An Oracle White Paper

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Oracle Database Cloning Solution Using Oracle Recovery Manager, Oracle’s Data Guard, and Oracle’s Pillar Axiom 600 Storage System
Executive Overview

Oracle’s Pillar Axiom 600 storage system is certified for support of a number of Oracle Database features including Oracle Hybrid Columnar Compression, Oracle Data Guard, and Oracle Recovery Manager (RMAN). These elements present an ideal solution setting for rapid Oracle Database operation and cloning.

Oracle’s Pillar Axiom 600 storage system provides a robust enterprise-class storage platform for mission-critical Oracle Databases. It also excels at running multiple tiers of applications such as for production, development, testing and QA, all in a single storage system. By prioritizing data access and dynamically managing any I/O contention, the Pillar Axiom 600 storage system dramatically simplifies the management and maintenance of storage and increases storage utilization without sacrificing performance for a mission-critical Oracle Database.

With its patented Quality of Service (QoS) capability, the Pillar Axiom 600 facilitates policy-based sharing of storage resources, prioritizing data access and dynamically managing any I/O contention. Pillar Axiom’s QoS changes can be made dynamically without disrupting a live Oracle Database or Oracle Automatic Storage Management instance.

Oracle’s Pillar Axiom 600 storage system can be easily added to an existing Data Guard or Oracle RMAN configuration to provide a highly scalable, highly efficient solution that simplifies the creation of an Oracle Database copy. This document will outline methodology to make a copy of an Oracle database using Pillar Axiom storage.
Introduction

Managing production Oracle Database instances as well as the additional need for periodic application development and testing, customers need an easy-to-manage solution to quickly and efficiently provide duplicates of the Oracle Database. The challenges are many.

- Multiple clones are required of each production Oracle Database to support the ongoing development and associated testing of production systems.
- Duplicated Oracle Databases must be refreshed frequently to enable testing to be performed on the latest version of the Oracle Database.
- Any process used to duplicate the Oracle Database must have no performance impact on the production Oracle Database.

A classic method of creating a copy of the Oracle Database is to restore the Oracle Database from a recent backup to a different Oracle Database server. This approach can waste resources and can be extremely time consuming. This inefficient solution leaves companies saddled with a substantial administrative burden that diverts attention away from more time-critical support functions.

Often database operations are all running on a single legacy storage array. Thus it is very likely that lower priority development or test activity will adversely impact the other production instances. In severe cases the impact can be significant causing huger performance problems. With these legacy disk arrays there isn’t a way to prioritize IO streams so all IO streams competes for the same resource. That is a low-priority process and a critical production process are given equal time on the controller and this contention introduces performance problems. Oracle’s Pillar Axiom 600 storage system solves this problem by using priority-based QOS storage management to mitigate resource contention.

Oracle’s Pillar Axiom 600 storage system is able to optimize performance based on application priority derived from policies set by the administration user. Through the use of its patented QoS capability, the Pillar Axiom 600 facilitates policy-based sharing of storage resources, CPU, capacity, and cache, based on the applications’ I/O requirements. This architecture effectively prioritizes resources for efficient conflict management. Further, the Pillar Axiom provides application-aware profiles for Oracle Databases with Automatic Storage Management. QoS allows flexibility to fine tune IO for data files, redo logs, archive logs, and control files dynamically.

The Pillar Axiom 600 storage system is the perfect match when considering Oracle Database cloning options. Using Oracle Data Guard or Oracle RMAN in conjunction with the sample scripts and workflows described in this paper, the entire cloning procedure can be automated and executed efficiently in a repeatable fashion.
About This Document

This document describes two methods to create a duplicate instance (copy) of a production Oracle Database using advanced features of the Pillar Axiom Storage system. These methods differ based on the solution setup.

- **Method 1** - Cloning a production Oracle Database managed by Oracle Automatic Storage Management and Oracle RMAN on a Pillar Axiom 600 storage system.

- **Method 2** – Clone a standby database instance when using Oracle’s Data Guard on a Pillar Axiom 600 storage system.

This document includes best practices and scripts tested by Oracle to automate the database cloning operation to quickly set up one or more test instances. These solutions place little or no additional overhead on the production systems.

The following operating system and Oracle Database versions are supported when using the solutions described in this document.

**TABLE 1. VERSIONS**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VERSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>Oracle Solaris 10 operating system and higher</td>
</tr>
<tr>
<td></td>
<td>(SPARC or x86)</td>
</tr>
<tr>
<td></td>
<td>Oracle Linux 4.x, 5.x, and higher</td>
</tr>
<tr>
<td></td>
<td>Red Hat Enterprise Linux 4.x, 5.x, and higher</td>
</tr>
<tr>
<td>Oracle Database</td>
<td>Oracle Grid Infrastructure, RDBMS 11.2.0.3 and higher</td>
</tr>
<tr>
<td></td>
<td>Oracle Database 11.2.0.3 Enterprise Edition with Oracle Hybrid Columnar Compression</td>
</tr>
<tr>
<td></td>
<td>Production: Single instance/Oracle Real Application Clusters (Oracle RAC), Oracle Automatic Storage Management or no Oracle Automatic Storage Management</td>
</tr>
<tr>
<td></td>
<td>Clone: Single instance</td>
</tr>
<tr>
<td></td>
<td>Data Guard, a feature of Oracle Active Data Guard</td>
</tr>
<tr>
<td></td>
<td>Oracle Recovery Manager</td>
</tr>
<tr>
<td>Storage</td>
<td>Oracle's Pillar Axiom 600 storage system</td>
</tr>
<tr>
<td>Protocol</td>
<td>Fibre Channel, iSCSI</td>
</tr>
<tr>
<td>Standby and Cloned Database</td>
<td>Sharing the same host</td>
</tr>
<tr>
<td></td>
<td>Sharing the same host as that of another standby host</td>
</tr>
<tr>
<td></td>
<td>Standby and cloned instances on separate hosts</td>
</tr>
</tbody>
</table>

Oracle Hybrid Columnar Compression is enabled when run on Oracle Database 11.2.0.3 Enterprise Edition and later Oracle Database hosts with Oracle Automatic Storage Management and Oracle RDBMS Patch Set 10404530.
Audience

This document is written for Oracle Database administrators, storage/system administrators, and technical sales personnel. It is assumed that the reader is familiar with the Oracle Active Data Guard and Oracle Recovery Manager functionality concepts.

