from the thin pool.

The end result is a space saving on the thin pool, as only tracks that contain data are stored in the pool.

---

**Oracle Database**

The solution involves a data warehouse on Oracle Database 11g R2 and uses features of Oracle Database 11g R2 such as Oracle Real Application Clusters (RAC) and Automatic Storage Management (ASM).

In Oracle Database 11g R2, Oracle Clusterware and Oracle ASM are part of the Oracle Grid Infrastructure software bundle. This provides the underlying clustering framework which is required to run an Oracle RAC database.
Solution architecture and design

EMC solutions are designed to reflect and validate real-world deployments. Figure 2 depicts the physical architecture of the solution described in this technical note.

![Solution architecture diagram]

**Figure 2. Solution architecture**

Table 1 details the environment profile for the solution.

**Table 1. Solution profile**

<table>
<thead>
<tr>
<th>Profile characteristic</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database type</td>
<td>Data warehouse</td>
</tr>
<tr>
<td>Database size</td>
<td>12 TB</td>
</tr>
<tr>
<td>Number of databases</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 2 details the hardware environment for the solution.

Table 2. Solution hardware environment

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Quantity</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage array (source)</td>
<td>1</td>
<td>EMC Symmetrix VMAX with:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Two engines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 256 GB cache memory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 240 x 450 GB, 15k FC drives, including spare</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Enginuity for VMAX 5875 2011Q3SR</td>
</tr>
<tr>
<td>Storage array (target)</td>
<td>1</td>
<td>EMC Symmetrix VMAX with:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Four engines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 512 GB cache memory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 32 x 200 GB, FC drives, plus spare</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 240 x 300 GB, 15k FC drives, plus spare</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 80 x 1,000 GB SATA drives, plus spare</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 64 x 600 GB 16k FC drives, plus spare</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Enginuity for VMAX 5875 2011Q3SR</td>
</tr>
<tr>
<td>Oracle Database servers</td>
<td>3</td>
<td>• 4 x eight-core Xeon 7560 CPUs, 2.26 GHz, 128 GB RAM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 2 x dual port 8 GB/s FC HBA</td>
</tr>
<tr>
<td>Network switches</td>
<td>2</td>
<td>1 Gb/s Ethernet switches</td>
</tr>
<tr>
<td>FC switches</td>
<td>2</td>
<td>8 Gb/s FC switches</td>
</tr>
</tbody>
</table>

Note For this solution, the source array is of a lower specification than the target array. This is typical in migration scenarios where the end goal is consolidation of workloads.
Table 3 details the software environment for the solution.

**Table 3. Solution software environment**

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC Symmetrix Management Console</td>
<td>7.3</td>
<td>Symmetrix VMAX configuration and management tool</td>
</tr>
<tr>
<td>EMC Solutions Enabler</td>
<td>7.3</td>
<td>Symmetrix VMAX management software</td>
</tr>
<tr>
<td>VMware vSphere</td>
<td>4.1 GA B260247</td>
<td>Hypervisor hosting management virtual machines</td>
</tr>
<tr>
<td>VMware vCenter</td>
<td>4.1 GA B259021</td>
<td>Management of VMware vSphere</td>
</tr>
<tr>
<td>Oracle Database 11g R2</td>
<td>Enterprise Edition 11.2.0.2</td>
<td>Oracle database software for grid computing</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux</td>
<td>5.5</td>
<td>Server OS for Oracle database server and management server</td>
</tr>
</tbody>
</table>

**EMC Migration of an Oracle Data Warehouse—EMC Symmetrix VMAX, Virtual Provisioning, and SRDF**
Configuring SRDF and the migration process

Overview

Both Symmetrix arrays have been configured to enable SRDF; this included the addition of RDF adapters. Additional zones were added to the fabric to allow communication between the arrays. The remaining steps are:

1. Create target devices and enable dynamic RDF capability.
2. Set up SRDF groups.
3. Set up source and target pairings, and synchronize data.
4. Configure access for hosts on the target Symmetrix.
5. Cut over to the target site.
6. Configure Oracle Grid Infrastructure.

Step 1: Create target devices and enable dynamic RDF

On the target array, devices must be created to pair with the source volumes; this was done using Solutions Enabler. SRDF requires that the target devices must be the same size or larger than the source devices. In this case, devices of the same size as the source were created. These devices are thin devices (TDev), so do not consume any actual space until written to.