About Oracle’s Pillar Axiom 600 Storage System

Architecture Overview

Oracle’s Pillar Axiom 600 storage system dramatically improves application deployment, facilitating rapid access to data by using a fundamentally different approach:

Intelligent algorithms dynamically adapt to application requirements

Oracle’s Pillar Axiom 600 storage system has a patented QoS-based architecture that works with administrator-defined policies to create a robust, efficient, and easy-to-manage enterprise storage system.

Scaling to accommodate growing performance and capacity demands

A virtualized storage pool allows live expansion of the system, while continuing storage services to address the business requirements. Horizontal scaling by additional controllers provides more CPU and Port bandwidth. Vertical scaling by additional storage shelves from 1 to 64 (Bricks) provides capacity and IO performance increases. This approach to storage dramatically simplifies data management as the system is scaled to meet growing demands.

Intuitive management tools to reduce administrative workload

QoS settings may be saved as Custom Application Profiles and reused to quickly provision storage for new or additional instances of any given application. Replication, data services, copy services, capacity planning, and a host of other enterprise features provide a complete, powerful software environment for enterprise network storage deployments.

The Pillar Axiom 600 storage system is an ideal solution for Oracle Database deployments providing industry-leading capacity utilization without sacrificing performance. This means consolidation of
Oracle Database Cloning Solution with Oracle’s Pillar Axiom 600 Storage System

storage onto a single system—all while maintaining the performance levels the business needs. With industry-leading storage utilization capability, the Pillar Axiom 600 storage system delivers more performance and storage capacity per watt of system power than similar products from other “green” storage vendors. The result is simply more storage for less cost.

For more information: http://www.oracle.com/goto/axiom

Concepts and Terminology

CloneLUN — A point-in-time, read-write, partial-block snapshot of a LUN that can be accessed immediately. A CloneLUN is created as sparse and uses almost no physical space initially. Blocks are written to the CloneLUN repository when there are changes to the source LUN.

Volume Copy — Block-level, full-image copy of a LUN or volume. This LUN copy can be read from and written to immediately throughout the copy process. QoS parameters for a Volume Copy can differ from the original. Copies use the available storage in the system.

Notes:

• When a CloneLUNs are used, it is recommended that the CloneLUN repository size is set at a value 2-4 times (or more) the size of the source LUN depending on the number of CloneLUNs required for that LUN.

• Performance/efficiency tradeoff: For performance advantage, leverage Volume Copy to create separate LUNs; for capacity efficiency, use CloneLUN.

Oracle Hybrid Columnar Compression is available with Pillar Axiom SAN storage. It achieves its compression using a logical construct called the compression unit, which is used to store a set of hybrid columnar-compressed rows. When data is loaded, a set of rows is pivoted into a columnar representation and compressed. After the column data for a set of rows has been compressed, it is fit into the compression unit. If conventional data manipulation language (DML) is issued against a table with Oracle Hybrid Columnar Compression, the necessary data is uncompressed to do the modification and then written back to disk using a block-level compression algorithm in the system.

Oracle Recovery Manager (Oracle RMAN) is an Oracle Database utility that backs up, restores, and recovers Oracle Databases. The incrementally updated backup feature of Oracle RMAN is a powerful backup utility that can be used to merge incremental changes made in an Oracle Database into a
backup Oracle Database, thereby providing a single up-to-date version of the backup data that can be used for many purposes.

**Oracle Data Guard** configuration consists of one production Oracle Database and one or more standby Oracle Databases. The Oracle Databases in a Data Guard configuration are connected by Oracle Net Services and may be dispersed geographically. There are no restrictions on where the Oracle Databases are located, provided they can communicate with each other. For example, there can be a standby Oracle Database on the same system as the production Oracle Database.
Oracle Database Cloning Architecture and Procedure

Strategy Overview

Each method outlines a procedure to create a copy of a database instance using a separate destination application server. Oracle Database 11gR2 with patches are assumed using Oracle’s Pillar Axiom 600 storage system.

Method 1: Oracle RMAN Backup to an Oracle Automatic Storage Management Disk Group

Use Pillar Axiom’s CloneLUN features to create a Secondary Instance copy using the RMAN backup diskgroup to incrementally update Oracle Database using Automatic Storage Management (ASM) managed LUNs.
Method 2: Clone of Data Guard Physical Standby Using Pillar Axiom’s Cloning Feature

Use Pillar Axiom’s 600 CloneLUN feature to create a Test Instance from the Standby instance of a Database.

Storage Configurations

**TABLE 2. TEST CONFIGURATION**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VERSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>Oracle Linux 6 U2 2.6.32-300.3.1.el6uek.x86_64</td>
</tr>
<tr>
<td>Oracle Database</td>
<td>RDBMS 11.2.0.3 Enterprise Edition with Oracle Hybrid Columnar Compression; Patch Set 10404530</td>
</tr>
<tr>
<td>Oracle Automatic Storage Management /Oracle Grid Infrastructure</td>
<td>11.2.0.3, Patch Set 10404530</td>
</tr>
<tr>
<td>Storage</td>
<td>Oracle’s Pillar Axiom 600 storage system; SAN-5.3, Build 050303-006800</td>
</tr>
<tr>
<td>Multipathing Software</td>
<td>Pillar AxiomONE Path Manager (APM), Version 3.2</td>
</tr>
<tr>
<td>Host Bus Adapter</td>
<td>Qlogic QLE2462</td>
</tr>
<tr>
<td>SAN Fabric</td>
<td>Brocade 7500</td>
</tr>
</tbody>
</table>
Method 1: Oracle RMAN Backup to an Oracle Automatic Storage Management Disk Group

Oracle RMAN Deployment Scenario

This scenario describes the methodology for cloning an Oracle Database using Oracle’s Pillar Axiom 600 storage system in conjunction with Oracle RMAN utility. Oracle RMAN utility is used for creating and managing the backup of a database. The CloneLUN features of the Pillar Axiom 600 storage system are then utilized to create a copy the newly created Oracle RMAN backup to update a second instance.

Architecture and Procedure

Outline of Methodology

- Set up an Oracle Database managed by Oracle Automatic Storage Management on the destination host with the same Oracle Automatic Storage Management disk groups and capacities as the production system using the Pillar Axiom SAN storage.
- Create an Oracle Automatic Storage Management disk group on the Pillar Axiom from the production system named RMAN.
- Perform a Level 0 RMAN backup to the 'RMAN' Oracle Automatic Storage Management location.
- Perform a CloneLUN of the RMAN Oracle Automatic Storage Management disk(s) and map to the destination host.
- Discover these new LUN(s) on the destination host.
- Perform an oracleasm scandisk on the destination system to discover the RMAN disk(s) and 'mount' the Oracle Automatic Storage Management diskgroup.
- Recover the RMAN backup on the destination system.