Table 4 shows the device sizes and count required for each ASM disk group.

Table 4. Device sizes

<table>
<thead>
<tr>
<th>ASM disk group</th>
<th>Number of devices</th>
<th>Device size (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMP</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>FRA</td>
<td>16</td>
<td>64</td>
</tr>
<tr>
<td>REDO01</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>REDO02</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>T0_DATA01</td>
<td>16</td>
<td>129</td>
</tr>
<tr>
<td>T1_DATA01</td>
<td>80</td>
<td>129</td>
</tr>
<tr>
<td>T5_DATA01</td>
<td>40</td>
<td>129</td>
</tr>
<tr>
<td><strong>Total devices</strong></td>
<td><strong>216</strong></td>
<td></td>
</tr>
</tbody>
</table>
Figure 3 shows a logical representation of how the storage layout corresponds to the ASM diskgroups for Oracle. For illustrative purposes names have been shortened.

![Diagram showing storage groups and ASM diskgroups](image)

**Figure 3.** Storage groups and ASM diskgroups

All devices have been created with the dynamic RDF capability, as shown in Figure 4. This means that the devices can serve as either R1 (source) or R2 (target) devices, providing flexibility. In addition, no pre-allocation of storage was done upfront for any devices except for the device to be used for Oracle REDO logs.

```
# symconfigure -sid 292 -cmd "create dev count=136, size=129056 mb, emulation=FBA, config=TDEV, mvs_ssid=0, dynamic_capability=dyn_rdf binding to pool 3RAID5_FC15K," commit=nop
```

**Figure 4.** Creating dynamic RDF TDev

Figure 5 shows the command used to create devices for the REDO ASM disk groups. It is recommended that these devices are fully pre-allocated on creation, using persistent allocation; this ensures that all storage is available upfront. If a zero space reclaim is run on the pool at any stage, these devices will not have any of their pre-allocated capacity returned to the pool's free space.

```
# symconfigure -sid 292 -cmd "create dev count=32, size=8066 mb, emulation=FBA, config=TDEV, mvs_ssid=0, dynamic_capability=dyn_rdf, binding to pool RAID1_FC15K, preallocate size=all, allocate_type=persistent;" preview
```

**Figure 5.** Creating fully allocated devices

Since the devices on the target array are configured to be RDF-capable from the outset, there is no further configuration needed on these devices; however on the source side, the dynamic_rdf capability had to be added to the devices. This was achieved with the set attribute flags for the SYMCLI symconfigure command. Refer to the symconfigure help file for more information.
Once devices were created, device identifiers were then added. These make administration easier by setting a meaningful name against the device. This can be viewed by the administrator and at the host accessing the devices with the `inq` toolset. Figure 6 shows labels being applied to one of the DATA ASM disk groups.

```
# symconfig -sid 292 -cmd "set dev 033B:034A device_name=TO_DATA01;"
commit -nop
```

**Figure 6. Labeling Symmetrix devices**

**Step 2: Set up SRDF groups**

An SRDF group defines the logical relationship between SRDF devices and SRDF directors on both sides of the SRDF links. It comprises a range of SRDF devices and SRDF directors that reside on a given Symmetrix system. These RDF groups must be configured by the storage administrator before creating RDF replica pairs. This is shown in Figure 7. For this solution, on both arrays directors 7 and 8 were used.

```
# symrdf -sid 292601853 addgrp -label dwmigrate -rdfg 1 -dir 7h -remote_rdfg 1 -remote_sid 000292602292 -remote_dir 7h
# symrdf -sid 292601853 modifygrp -rdfg 1 -dir 8h -add
```

**Figure 7. Creating RDF group**

**Step 3: Create SRDF pairings file**

Once the RDF group has been created, a pairs file needs to be created to configure the source and target pairings for the replication. The output from Figure 8 can be used to build this file. A section of the pairs file is shown in Figure 9.

```
# symdev list -identifier device_name

| Source Array | | Target Array |
|--------------|------------------------|
| Sym Config   | Attr Device Name       | Sym Config   | Attr Device Name |
| 0050 RAID-5  | TO_DATA01              | 033B TDEV    | TO_DATA01        |
| 0051 RAID-5  | TO_DATA01              | 033C TDEV    | TO_DATA01        |
| 0052 RAID-5  | TO_DATA01              | 033D TDEV    | TO_DATA01        |
```

**Figure 8. List of devices on arrays**
On the right are the target devices, which are the newly created thin devices on the target array. A sample of the text file used in this solution is shown in Figure 9.

![Example text file](image)

**Figure 9. Example text file**

When the preparation work is completed, the migration was started. These steps are an overview of how to set up the device pairings:

1. The `createpair` command was run to set up RDF relationships between the source and target devices listed in the command file.

2. The syntax shown in Figure 10 sets up the relationship and begins copying data from R1 to R2.

3. The RDF mode of operation has also been set to adaptive copy disk mode; this will ensure that there is no noticeable impact to any host I/O as a result of the copy process.

**Note** For more information on SRDF modes of operation, refer to the *EMC® Solutions Enabler Symmetrix® SRDF® Family CLI Product Guide.*

![Set up RDF relationships](image)

**Figure 10. Set up RDF relationships**

An Auto-provisioning masking view was configured to enable access to the thin provisioned devices.

**Note** Prior to creating the masking view, additional zoning on switches was also put in place to allow connectivity between the server HBAs and storage ports of the array.

Figure 11 shows the creation of the masking view on the target VMAX.

The masking view has three main components:

1. **Storage group:** containing all devices in migration, plus five additional 5 GB devices used for CRS and Voting.

2. **Initiator group:** containing all HBA WWNs for target servers.

3. **Port group:** containing all VMAX front-end ports to be utilized by the cluster.

![Create masking view](image)

**Figure 11. Create masking view**
For ease of management, a device group was created and all RDF devices involved in the migration were added to it, as shown in Figure 12.

```
# symdg create Oracle_DW -type RDF1
# symld -g Oracle_DW addall -rdff 1 -sid 1853
```

**Figure 12. Add RDF devices to device group**

The device group can be queried periodically to check on the status of the migration, by using the `verify` command, as shown in Figure 13.

```
# symrdf -g Oracle_DW verify -synchronized -i 30

All of the devices in the group 'Oracle_DW' are in 'synchronized' state
```

**Figure 13. Verify status of migration**

Once all devices were in a synchronized state, as shown in Figure 13, the Oracle instance was shut down and the `symrdf split` command was issued to enable host access on the R2 devices on the target array. The cluster nodes on the target side were rebooted to detect devices.
The Oracle 11g R2 Grid Infrastructure software was installed on the target server. This install included the Oracle Clusterware and ASM binaries, configuration of an Oracle ASM instance, and startup of the Oracle listener. A normal redundancy ASM disk group, CRS, was created to hold the OCR and voting disks. This is shown in Figure 14.

![ASM Configuration Assistant](image)

**Figure 14. Confirm ASM configuration for Oracle Clusterware**

**Oracle ASM disk group configuration**

As the server had already been rebooted, the masked devices were detected by the operating system and were visible to the ASM instance. Once it was confirmed that the ASM disks and disk groups were correctly detected using the ASM Configuration Assistant, the disk groups were mounted. This is shown in Figure 15.

![ASM Configuration Assistant](image)

**Figure 15. ASM Configuration Assistant**
Converting single instance Oracle 11g R2 database to RAC

Once the RAC-enabled Oracle 11g R2 binaries were installed, the single instance database was converted to an Oracle RAC database using the Oracle rconfig utility. These steps explain the process:

1. Create an initODWT.ora file with a single parameter pointing to the existing spfile: +ODWT_T1_DATA01/spfileODWT.ora
2. Start up the single instance database.
3. Edit and save a copy of the rconfig instruction file: $ORACLE_HOME/assistants/rconfig/sampleXMLs/ConvertToRAC.xml. The required and amended parameter values in the xml file are shown in Table 5.