Procedure Steps:

1. Using the Pillar Axiom Storage Manager GUI, create the LUNs. Note: This example uses a single LUN for the Oracle Automatic Storage Management diskgroup "RMAN," but multiple LUNs can also be used.
2. Map the LUNs to the Production Host (or Host Group) using the Data Protection tab use two to four times the size of the LUN for the CloneLUN repository.
3. As root user, scan for the new LUN and discover, verify the LUID by correlating the output of multipath -ll with the Axiom ID
   
   $ /sbin/multipath -ll | grep Pillar | awk '{print $1}' | sort

4. Create the Oracle Automatic Storage Management diskgroup.
Oracle Database Cloning Solution with Oracle's Pillar Axiom 600 Storage System

a. Label the disk with oracleasm

$ /etc/init.d/oracleasm createdisk RMAN /dev/mapper/<LUID from previous step>

b. Scan and list the oracleasm disks on each node

$ /etc/init.d/oracleasm scandisks ; /etc/init.d/oracleasm listdisks

c. Create the ASM diskgroup

5. Create the necessary directories on the RMAN diskgroup.

6. Perform the RMAN backup.

   a. Perform RMAN datafile backup copy (see appendix for script details)
   
   b. Perform RMAN archivelog backup copy

7. Perform CloneLUNs with Pillar Axiom GUI and map the CloneLUNs to the remote host.

8. Discover the LUN on the remote host.
   Attention: Verify the LUID by correlating the output of multipath -ll with the Axiom LUID from the GUI listing.

9. Scan for the New LUN and verify the LUID.
   Scan and list the oracleasm disks on each node by:

   $ /etc/init.d/oracleasm scandisks ; /etc/init.d/oracleasm listdisks

10. List the oracleasm disks:

    ls -l /dev/oracleasm/disks/*

    Add the LUN to ASM, mount the disk group and verify

11. Backup the production controlfile to trace and modify the tracefile.
    Create a pfile from the spfile on the production database with the clone database name. For example initclone1.ora

    Edit the init<SID>.ora on the destination host
    Globally change the database ID / SID with the name of the new database.
    (clone1)

    Create any directories that are defined in the init<SID>.ora

    $ mkdir -p /u01/app/oracle/admin/clone1/adump

12. Edit the trace control file and name create_control.sql
    Globally replace the source Database ID / SID with the intended destination SID.
    Modify the beginning of the sql script with
    
    CREATE CONTROLFILE REUSE SET DATABASE clone1 RESETLOGS ARCHIVELOG
    
    Modify the datafile locations in the create_control sql script to match the RMAN ASM location.

13. Set the environmental variable for ORACLE_SID
[oracle@desthost~]$ export ORACLE_SID=clone1

14. Connect as the sysdba user and recover the database

   [oracle@desthost ~] sqlplus /nolog
   SQL> connect / as sysdba
   SQL> startup nomount pfile='<path to init<SID>.ora>
   SQL> @create_control.sql
   SQL> recover database until cancel using backup controlfile;
   Note: When you are prompted for archivelogs for recovery, use the location
   of the archivelog threads on +RMAN, or a local copy of the archivelogs
   (not the suggested archivelog).

15. When the archivelogs necessary for recovery have been applied, open the database with resetlogs.
   SQL> alter database open resetlogs;

16. Perform Oracle Database post-creation steps to harden the database, multiplex control files, create
   and backup spfiles, init<SID>.ora and password files.
Method 2: Clone of Data Guard Physical Standby Using Pillar Axiom’s Cloning Feature

Data Guard Deployment Scenario

This scenario describes the methodology for cloning a standby Oracle Database using Oracle’s Pillar Axiom 600 storage system in conjunction with Oracle Data Guard software feature. The Data Guard physical standby Oracle Database is cloned by halting redo services and then performing Axiom CloneLUN functions on each of the LUNs used.

The simplest configuration would utilize the Pillar Axiom 600 storage system for both the primary Oracle Database and the standby Oracle Database. However, Data Guard’s inherent flexibility allows the use of using Oracle’s Pillar Axiom 600 storage system for the standby Oracle Database system (target) and the use of any another vendor’s storage array for the primary Oracle Database (source). Used in this way, Oracle’s Pillar Axiom 600 storage system can be added to existing Data Guard environments without disruption. The Oracle instance managing the standby Oracle Database may be deployed on the same server or on a different server than the existing standby Oracle Database(s).

A new standby Oracle Database, dedicated to supporting cloning operations, is created on the target Pillar Axiom 600 storage system (Data Guard supports up to 30 standby Oracle Databases in a single Data Guard configuration). Once established, redo services are suspended, and a clone of the LUNs/Oracle Automatic Storage Management disks managed by Oracle Automatic Storage Management is created yielding a copy of the Oracle Database at that point in time. Redo services are resumed and the cloned standby Oracle Database is activated and converted, enabling it to be used for test, development or QA.

Architecture and Procedure

Outline of Methodology

• Set up a destination system using the patched version of Oracle Grid Infrastructure/RDBMS that enables Oracle Hybrid Columnar Compression on Pillar Axiom SAN storage.
• Create Pillar Axiom storage LUNs with appropriate size to handle the capacity of the Oracle Database.
• Create a physical standby Oracle Database on the destination system.
• Configure the destination standby Oracle Database to receive redo and monitor the redo transport status to determine when the production and standby are in sync.
• Halt the Redo transport to the standby and duplicate the LUNs of the Data Guard Standby using Pillar Axiom’s cloning feature.
• Enable Redo transport.
• Map the cloned LUN to the destination system.
• Scan and present the LUNs to the destination and perform an oracleasm scandisk to discover the Oracle Automatic Storage Management disks. Mount the Oracle Automatic Storage Management diskgroups.
• Convert the destination from a physical standby Oracle Database to a standalone Oracle Database.

Procedure Steps:

Configure the Destination (Note: This is a one-time setup process.)

1. Install Oracle Linux 6.x on host server. Update all of the packages if out of date.
2. Prepare the operating system for the Oracle Automatic Storage Management and RDBMS install:
   Oracle® Grid Infrastructure Installation Guide
   Oracle® Database Installation Guide
3. Create LUNs of a similar number and capacity to match the production system and map these LUNS to the destination host.
4. Scan and discover the LUNs on the destination host.
5. Perform “createdisk” using /etc/init.d/oracleasm for the “+DATA” disks/disk groups in preparation for the grid/ASM install.
6. Install Grid Patch Request 14125322 11.2.0.3.0 PATCH SET FOR ORACLE DATABASE SERVER
7. Create the remaining oracleasm disk groups to match production.
8. Install Database/RDBMS Patch Request 14125322 11.2.0.3.0 PATCH SET FOR ORACLE DATABASE SERVER
9. Patch the RDBMS and the Oracle Automatic Storage Management product with patch 13041324 to enable Oracle Hybrid Columnar Compression. See details in the appendix.
10. Using Oracle Recovery Manager (Oracle RMAN), duplicate the primary production Oracle Database to the standby location.
11. Set up Oracle’s Data Guard or Oracle Active Data Guard and establish real-time replication between the primary and new standby sites.
12. Enable the managed recovery procedure. If you are using Oracle Database 11g Release 2 (or higher), you can also establish cascaded standby.

Oracle Database Cloning Procedure

1. Stop the managed recovery to place the standby Oracle Database in a consistent state.
2. From the Pillar Axiom 600, Volume Copy (LUN Copy) the LUNs belonging to the standby Oracle Database and map to the destination host.
3. Resume the managed recovery of the standby Oracle Database.
4. Rescan and discover the new LUNs and correlate to the LUIDs reported by the Pillar Axiom.

Recover the Standby Clone on the Same Host as the Data Guard Standby Procedure

1. Write a unique signature (Oracle Automatic Storage Management disk name) to the new LUNs using /etc/init.d/oracleasm force-rename (this is only necessary when the same host is used for the Standby and the Standby Clone).

2. Verify the force-rename with /etc/init.d/oracleasm listdisks

3. Rename the oracle ASM disk groups with the "grid" tool
   [grid~]$ORACLE_HOME/bin/renamedg

4. Mount the disk groups with $ORACLE_HOME/bin/sqlplus as sysasm

5. Verify the new disk groups.

6. Convert the cloned standby Oracle Database into a read/write Oracle Database for test, development, and QA.
Conclusion:

Advantages of Deploying Oracle Databases Using Oracle’s Pillar Axiom 600 Storage System

Using the combination of Oracle Recovery Manager, Oracle Data Guard, and Oracle’s Pillar Axiom 600 storage system is an efficient solution to duplicating mission-critical Oracle Databases.

Oracle’s Pillar Axiom 600 storage system can be easily added to an existing Data Guard/Oracle RMAN configuration to provide a highly scalable, highly efficient solution that addresses the requirements for creating clones of a production Oracle Database. Furthermore, Pillar Axiom’s QoS changes can be made dynamically without disrupting a live Oracle Database or Oracle Automatic Storage Management instance. With unlimited cloning possibilities, many concurrent Oracle Database instances can be launched for various purposes without impacting the production Oracle Database.

Oracle’s Pillar Axiom 600 storage system provides a robust enterprise-class storage platform for mission-critical Oracle Databases, but it also excels at running multiple tiers of applications (including development, testing and QA) all in a single storage system. With its patented QoS capability, the Pillar Axiom 600 facilitates policy-based sharing of storage resources, prioritizing data access, and dynamically managing any I/O contention. This dramatically simplifies the management and maintenance of the storage, increases storage utilization, and ensures that the mission-critical production Oracle Databases/applications will always be performing optimally under varying workloads.
Appendix

Sample Scripts: Oracle RMAN Backup to an Oracle Automatic Storage Management Disk Group

Create a Diskgroup

- Create the LUN(s) and map to a host or host group.
  This example uses a single LUN for the Oracle Automatic Storage Management diskgroup "RMAN", but multiple LUNs/Oracle Automatic Storage Management disks could also be used.

- From the Axiom GUI ---> Configure ---> Storage ---> LUNs

- Map to the Host or Host Group, and under the Data Protection tab, give two to four times the size of the LUN for the CloneLUN repository.

Scan for the New LUN and Discover

- As the root user

  /etc/init.d/axiompmd stop
  /etc/init.d/multipathd restart
  /etc/init.d/axiompmd start
  for i in {0..10}
    do
      echo '---' > /sys/class/scsi_host/host$i/scan
    done
  /sbin/multipath -ll | grep Pillar | awk '{print $1}' | sort

  Attention: Verify the LUID by correlating the output of multipath -ll with the Axiom ID

  - Create the ASM diskgroup
  - Label the disk with oracleasm as root.

    $/etc/init.d/oracleasm createdisk RMAN /dev/mapper/<LUID from previous step>

Scan and list the oracleasm disks on each node

    $ /etc/init.d/oracleasm scandisks ; /etc/init.d/oracleasm listdisks
Create the Oracle Automatic Storage Management diskgroup as the "grid" user

```
[grid@host ~]$ $ORACLE_HOME/bin/sqlplus / as sysasm
CREATE DISKGROUP RMAN EXTERNAL REDUNDANCY
DISK '/dev/oracleasm/disks/RMAN*';
```

Note: Alter the attributes of the diskgroup if being used for HCC on Axiom SAN storage.

```
ALTER diskgroup RMAN SET attribute 'compatible.ASM' = '11.2.0.3.0';
ALTER diskgroup RMAN SET attribute 'compatible.rdbms' = '11.2.0.3.0';
ALTER diskgroup RMAN SET attribute 'storage.type' = 'AXIOM';
```

As the "grid" user create the necessary directories on the RMAN diskgroup.

```
[grid@host ~]$ /u01/app/11.2.0/grid/bin/asmcmd
ASMCMD [+RMAN] > mkdir rman_master
ASMCMD [+RMAN] > mkdir rman_master/<DBNAME>
ASMCMD [+RMAN] > mkdir rman_master/<DBNAME>/datafiles
ASMCMD [+RMAN] > mkdir rman_master/<DBNAME>/archive
```