![Table 5. rconfig parameter values](image)

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convert verify</td>
<td>&quot;YES&quot;</td>
</tr>
<tr>
<td>SourceDBHome</td>
<td>/u01/app/oracle/product/11.2.0.2/dbhome_1</td>
</tr>
<tr>
<td>TargetDBHome</td>
<td>/u01/app/oracle/product/11.2.0.2/dbhome_1</td>
</tr>
<tr>
<td>SourceDBInfo SID</td>
<td>&quot;ODWT&quot;</td>
</tr>
<tr>
<td>User</td>
<td>Sys</td>
</tr>
<tr>
<td>Password</td>
<td>xxxxx1xxxx</td>
</tr>
<tr>
<td>Role</td>
<td>Sysdba</td>
</tr>
<tr>
<td>Node name</td>
<td>&quot;tce-r910-ora05&quot;</td>
</tr>
<tr>
<td>InstancePrefix</td>
<td>ODWT</td>
</tr>
<tr>
<td>SharedStorage type</td>
<td>“ASM”</td>
</tr>
</tbody>
</table>

4. Run the rconfig utility at the command line and monitor the output, as shown in Figure 16.
5. Check the configuration of the Oracle database. Figure 17 shows the output of a SQL script used to validate the layout of the converted RAC database for comparison against the source system.
After conversion and validation of the Oracle 11g R2 RAC database, the following tasks were completed:

- A second node was added to the cluster
- A second instance was added Oracle RAC database

Detailed steps for the process used are in the white paper: *Maximize Operational Efficiency for Oracle RAC with EMC Symmetrix FAST VP (Automated Tiering) and VMware vSphere.*
Space utilization following migration

Displaying storage utilization post-migration

Figure 18 shows the storage usage of the thin devices on the target array following the migration.

Note The actual space allocated from the thin pools is 7 TB less than the total capacity subscribed.

Figure 18. Storage usage of thin devices
Figure 19 shows the amount of storage space consumed to store data for the EMC IT data warehouse in a traditional thick provisioned environment versus the thin provisioned environment, as shown in Figure 20.

**Figure 19. Storage consumed pre-migration**

Although the same capacity of storage is provisioned at the target site, only tracks which contain data at the target site consume physical storage. The result is a more space-efficient use of the storage on the thin provisioned array with 37% less storage consumed.

**Figure 20. Storage space reclaimed post-migration**
Conclusion

Summary

This document describes how SRDF can be used to migrate a large Oracle RAC 11g data warehouse from a traditional storage deployment on Symmetrix storage using thick devices, to a new VMAX array using thin provisioned storage. The source database was 12 TB in size with approximately 19 TB of storage allocated.

During the migration, SRDF automatically detected zero data blocks on the source devices, marking these tracks as never written on the target storage array. This reduced the actual storage consumed on the target array, 37 percent of the total provisioned storage was reclaimed as a result.

The migration has led to more efficient storage deployment using pooled resources, and the potential for a greater consolidation of more applications onto a single VMAX storage array.

Migrating to thin provisioning has paved the way for automated tiering of data with FAST VP. This enables automatic tiering of sub-LUN data between thin pools to optimize workload performance based on data access patterns and user-defined polices. In data warehouse environments where data is often partitioned, FAST VP ensures that the most active data is always tuned for optimal performance, with zero downtime and no disruption to the production environment.
References

White papers
For additional information, see the white papers listed below.

- Remote Site Recovery of Oracle Enterprise Data Warehouse Using EMC Data Domain — A Detailed Review
- Maximize Operational Efficiency for Oracle RAC with EMC Symmetrix FAST VP (Automated Tiering) and VMware vSphere
- Best Practices for Fast, Simple Capacity Allocation with EMC Symmetrix Virtual Provisioning Technical Note
- Implementing Virtual Provisioning on EMC Symmetrix VMAX with Oracle Database 10g and 11g — Applied Technology

Product documentation
For additional information, see the product documents listed below.

- EMC Solutions Enabler Symmetrix SRDF Family CLI Product Guide
- EMC Solutions Enabler Symmetrix Array Management CLI Product Guide
- EMC TechBook: Choosing a Data Migration Solution for EMC Symmetrix Arrays

Other documentation
For additional information, see the third-party documents listed below.

- Oracle Grid Infrastructure Installation Guide 11g Release 2 (11.2) for Linux
- Oracle Real Application Clusters Installation Guide 11g Release 2 (11.2) for Linux
- Oracle Database Installation Guide 11g Release 2 (11.2) for Linux
- Oracle Database Storage Administrator’s Guide 11g Release 2 (11.2)
- Oracle Real Application Clusters Administration and Deployment Guide 11g Release 2 (11.2)
- Oracle Clusterware Administration and Deployment Guide 11g Release 2 (11.2)