Perform the Oracle RMAN backup

- Perform RMAN datafile backup copy
- As the "oracle" user, run:

```
[oracle@host ~]$ rman
Oracle Recovery Manager: Release 11.2.0.3.0 - Production on Tue Mar 20 13:45:12 2012
Copyright (c) 1982, 2011, Oracle and/or its affiliates. All rights reserved.
RMAN> connect target /
connected to target database: OASTDB (DBID=4139577790)
RMAN> configure controlfile autobackup on;
run {
    configure device type disk parallelism 8 backup type to copy;
allocation channel ch1 device type disk format
    '+RMAN/rman_master/%d/datafiles/datafile_%f.dbf';
allocation channel ch2 device type disk format
    '+RMAN/rman_master/%d/datafiles/datafile_%f.dbf';
allocation channel ch3 device type disk format
    '+RMAN/rman_master/%d/datafiles/datafile_%f.dbf';
allocation channel ch4 device type disk format
    '+RMAN/rman_master/%d/datafiles/datafile_%f.dbf';
allocation channel ch5 device type disk format
    '+RMAN/rman_master/%d/datafiles/datafile_%f.dbf';
allocation channel ch6 device type disk format
    '+RMAN/rman_master/%d/datafiles/datafile_%f.dbf';
allocation channel ch7 device type disk format
    '+RMAN/rman_master/%d/datafiles/datafile_%f.dbf';
allocation channel ch8 device type disk format
    '+RMAN/rman_master/%d/datafiles/datafile_%f.dbf';
backup incremental level 1 for recover of copy with tag 'axiom_clone'
database reuse;
recover copy of database with tag 'axiom_clone';
}
```
Perform Oracle RMAN archivelog backup copy

```sql
'alter system archive log current';
run {
    configure device type disk parallelism 8 backup type to copy;
    allocate channel ch1 device type disk format
        '+RMAN/rman_master/%d/archive/%h_%e_%a.arc';
    allocate channel ch2 device type disk format
        '+RMAN/rman_master/%d/archive/%h_%e_%a.arc';
    allocate channel ch3 device type disk format
        '+RMAN/rman_master/%d/archive/%h_%e_%a.arc';
    allocate channel ch4 device type disk format
        '+RMAN/rman_master/%d/archive/%h_%e_%a.arc';
    allocate channel ch5 device type disk format
        '+RMAN/rman_master/%d/archive/%h_%e_%a.arc';
    allocate channel ch6 device type disk format
        '+RMAN/rman_master/%d/archive/%h_%e_%a.arc';
    allocate channel ch7 device type disk format
        '+RMAN/rman_master/%d/archive/%h_%e_%a.arc';
    allocate channel ch8 device type disk format
        '+RMAN/rman_master/%d/archive/%h_%e_%a.arc';
    BACKUP AS COPY skip inaccessible (archivelog all) ;
}
```

Perform Volume Copy (LUN Copy) and map to the remote host

- From the Axiom GUI ---> Configure ---> Storage ---> LUNs
- Right Click on the LUN(s) used for the RMAN backup and choose Copy LUN.
- Give the CopyLUN a descriptive name and under the Mapping tab map the CopyLUN to the destination host.

Discover the LUN on the remote host

- As the root user, issue these commands:

  ```bash
  $ /etc/init.d/axiompmd stop
  $ /etc/init.d/multipathd restart
  $ /etc/init.d/axiompmd start
  $ for i in {0..10} do
        echo '---' > /sys/class/scsi_host/host$i/scan
    done
  $ /sbin/multipath -ll | grep Pillar | awk '{print $1}' | sort
  
  Attention: Verify the LUID by correlating the output of `multipath -ll` with the Axiom LUID from the GUI.

- Scan For the New LUN and Verify the LUID

- As the root user, issue this command set:

  ```bash
  $/etc/init.d/axiompmd stop
  $/etc/init.d/multipathd restart
  ```
$/etc/init.d/axiompmmd start
$for i in {0..10}
do
echo '- - -' > /sys/class/scsi_host/host$i/scan
done
/sbin/multipath -ll | grep Pillar | awk '{print $1}' | sort

Attention: Verify the LUID by correlating the output of multipath -ll with the Axiom

☐ Scan and list the oracleasm disks on each node.

$ /etc/init.d/oracleasm scandisks ; /etc/init.d/oracleasm listdisks

☐ List the oracleasm disks:

$ ls -l /dev/oracleasm/disks/*

☐ Add the LUN to ASM and verify

☐ Modify the asm_diskstring

☐ As the "grid" user

[grid@host~]$ $ORACLE_HOME/bin/sqlplus / as sysasm
SQL> alter system set asm_diskstring = '/dev/oracleasm/disks/*';
System altered.
SQL> show parameter asm_diskstring
NAME TYPE VALUE
------------------ -------- -----------------------------------------------
asm_diskstring string /dev/oracleasm/disks/*

☐ Stop and Start ASM

As the "grid" user on the destination host, run these commands:

/u01/app/grid/product/11.2.0/grid/bin/srvctl stop asm -o immediate -f
/u01/app/grid/product/11.2.0/grid/bin/srvctl start asm

☐ Mount the ASM diskgroup

☐ As the "grid" user on the destination host, run this command sequence:

[grid@desthost ~]$ $ORACLE_HOME/bin/sqlplus / as sysasm
SQL> alter diskgroup RMAN mount;
Check the diskgroup attributes:
select dg.name as DG_NAME, at.name as ATR_NAME, at.value as ATR_VALUE from v$asm_diskgroup dg, V$asm_attribute at
where at.group_number(+)=dg.group_number
order by DG_NAME
Set the asm_diskstring back to the default value
[grid@host~]$ $ORACLE_HOME/bin/sqlplus / as sysasm
SQL> alter system set asm_diskstring = '/dev/oracleasm/disks';
System altered.
SQL> show parameter asm_diskstring
Oracle Database Cloning Solution with Oracle’s Pillar Axiom 600 Storage System

<table>
<thead>
<tr>
<th>NAME</th>
<th>TYPE</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>asm_diskstring</td>
<td>string</td>
<td>/dev/oracleasm/disks</td>
</tr>
</tbody>
</table>

- Recover the Database Using the RMAN Backup on the Remote Host
- On the source database, generate a human readable controlfile and init<SID>.ora and copy to the "oracle" working directory of destination host.

```sql
SQL> connect / as sysdba
Connected.
SQL> alter database backup controlfile to trace;
Database altered.
SQL> create pfile='/tmp/initclone1.ora' from spfile;
File created.
```

- Edit the init<SID>.ora on the destination host
- Globally change and database ID / SID the name of the new database. (clone1)
- Create any directories that are defined in the init<SID>.ora

```
$ mkdir -p /u01/app/oracle/admin/clone1/adump
```

- Edit the trace control file and name create_control.sql
- Globally replace the source Database ID / SID with the intended destination SID.
- Modify the beginning of the sql script with

```
CREATE CONTROLFILE REUSE SET DATABASE clone1 RESETLOGS ARCHIVELOG
```

- Modify the datafile locations in the create_control sql script to match the RMAN ASM location.
- Set the environmental variable for ORACLE_SID

```
[oracle@desthost~]$ export ORACLE_SID=clone1
```

- Connect as the sysdba user and recover the database

```
[oracle@desthost ~] sqlplus /nolog
SQL> connect / as sysdba
SQL> startup nomount pfile='<path to init<SID>.ora>'
SQL> @create_control.sql
SQL> recover database until cancel using backup controlfile;
```

Note: When you are prompted for archivelogs for recovery you need to use the location of the archivelog threads on +RMAN, or a local copy of the archivelogs. (not the suggested archivelog)

- When the archivelogs necessary for recovery have been applied, open the database with resetlogs.

```
SQL> alter database open resetlogs;
```
Perform Oracle database post creation steps to harden the database, multiplex control files, create and backup spfiles, init<SID>.ora and password files.

Sample Scripts: Data Guard

Set up the environment for the Data Guard Clone database on the destination server

- Install the OS and supporting packages.
- Install Oracle Grid Infrastructure with the Oracle Automatic Storage Management disk groups that match the primary system.
- Install the Oracle RDBMS product.

For further details, please refer to:

Oracle® Data Guard Concepts and Administration 11g Release 2 (11.2)

Oracle® Data Guard Broker 11g Release 2 (11.2)

Configure the Source Oracle Database for Data Guard

- Set up Oracle’s Data Guard or Oracle Active Data Guard and establish real-time replication between the primary and new standby sites.

```
log_archive_dest_2= 'service=OASTDB_DR async
db_unique_name=OASTDB_DR valid_for=(primary_role,online_logfile)'
log_archive_config= 'dg_config=(OASTDB,OASTDB_DR)'
log_archive_dest_state_2= DISABLE
```

Configure the Destination for Oracle’s Data Guard

- Enable the managed recovery procedure. If you are using Oracle Database 11g Release 2 (or higher), you can also establish cascaded standby.

```
OASTDB_DR
==============
*db_files=200
*db_keep_cache_size=256M
*db_name='OASTDB'
*db_unique_name='OASTDB_DR'
*fal_client='OASTDB_DR'
*fal_server='OASTDB'
*file_systemio_options='SETALL'
*instance_name='OASTDB_DR'
*java_pool_size=16M
*large_pool_size=16M
*log_archive_dest_2='service=OASTDB async db_unique_name=OASTDB valid_for=(primary_role,online_logfile)'
```
Clone the Data Guard Standby by Cloning the Oracle Automatic Storage Management Disks

Halt the redo apply to the standby Oracle Database:

SQL> ALTER DATABASE RECOVER MANAGED STANDBY DATABASE CANCEL;

Clone the LUNs being used by ASM on the standby system and map to the host:

[root@cofunintel06 ~]# /root/clone_luns.sh OASTDB_DR
axiomcli clone_lun -add -name Clone20120324OASTDB_DR_DATA000 -source /OASTDB_DR_DATA000 -active
NewObject
  Id : 4130303132343042A104B03F03C08D7C
  Fqn : /Clone20120324OASTDB_DR_DATA000
Command Succeeded

axiomcli clone_lun -add -name Clone20120324OASTDB_DR_FRA000 -source /OASTDB_DR_FRA000 -active
NewObject
  Id : 4130303132343042A104B040380A6E56
  Fqn : /Clone20120324OASTDB_DR_FRA000
Command Succeeded

[root@cofunintel06 ~]# /root/map_clone_luns.sh OASTDB_DR cofunintel03
axiomcli hostmap -add -lun /Clone20120324OASTDB_DR_DATA000 -lunNumber 254 -host /cofunintel03.us.oracle.com
Oracle Database Cloning Solution with Oracle’s Pillar Axiom 600 Storage System

NewObject
  Id : 4130303132343042A12FB04299987319
  Fqn :
  /Clone20120324OASTDB_DR_DATA000/10000000C9766654

NewObject
  Id : 4130303132343042A12FB042999AE0D5
  Fqn :
  /Clone20120324OASTDB_DR_DATA000/10000000C9766655

NewObject
  Id : 4130303132343042A12FB0429996887E
  Fqn :
  /Clone20120324OASTDB_DR_DATA000/1qf.1988-12.com.oracle:a7fcc1c1f8f8
Command Succeeded
axiomcli hostmap -add -lun /Clone20120324OASTDB_DR_FRA000 -lunNumber 253 -host /counintel03.us.oracle.com
NewObject
  Id : 4130303132343042A12FB0436F768D6D
  Fqn :
  /Clone20120324OASTDB_DR_FRA000/10000000C9766654

NewObject
  Id : 4130303132343042A12FB0436F94620A
  Fqn :
  /Clone20120324OASTDB_DR_FRA000/10000000C9766655

NewObject
  Id : 4130303132343042A12FB0436FABB373
  Fqn :
  /Clone20120324OASTDB_DR_FRA000/iqf.1988-12.com.oracle:a7fcc1c1f8f8
Command Succeeded

Rename disk (will create disknames under /dev/oracleasm/disks location)

[root@cofunintel03 ~]# /etc/init.d/oracleasm force-renamedisk
/dev/mapper/2000b0800650001240 CLONE1_DATA
Renaming disk "/dev/mapper/2000b0800650001240" to "CLONE1_DATA"
[root@cofunintel03 ~]# /etc/init.d/oracleasm force-renamedisk
/dev/mapper/2000b0800660001240 CLONE1_FRA
Renaming disk "/dev/mapper/2000b0800660001240" to "CLONE1_FRA"

Rename diskgroup using renamedg

[grid@cofunintel03 ~]$ renamedg phase=BOTH dgname=DATA newdgname=CLONEDATA
asm_diskstring='/dev/oracleasm/disks/CLONEDATA' verbose=TRUE
NOTE: No asm libraries found in the system
Parsing parameters..
Parameters in effect:
  Old DG name : DATA
  New DG name : CLONEDATA
  Phases :
    Phase 1
    Phase 2
  Discovery str : /dev/oracleasm/disks/CLONEDATA
  Clean : TRUE
  Raw only : TRUE
renamedg operation: phase=BOTH dgname=DATA newdgname=CLONEDATA
asm_diskstring=/dev/oracleasm/disks/CLONEDATA/CLONEDATA verbose=TRUE
Executing phase 1
Discovering the group
Performing discovery with string:/dev/oracleasm/disks/CLONEDATA
Identified disk UFS:/dev/oracleasm/disks/CLONEDATA with disk number:0 and
timestamp (32967916 40923136)
Checking for heartbeat...

[grid@cofuninte103 ~]$ renamedg phase=BOTH dgname=FRA newdgname=CLONEFRA
asm_diskstring='/dev/oracleasm/disks/CLONEFRA' verbose=TRUE

NOTE: No asm libraries found in the system

Parsing parameters..

Parameters in effect:
- Old DG name : FRA
- New DG name : CLONEFRA
- Phases:
  - Phase 1
  - Phase 2
- Discovery str : /dev/oracleasm/disks/CLONEFRA
- Clean : TRUE
- Raw only : TRUE

renamedg operation: phase=BOTH dgname=FRA newdgname=CLONEFRA
asm_diskstring='/dev/oracleasm/disks/CLONEFRA' verbose=TRUE

Executing phase 1

Discovering the group
Performing discovery with string:/dev/oracleasm/disks/CLONEFRA
Identified disk UFS:/dev/oracleasm/disks/CLONEFRA with disk number:0 and
timestamp (32967918 1012560896)
Checking for heartbeat...
Re-discovering the group
Performing discovery with string:/dev/oracleasm/disks/CLONEFRA
Identified disk UFS:/dev/oracleasm/disks/CLONEFRA with disk number:0 and
timestamp (32967918 1012560896)
Checking if the diskgroup is mounted or used by CSS
Checking disk number:0
Generating configuration file..
Completed phase 1
Executing phase 2
Looking for /dev/oracleasm/disks/CLONEFRA
Modifying the header
Completed phase 2
Terminating kgfd context 0x7fc95b3bf0a0
Mount the new diskgroups

Start the clone instance with nomount (have the initclone1.ora ready)

Create and Edit a pfile for the clone1 database.

[oracle@cofuninte103 ~]$ sqlplus /nolog
SQL*Plus: Release 11.2.0.3.0 Production on Fri Mar 30 13:29:44 2012
Copyright (c) 1982, 2011, Oracle. All rights reserved.
Connected to:
Oracle Database 11g Enterprise Edition Release 11.2.0.3.0 - 64bit Production
With the Oracle Automatic Storage Management option
SQL> alter diskgroup CLONEFRA mount;
Diskgroup altered.
SQL> alter diskgroup CLONEDATA mount;
Diskgroup altered.
Edit initclone1.ora and modify for clone1.
Create any directories referenced in the pfile.
[oracle@cofuninte103 ~]$ export ORACLE_SID=clone1
[oracle@cofuninte103 ~]$ sqlplus /nolog
SQL*Plus: Release 11.2.0.3.0 Production on Fri Mar 30 13:24:37 2012
Copyright (c) 1982, 2011, Oracle. All rights reserved.
SQL> connect / as sysdba
Connected to an idle instance.
SQL> startup nomount pfile='/home/oracle/initclone1.ora';
ORACLE instance started.
Total System Global Area 4275781632 bytes
Fixed Size 2235208 bytes
Variable Size 2617246904 bytes
Database Buffers 1644167168 bytes
Redo Buffers 12132352 bytes

Run the Create Controlfile with New Datafile Location

Note: In this example the LUNs for the REDO log groups were not cloned. Thus the Oracle Database was opened with “RESETLOGS.”

SQL> STARTUP NOMOUNT
SQL> CREATE CONTROLFILE REUSE DATABASE clone1 RESETLOGS FORCE LOGGING
ARCHIVELOG
MAXLOGFILES 320
MAXLOGMEMBERS 5
MAXDATAFILES 1024
MAXINSTANCES 32
MAXLOGHISTORY 292
LOGFILE
GROUP 1 {
   '+CLONEDATA/oastdb_dr/onlinelog/group_1.269.778696299',
   '+CLONEDATA/oastdb_dr/onlinelog/group_1.269.778696301'
} SIZE 500M BLOCKSIZE 512,
GROUP 2 {
   '+CLONEDATA/oastdb_dr/onlinelog/group_2.268.778696303',
   '+CLONEDATA/oastdb_dr/onlinelog/group_2.268.778696305'
} SIZE 500M BLOCKSIZE 512
DATAFILE
'+CLONEDATA/oastdb_dr/datafile/system.256.778696253',
'+CLONEDATA/oastdb_dr/datafile/sysaux.257.778696253',
'+CLONEDATA/oastdb_dr/datafile/undotbs1.258.778696277',
'+CLONEDATA/oastdb_dr/datafile/undotbs2.259.778696277',
'+CLONEDATA/oastdb_dr/datafile/undotbs3.260.778696285',
'+CLONEDATA/oastdb_dr/datafile/undotbs4.261.778696285',
'+CLONEDATA/oastdb_dr/datafile/users.262.778696291'
CHARACTER SET WE8MSWIN1252
;

Open the Clone Instance with Resetlogs
SQL> alter database open resetlogs;
Database altered.
SQL> select * from v$instance;
INSTANCE_NUMBER INSTANCE_NAME
Oracle Database Cloning Solution with Oracle’s Pillar Axiom 600 Storage System

<table>
<thead>
<tr>
<th>HOST_NAME</th>
<th>VERSION</th>
<th>STARTUP_T</th>
<th>STATUS</th>
<th>PAR</th>
<th>THREAD#</th>
<th>ARCHIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>------------</td>
<td>---------</td>
<td>-----------</td>
<td>--------</td>
<td>-----</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>cofunintel03.us.oracle.com</td>
<td>11.2.0.3.0</td>
<td>25-MAR-12</td>
<td>OPEN</td>
<td>NO</td>
<td>1</td>
<td>STARTED</td>
</tr>
<tr>
<td>ALLOWED</td>
<td>NO</td>
<td>ACTIVE</td>
<td>PRIMARY_INSTANCE</td>
<td>NORMAL</td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>

Oracle Hybrid Columnar Compression on Oracle’s Pillar Axiom Storage System

To enable Oracle Hybrid Columnar Compression on Pillar Axiom storage system for SAN, refer to Note: http://docs.oracle.com/cd/E11882_01/server.112/e18951/asmdiskgrps.htm

For Oracle Hybrid Columnar Compression to be enabled, the Oracle Automatic Storage Management/Oracle Grid Infrastructure product must be at 11.2.0.3 with Patch Set 10404530. Oracle Automatic Storage Management then needs alter statements to be applied to each disk group. The first two alter statements 'compatible.ASM' and 'compatible.rdbms’ enable advanced features of Oracle Automatic Storage Management and 'storage.type' = 'AXIOM' enables Oracle Hybrid Columnar Compression on Pillar Axiom SAN storage.

For example:

```
ALTER diskgroup DATA SET attribute 'compatible.ASM' = '11.2.0.3.0';
ALTER diskgroup DATA SET attribute 'compatible.rdbms' = '11.2.0.3.0';
ALTER diskgroup DATA SET attribute 'storage.type' = 'AXIOM';
The only Oracle Database alter that is needed is:
ALTER SYSTEM SET compatible = "11.2.0.3.0" SCOPE=SPFILE;
```
Note: An Oracle Automatic Storage Management and Oracle Database backup of an Oracle Hybrid Columnar Compression-enabled Oracle Database will retain the settings upon recovery. If compatible = "11.2.0.3.0" has been set on the source Oracle Database, then Oracle Hybrid Columnar Compression will be available upon recovery of a properly patched destination.

Oracle’s Pillar Axiom 600 Storage System – Features/Specifications

### TABLE 3. ORACLE’S PILLAR AXIOM 600 STORAGE SYSTEM SOFTWARE FEATURES

<table>
<thead>
<tr>
<th>INCLUDED FEATURES</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pillar Axiom Quality of Service</td>
<td>Prioritization of I/Os via multiple queues to align performance with an application’s business value</td>
</tr>
<tr>
<td>Pillar Axiom MaxMan</td>
<td>Management of multiple Pillar Axiom systems via a single pane of glass</td>
</tr>
<tr>
<td>Oracle Axiom Storage Connect</td>
<td>“Phone home” capability with automatic case creation, configurable alerts</td>
</tr>
<tr>
<td>Pillar Axiom Distributed RAID</td>
<td>Dual redundant RAID controllers embedded in every disk enclosure (Pillar Axiom Brick) to scale IOPS linearly, based on capacity, and deliver fast rebuilds</td>
</tr>
<tr>
<td>Oracle Hybrid Columnar Compression</td>
<td>Supported with Oracle Database hybrid columnar compression, a combination of both row and columnar methods for storing data</td>
</tr>
<tr>
<td>Pillar Axiom CLI</td>
<td>Scriptable interface to allow for automation of common functions</td>
</tr>
<tr>
<td>Pillar Axiom Software Path Management</td>
<td>Multipath host support with failover; supported platforms: Windows, Linux, Oracle Solaris, HP-UX, AIX</td>
</tr>
<tr>
<td>Pillar Axiom SMI Provider</td>
<td>Oracle’s implementation of the Storage Management Initiative Specification (SMI-S)</td>
</tr>
<tr>
<td>Pillar Axiom Data Protection Manager</td>
<td>Leveraging of Microsoft Volume Shadow Copy Service to enable automatic creation of application-consistent snapshots</td>
</tr>
<tr>
<td>File-level protocol</td>
<td>NFS v2/v3 for UDP and TCP, CIFS over TCP</td>
</tr>
<tr>
<td>Block-level protocol</td>
<td>iSCSI, FC</td>
</tr>
<tr>
<td>Remote management</td>
<td>SSH, SNMP v1/v2c, SMTP</td>
</tr>
<tr>
<td>Network services</td>
<td>NTP, DHCP, SMTP</td>
</tr>
<tr>
<td>Backup</td>
<td>NDMP v3/v4</td>
</tr>
</tbody>
</table>

**OPTIONAL FEATURES (LICENSED SEPARATELY)**

<table>
<thead>
<tr>
<th>INCLUDED FEATURES</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pillar Axiom Copy Services Bundle</td>
<td>CloneLUN, CloneFS, volume copy, File System Snapshot, and SnapDelta File System features</td>
</tr>
<tr>
<td>Pillar Axiom SecureWORMfs</td>
<td>Write once, read many for secure, compliant archiving solutions</td>
</tr>
<tr>
<td>Pillar Axiom Storage Domains</td>
<td>Ability to create multiple virtual storage environments from the same pool</td>
</tr>
<tr>
<td>Pillar Axiom MaxRep Replication for SAN</td>
<td>Synchronous and asynchronous replication, with or without application protection</td>
</tr>
<tr>
<td>Pillar Axiom MaxRep Replication for NAS</td>
<td>Asynchronous replication</td>
</tr>
</tbody>
</table>

1. All storage resource management software is compatible with the currently shipping hardware platform: the Pillar Axiom 600 release 4.3 and 5.0.
### TABLE 4. ORACLE’S PILLAR AXIOM 600 STORAGE SYSTEM SPECIFICATIONS

<table>
<thead>
<tr>
<th>FEATURES</th>
<th>SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Controller Cache</td>
<td>48 GB to 192 GB</td>
</tr>
<tr>
<td>Storage Controller Units</td>
<td>2 to 8 Controller Units, Active-Active</td>
</tr>
<tr>
<td>RAID Controllers</td>
<td>2 to 128 RAID Controllers</td>
</tr>
<tr>
<td>Storage Capacity</td>
<td>12 to 832 drives (3.6 TB to 1.6 PB)</td>
</tr>
<tr>
<td>Drives Supports:</td>
<td>• FC: 300 GB, 600 GB, 15,000 rpm</td>
</tr>
<tr>
<td></td>
<td>• SSD: 50 GB, 200 GB</td>
</tr>
<tr>
<td></td>
<td>• SATA-II: 2 TB, 7,200 rpm</td>
</tr>
<tr>
<td>Host Interfaces</td>
<td>Pillar Axiom SAN Slammer</td>
</tr>
<tr>
<td></td>
<td>• Four 4 Gbps or 8 Gbps FC interfaces</td>
</tr>
<tr>
<td></td>
<td>Pillar Axiom iSCSI Slammer</td>
</tr>
<tr>
<td></td>
<td>• Four 1 GbE interfaces for iSCSI host attachments</td>
</tr>
<tr>
<td></td>
<td>Pillar Axiom NAS Slammer</td>
</tr>
<tr>
<td></td>
<td>• Eight 1 Gb or four 10 GbE interfaces for client network connectivity</td>
</tr>
<tr>
<td></td>
<td>• Optional FC card for tape connectivity</td>
</tr>
<tr>
<td></td>
<td>Pillar Axiom iSCSI Combo Slammer</td>
</tr>
<tr>
<td></td>
<td>• Four 1 GbE interfaces, four 4 Gbps or 8 Gbps FC interfaces</td>
</tr>
<tr>
<td>Host Supported Protocols</td>
<td>• SAN FC protocol iSCSI protocol</td>
</tr>
<tr>
<td></td>
<td>• NAS NFS V2/V3 over UDP or TCP, CIFS, NDMP</td>
</tr>
</tbody>
</table>
Resources

Oracle Database 11g Release 2

Oracle’s Data Guard Documentation

Oracle Recovery Manager (Oracle RMAN)

Pillar Axiom 600 Storage System Documentation

http://docs.oracle.com/cd/E26030_01/index.html

Oracle SAN Storage Overview

http://www.oracle.com/technetwork/server-storage/san-storage/overview/index.html

How We Improved SAN and NAS Performance with Hybrid Columnar Compression